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G.I.-30 SEPT. 1976

GEOCRES No. 40P2-A9

DIST. 2 REGION

W.P. No. 510-90-01

CONT. No. 92-18

W. O. No.

STR. SITE No. 23-442

HWY. No. 401

LOCATION Hwy 401 & Cedar Creek N/S-W Ramp

No of PAGES - 2

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 510-90-01 DIST 2

HWY 401 STR SITE 23-442

Cedar Creek N/S-W Ramp Bridge

CONT 92-18

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GEOCRES 40P2-49 DATE JUN 12 1991

FOUNDATION INVESTIGATION REPORT
For
Cedar Creek N/S-W Ramp Bridge
W.P. 510-90-01, Site No. 23-442
Hwy. 401, District 2, London

INTRODUCTION

This report contains the results of a site investigation carried out at the above mentioned site to provide information for the design and construction of the proposed bridge at the Cedar Creek crossing.

The field work for this project was carried out between 91 04 04 and 91 04 08, and comprised of two sampled boreholes and Dynamic Cone Penetration Test adjacent to these holes.

Boreholes were advanced to a maximum depth of 18.7 m below the existing ground level (El. 266.2 m) using a 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 between Hwy. 401 and Athlone Avenue in the City of Woodstock.

The topography of the site with the exception of the existing crossings at Hwy. 401 and Cedar Creek and Athlone Avenue and Cedar Creek (embankments), and the flood plain of the Creek is generally undulating with drumlins to the south. The site as well as the alignment of the Creek was modified to the present condition by the construction of the existing bridges and prior to the construction of these bridges, the Creek was meandering at this location. Physiographically the area is located in the region known as the "Oxford Till Plain".

SUBSURFACE CONDITIONS

The underlying subsoil at this site consists of compact to loose alluvial sand with varying proportions of gravel and silt underlain by stiff to very stiff clayey silt with occasional sand and silt seams. The clayey silt layer is underlain by very dense sand with varying proportions of gravel and silt which overlies the limestone bedrock. For classification purposes, the soils encountered at this site can be divided in to six different zones.

a) Organic Silt, some Sand
b) Sandy Gravel, trace of Silt
c) Sand to Sandy Silt, trace of Gravel
d) Clayey Silt
e) Gravelly Sand, some Silt
f) 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 profile is shown on Drawing No. 5109001-A. This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

Initially, it was planned to widen the bridge at the crossing of Hwy. 401 and Cedar Creek, and to provide information for the design of foundation, a site investigation was carried out in April of 1990. The Record of Borehole sheets of this investigation are also appended to this report.

Organic Silt, some Sand

This organic silt with varying proportions of sand was encountered immediately below the existing ground level. The east side of the creek is slightly marshy and the organic content was observed to be more on this side. The thickness of this deposit varies from 1.1 m to 1.3 m and extends to elevation 283.8 m to 283.6 m.

Sandy Gravel, trace of Silt

This alluvial sandy gravel layer was encountered immediately below the organic silt deposit. The thickness of this layer varies from 1.1 m to 2.3 m and extends to elevation 281.3 m to 282.7 m. The results of the Gradation Test carried out on representative soil samples are shown on Figure 1 in an envelope form. These test results indicate 48% to 58% gravel, 32% to 49% sand and 3% to 10% silt. The Standard Penetration Test results were observed to vary between 12 blows/0.3 m and 22 blows/0.3 m and these results indicate that this stratum is in a compact state of compaction.

Sand to Sandy Silt, trace of Gravel

The sandy gravel deposit is underlain by this stratum. The thickness of this layer varies from 3.6 m to 4.2 m and extends to elevation 278.5 m to 277.7 m. The result of Gradation Test carried out on representative soil samples are shown on Figure 2 and this result indicates 0% to 15% gravel, 47% to 80% sand and 5% to 53% silt. The Standard Penetration Test results were observed to vary between 7 blows/0.3 m and 21 blows/0.3 m. These test results indicate loose to compact state of compaction.

Clayey Silt

The sand to sandy silt deposit is underlain by this clayey stratum. The thickness of this layer varies from 2.8 m to 3.6 m and extends to elevation 274.9 m. Occasional sand and silt seams varying in thickness from a few millimetres to a maximum of 0.4 m were also intercepted in this stratum. The natural moisture content was observed to vary from 18.0% to 18.5%. The Atterberg Limits determined for the representative soil samples of this deposit are shown on Figure 3. The Standard Penetration Test results were observed to vary from 6 blows/0.3 m to 15 blows/0.3 m. However, the in situ Vane Shear Test results were observed to vary from 65 kPa to over 100 kPa. The shear strength values indicate stiff to very stiff consistency.

