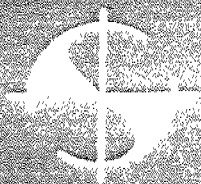


G.I.-30 SEPT. 1976

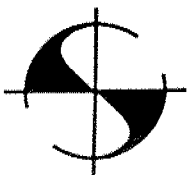
GEOCRES No. 316-207DIST. 9 REGION W.P. No. 371-89-02CONT. No. 96-59W. O. No. STR. SITE No. 3-574HWY. No. 416LOCATION Hwy 416 & Reg. Rd. 13
UnderpassNo of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

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STRATA ENGINEERING CORP.



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FOUNDATION INVESTIGATION REPORT

for

Regional Road 13 Underpass

W.P. 371-89-02, District 9, Ottawa

Highway 416, Str. Site 3-574

CONT 96-59

Submission Date: 1992 03 27
Strata File: E-90-036C

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FOUNDATION INVESTIGATION REPORT

for

Regional Road 13 Underpass

W.P. 371-89-02, District 9, Ottawa

Highway 416, Str. Site 3-574

1.0 INTRODUCTION

Strata Engineering Corporation has been retained by M.M. Dillon Consulting Engineers to conduct a geotechnical study for a proposed interchange at future Highway 416 and Regional Road 13. The terms of reference were to investigate the site by means of sampled boreholes and dynamic cone penetration tests and to provide a full foundation report.

This report, which follows a letter report dated 1991 01 03, is submitted in compliance with these terms of reference.

2.0 SITE AND GEOLOGY

The site is located in Rideau Township approximately 45 km south of Ottawa along Highway 16. The site location is shown on the key plan in Drawing No. 3718902-A, appended.

The topography is gently undulating. South of the site the land is used as pasture. To the north there is a small poorly drained area. Limestone boulders are present at the surface.

This site lies within the physiographic region known as the North Gower Drumlin Field. The drumlins are oriented more or less north-south. In some areas, these glacial deposits are draped with marine clays.

Bedrock in this area has been mapped as magnesium limestone to dolostone of the Oxford Formation, Lower Ordovician age.

3.0 FIELD AND LABORATORY WORK

The field work took place between 1990 10 03 and 10. Eight boreholes were drilled, of which five were placed near proposed structure footing locations and three were placed at approach fill and high ramp locations. The borehole locations are shown on Drawing No. 3718902-A.

The boreholes for the structure were drilled as close as possible to the footing locations staked out by M.M. Dillon personnel who also provided the borehole elevations, which are referenced

to Geodetic datum.

Drilling was conducted with two CME 55 bombardier mounted drill rigs. Hollow stem augers as well as wash boring using N sized casing were used to advance the boreholes. All boreholes, with the exception of Borehole 6, were accompanied by dynamic cone penetration tests.

The overburden was sampled by means of the Standard Penetration Test. Bedrock was cored at all five structure borehole locations.

Water levels were noted in the uncased boreholes after the last soil sample was taken. Perforated standpipes with bentonite seals were installed in Boreholes 2, 3, 5 and 6. All other boreholes were backfilled with native soil cuttings. The water levels in the standpipes were monitored over a period of time.

Recovered soil samples were transported to our Don Mills laboratory where they were visually examined and classified. Index properties such as field moisture content and grain size analyses were performed. The results are shown on the Office Record of Boreholes and on Figure 1, 2 in the Appendix. All rock cores were examined for recovery and their RQD's noted.

4.0 SUBSURFACE CONDITIONS

4.1 General

The soil conditions comprise mostly non-cohesive glacial till overburden consisting of sandy silt overlying gravelly sand above bedrock.

4.2 Sandy Silt (Glacial Till)

Sandy silt with trace to some gravel (glacial till) was found in Boreholes 1 and 7 from surface to depths of approximately 2 m. The moisture content ranged from 12 to 18 per cent. Grain size curves of this deposit are shown on Figure 1. N values of 15 to 42 blows/0.3 m indicate this deposit to be compact to dense.

4.3 Gravelly Sand to Sandy Gravel (Glacial Till)

Below the sandy silt (glacial till) in Boreholes 1 and 7 and from surface down in the other boreholes there is a deposit of gravelly sand to sandy gravel (glacial till) with random cobbles and boulders. This deposit lies immediately above the bedrock. The thickness of this deposit varies between