Gravelly Sand, some Silt

The clayey silt is underlain by this deposit. The thickness of this deposit varies from 4.7 m to 5.2 m and extends to elevation 270.2 m to 269.7 m. The Grain Size Distribution Test results are shown on Figure 4 in an envelope form. These results indicate about 5% to 30% gravel, 45% to 79% sand and 14% to 28% silt. The Standard Penetration Test results indicate that this stratum is in very dense state of compaction (N-values 58 blows/0.3 m to over 100 blows/0.3 m).

Bedrock

The project area is underlain by limestone bedrock of the Detroit River Group. The thickness of the weathered rock was observed in the range of 200 mm to 400 mm and the elevation of the unweathered rock is expected to be in the depth range of elevation 270.0 m to 269.3 m.

The RQD values measured from BX size cores (0% to 31%) indicate that the bedrock up to the depth of coring may be classified as very poor to poor quality rock.

The detail description of the bedrock is included in the Appendix of this report.

Groundwater Conditions

The groundwater level was observed at or near the creek water level (elevation 284.0 m). However, artesian condition was encountered at about elevation 269.5 m in the fractured zone of the bedrock on the east side of the creek and the water level rose to about 0.2 m above the existing ground level (ie elevation 285.1 m). Seasonal fluctuation of the groundwater level may be expected. The groundwater level at each borehole location is as follows:

Borehole No.	Elevation	Remarks
101	284.0 m	Water level rose to 0.2 m above ground level (i.e. elevation 285.1 m)
102	284.0 m	

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to accommodate one future lane on either side of Hwy. 401 without widening the bridge at the crossing of Cedar Creek. As a part of this plan, the existing N/S-W Ramp will be relocated and this will involve construction of a new bridge at the crossing of Cedar Creek and the new ramp.

The proposed bridge will be a single span reinforced concrete integral abutment structure. The clear span between the face of the abutment will be about 25.4 m. The profile grade of the ramp is set at about elevation 289.5± m. The new structure will be located approximately 20 m north of the existing bridge at the crossing of Hwy. 401 and Cedar Creek.

Structure Foundations

Considering the subsoil conditions at this site and high water level, it is recommended that the abutments and wing walls be supported on steel H-piles driven to bedrock which will be encountered around elevation 270.0 m.

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

	HP310x110	HP310x79
Factored Bearing Capacity at U.L.S.	1600 kN	1150 kN
Bearing Capacity at S.L.S. Type II	1150 kN	900 kN

Earth pressure should be computed as per Section 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.

	Granular 'A'	Granular 'B'
Angle of Internal Friction	ϕ = 35°	ϕ = 30°
Unit Weight (kN/m^3)	γ = 22.8	γ = 21.2

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

Approach Embankment

The proposed finished grade of the N/S-W Ramp is set at about elevation 289.5± m and the maximum height of approach fill above the existing ground level will be about 5.0 m. If the fill height is limited to 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. In addition, the organic silt and other soft materials on both sides of the creek should be subexcavated up to a depth of about 1.9 m to 1.3 m below the existing ground level before the placement of fill.

Other Considerations

The pile tips should be reinforced with pile driving shoe as per MTO Standard. The pile caps for the closed-end abutments at this site will have to be constructed below the creek water level which may be expected to fluctuate. Considering the presence of sandy gravel to sandy material up to the anticipated depth of excavation, a gravity drainage system may be used for dewatering during construction.

MISCELLANEOUS

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

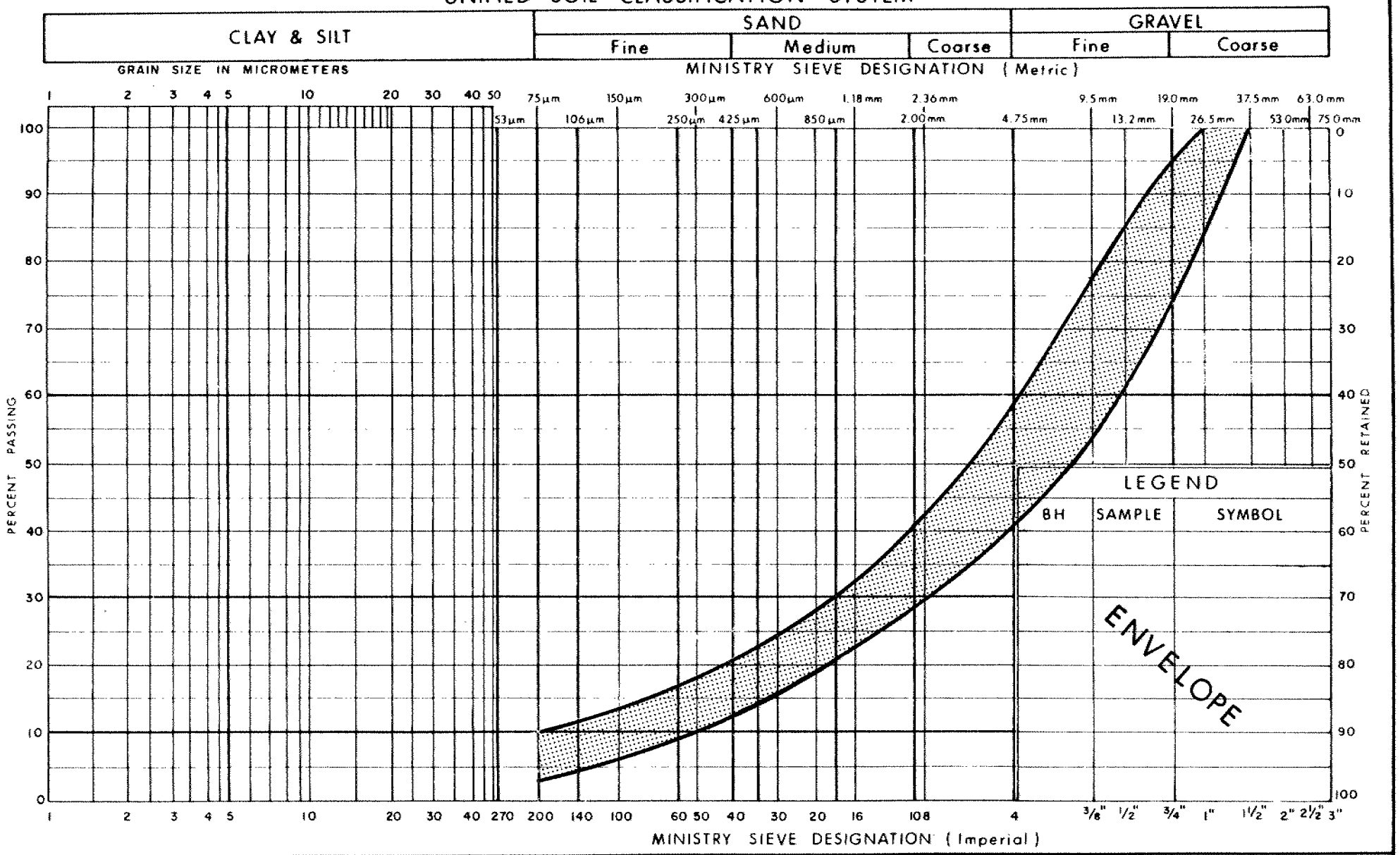
M. Vasavithasan, P.Eng.
Foundation Engineer

M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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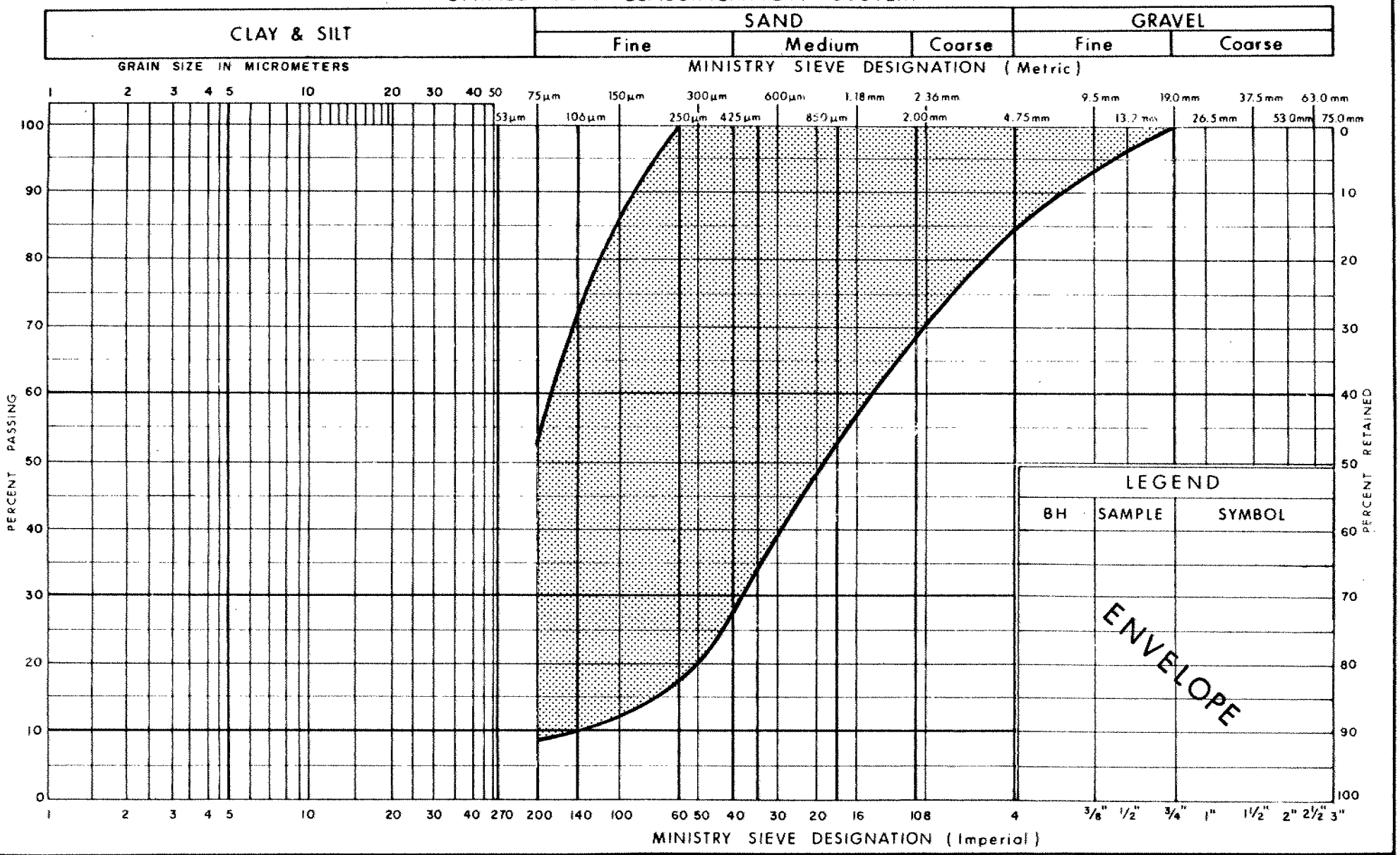
GRAIN SIZE DISTRIBUTION

SANDY GRAVEL, TRACE OF SILT

FIG No 1

W P 510-90-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
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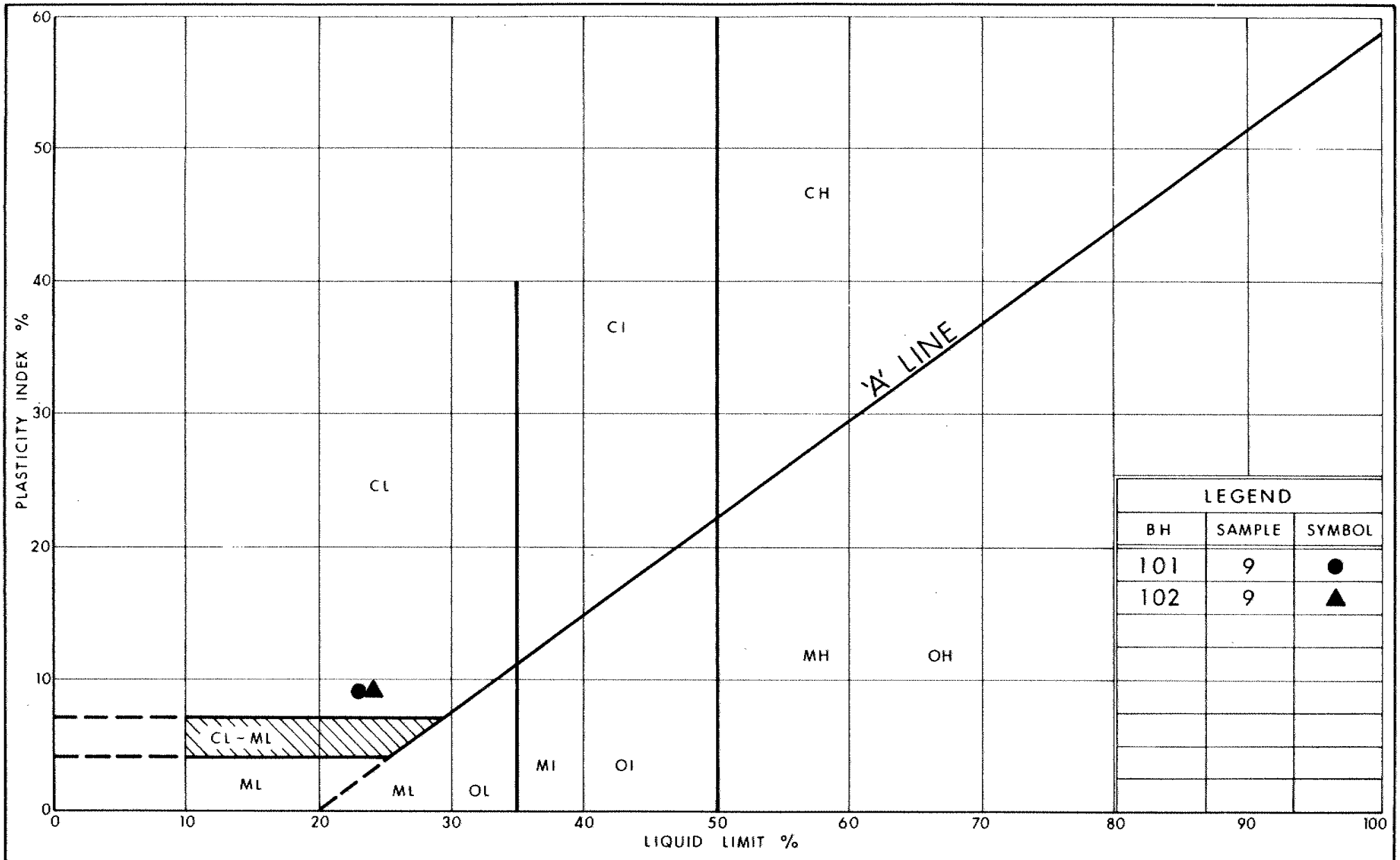
GRAIN SIZE DISTRIBUTION
SAND TO SANDY SILT
SOME/TRACE GRAVEL

FIG No 2

W P 510-90-01

Oct 75, FF-S-21



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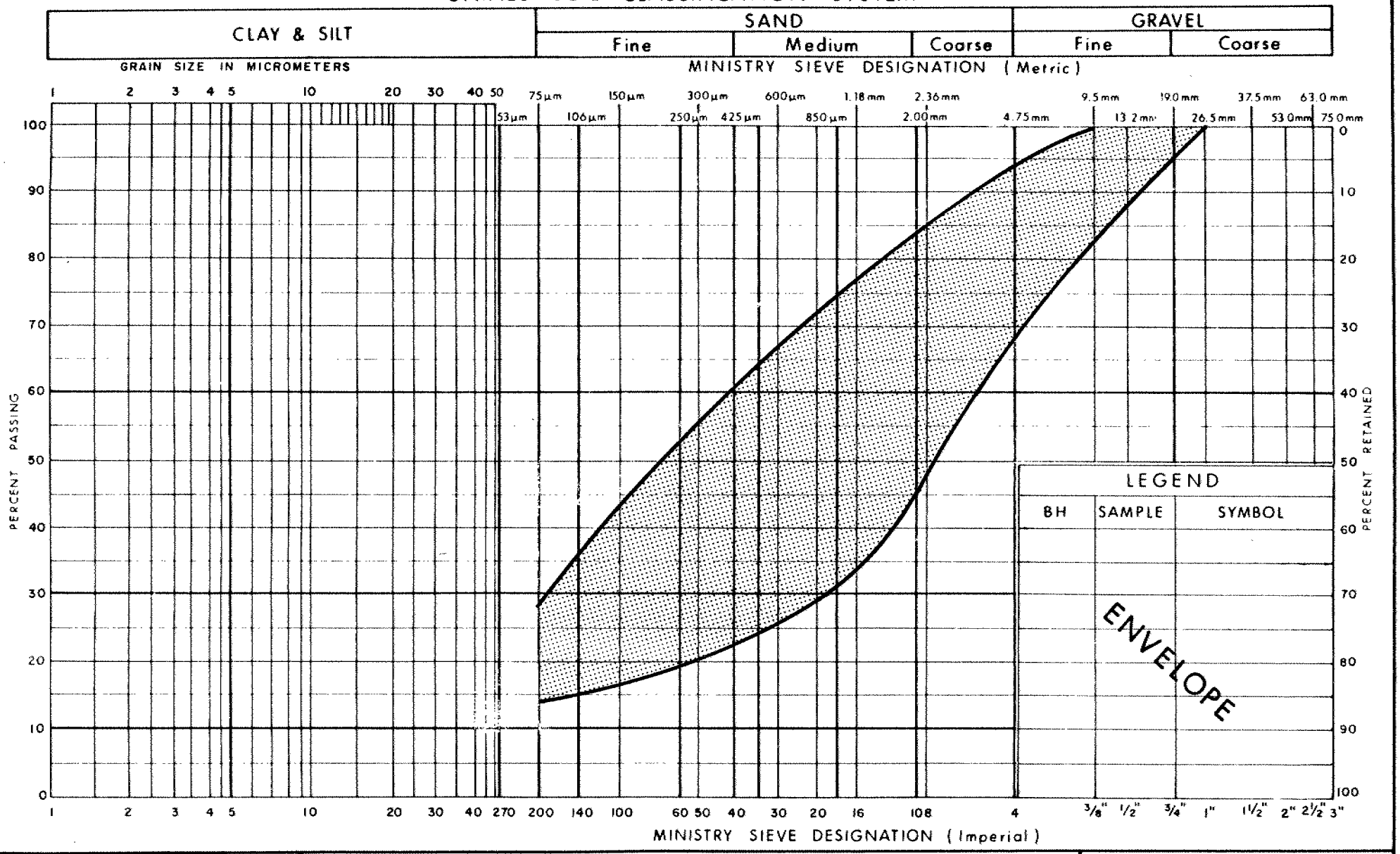
PLASTICITY CHART
CLAYEY SILT

FIG No 3
W P 510-90-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

GRAVELLY SAND, SOME SILT

FIG No 4

W P 510-90-01

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 (R Q D), 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

RECORD OF BOREHOLE No 101 1 OF 1 METRIC

W.P. 510 - 90 - 01 LOCATION CO - ORDS. N 4 774 883.6; E 203 945.2 ORIGINATED BY M V

DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, H.S. AUGER & B.W. CASING COMPILED BY M V

DATUM GEODETIC DATE 91 04 04 & 91 04 05 CHECKED BY P P

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
284.9	Ground Surface						
0.0 / 283.8	ORGANIC SILT, With Occasional Peat Layers, Some Sand		1	SS	14	▽	284
1.1 / 282.7	SANDY GRAVEL, Trace of Silt, Compact		2	SS	14		
2.2	SAND to SANDY SILT, Some/Trace Gravel, Occasional Clayey Silt Seams, Compact to Loose		3	SS	16		282
			4	SS	21		
			5	SS	11		
			6	SS	10		280
			7	SS	9		
278.5			8	SS	9		
6.4	Silt		9	SS	6		278
	CLAYEY SILT, With Occasional Silt Seams, Stiff to Very Stiff						
274.9			10	SS	11		276
10.0	GRAVELLY SAND, Some Silt Very Dense		11	SS	104		
			12	SS	61		274
			13	SS	58		
270.2							272
14.7	Weathered LIMESTONE BEDROCK, Unweathered		14	RC BX	REC 70%		270
268.5			15	RC BX	REC 97%		
16.4	End of Borehole						

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

+7

120/8cm

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	48	49	(3)	
	15	80	(5)	
	0	47	(53)	
	22	64	(14)	
	14	58	(28)	
RQD 0%				
RQD 0%				

▲ Note: Artesian Condition Encountered at About El: 269.5 in the Fractured Zone of the Bedrock. Water Level Rose to 0.2m Above the Ground Level (ie El:285.1)

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 102 1 OF 1 METRIC

W.P. 510 - 90 - 01 LOCATION CO - ORDS. N 4 774 872.9; E 203 923.4 ORIGINATED BY M V

DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, H.S. AUGER & B.W. CASING COMPILED BY M V

DATUM GEODETIC DATE 91 04 05 & 91 04 08 CHECKED BY P P

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
284.9	Ground Surface						
0.0 / 283.6	ORGANIC SILT, With Occasional Peat Layers, Some Sand and Gravel,		1	SS	5		284
1.3	SANDY GRAVEL, Trace of Silt, Compact		2	SS	12		
			3	SS	16		
281.3	Clayey Silt, Some Sand & Gravel		4	SS	22		282
3.6	SANDY SILT, Occasional Clayey Silt Seams, Compact to Loose		5	SS	18		
			6	SS	12		280
			7	SS	14		
277.7			8	SS	7		278
7.2	CLAYEY SILT, Trace of Sand, Stiff		9	SS	15		
			10	SS	14		276
274.9							
10.0	GRAVELLY SAND, Some Silt Very Dense		11	SS	77		274
			12	SS	100/9cm		
			13	SS	119		272
269.7							
15.2	Weathered						270
	LIMESTONE BEDROCK Unweathered		14	RC BX	REC 82%		
			15	RC BX	REC 100%		268
266.2							
18.7	End of Borehole						

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

120/17cm

UNIT WEIGHT 7 kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	58	32		(10)
	0	48		(52)
	5	79		(16)
	30	45		(25)
RQD 8%				
RQD 31%				

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3 1 OF 1 METRIC

W.P. 510 - 90 - 01 LOCATION CO - ORDS. N 4 774 873.6; E 203 947.6 ORIGINATED BY M V

DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER & BW CASING COMPILED BY M V

DATUM GEODETIC DATE 90 04 09 & 90 04 11 CHECKED BY PP

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
284.8	Ground Surface										
0.0 / 283.4	Sandy Silt to Clayey Silt, Some Gravel, Trace of Organics Compact/Stiff		1	SS	12	▼	284				
1.4	Sandy Gravel, Some Silt		2	SS	29						
			3	SS	16		282		o		0 93 (7)
			4	SS	22						
			5	SS	24						
			6	SS	32		280		o		0 96 (4)
			7	SS	32						
	SAND, Trace of Silt, Compact to Dense		8	SS	61		278	120/25cm			
275.8			9	SS	28						
9.0 / 274.8	CLAYEY SILT, Stiff		10	SS	10		276		⊢o⊣		0 0 60 40
10.0			11	SS	100	/13cm	274		o		54 35 (11)
	SAND and GRAVEL, Some Silt, Very Dense						272				
270.6											
14.2	End of Borehole Probable Bedrock										

Note: Formerly BH# 3 of W.P. 481 - 89 - 04

+³, ×⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4 1 OF 1 METRIC

W.P. 510 - 90 - 01 LOCATION CO - ORDS. N 4 774 818.2; E 203 958.5 ORIGINATED BY M V

DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER & BW CASING COMPILED BY M V

DATUM GEODETIC DATE 90 04 11 & 90 04 16 CHECKED BY PP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
285.4	Ground Surface							
0.0	Topsoil							
	SAND, Some Silt, Some Gravel, Trace of Organics, Loose to Compact		1	SS	19	▼	284	
			2	SS	6			
282.6	Organic Silt & Peat		3	SS	15			
2.8	SAND, Some Silt, Trace of Gravel, Compact		4	SS	12		282	
			5	SS	12			
			6	SS	24		280	
			7	SS	15			
278.9			8	SS	15			
6.5	Layered CLAYEY SILT and SANDY SILT, Stiff/Compact		9	SS	15		278	
			10	SS	13		276	
274.7			11	SS	92			120/8cm
10.7	SAND and GRAVEL, Some Silt, Very Dense		12	SS	89		274	
			13	SS	55	/15cm	272	31 55 (14)
269.6							270	
15.8	Weathered		14	RC BX	REC 62%			RQD 0%
	LIMESTONE BEDROCK, Unweathered		15	RC BX	REC 96%		268	RQD 9%
266.2			16	RC BX	REC 100%			RQD 0%
19.2	End of Borehole							

Note: Formerly BH# 4 of W.P. 481 - 89 - 04

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

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

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

ROCK CORE DESCRIPTION
WP 510-90-01

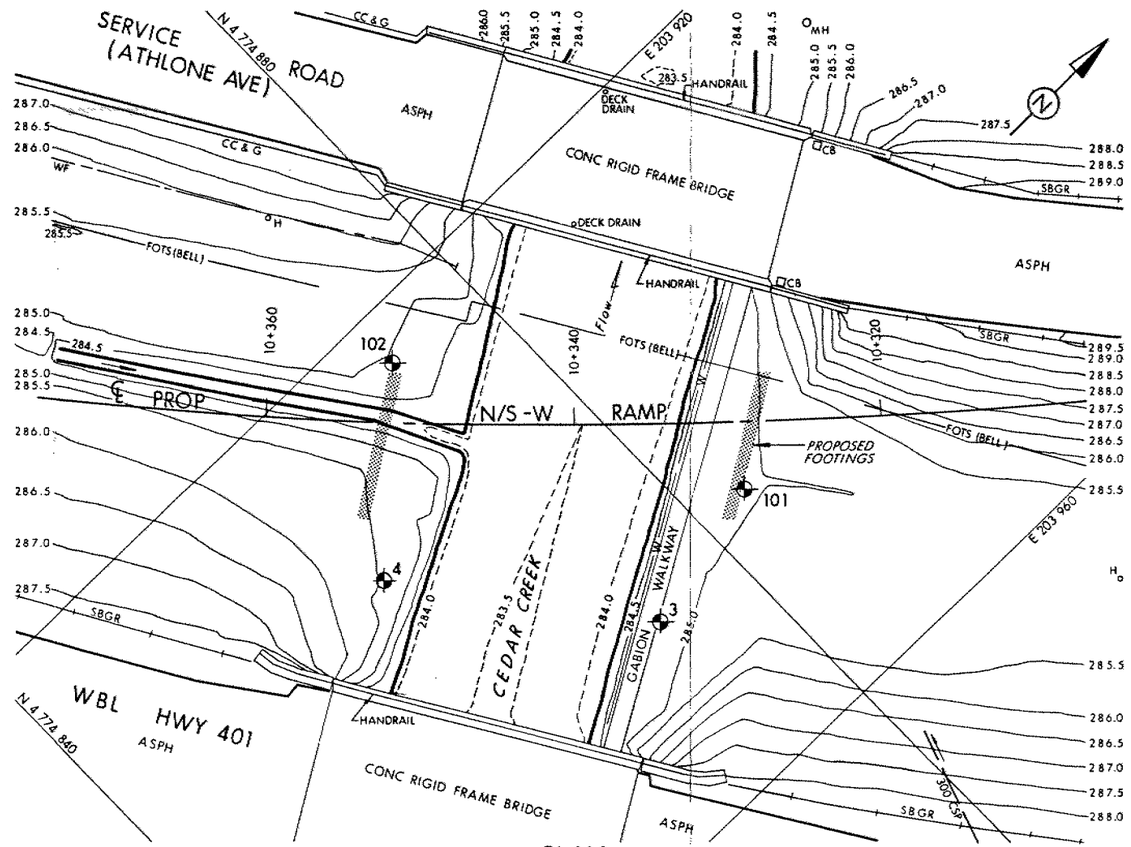
CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
101	14	14.86-15.54	70	0	14.86-16.36	**LIMESTONE** with chert nodules and abundant fossils (corals, stromatoporoids), pale yellowish brown (matrix) to white (fossils); medium crystalline; medium strong; unweathered to slightly weathered; fractures very close to extremely close spaced, flat to near vertical, undulating, smooth to rough.
	15	15.54-16.36	97	0		
102	14	15.65-17.17	82	8	15.65-18.69	**LIMESTONE** with chert nodules and abundant fossils (corals, stromatoporoids), pale yellowish brown (matrix) to white (fossils); medium crystalline; medium strong; unweathered to slightly weathered; fractures close to extremely close spaced, flat to near vertical, undulating, smooth to rough.
	15	17.17-18.69	100	31		

***CR** = CORE RECOVERY
***RQD** = ROCK QUALITY DESIGNATION

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

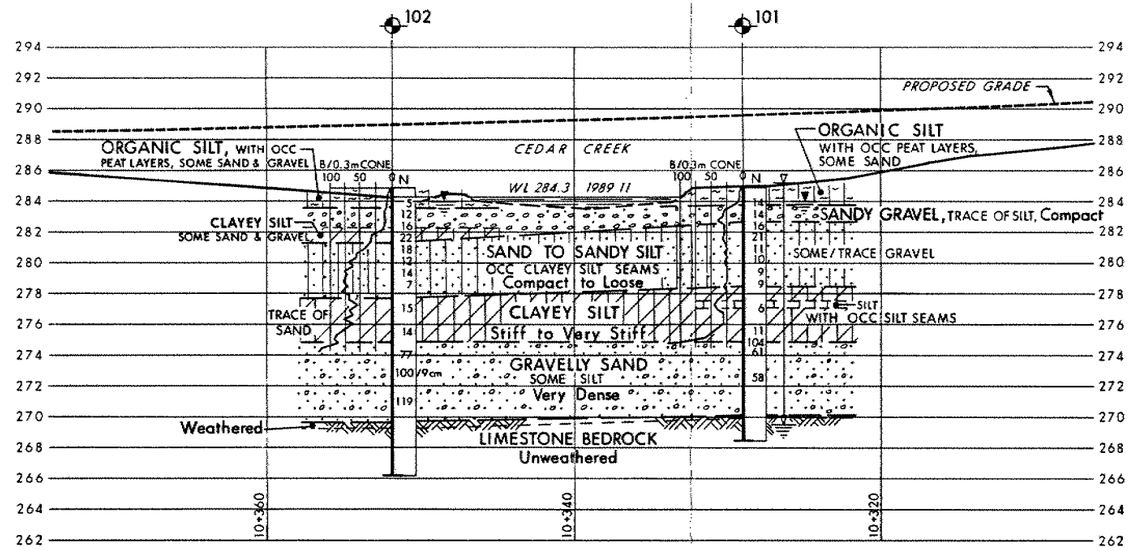
Logged by: DAW, Soils and Aggregates Section

MINISTRY OF TRANSPORTATION, ONTARIO PH-0-207 88 10



PLAN
SCALE
4m 2 0 4m

NOTE
For Subsoil information of BH's 3 & 4 refer to Record of Borehole Sheets.



℄ PROFILE PROPOSED N/S- W RAMP

SCALE
4m 2 0 4m

REF No E-89-401-4; 1990 10

METRIC

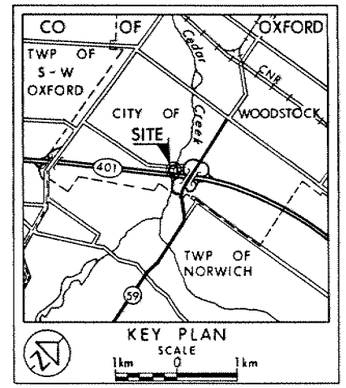
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 510-90-01

CEDAR 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 1991 04
- Head ARTESIAN WATER Encountered

No	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
101	284.9	4 774 883.6	203 945.2
102	284.9	4 774 872.9	203 923.4
1990 04 WP 481-89-04 3	284.8	4 774 873.6	203 947.6
1990 04 WP 481-89-04 4	285.4	4 774 862.6	203 933.2

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

Geocres No 40P2-49

HWY No 401 N/S-W RAMP			DIST 2
SUBM'D MV	CHECKED HW	DATE 1991 05 30	SITE 23-442
DRAWN RS	CHECKED	APPROVED	DWG 5109001-A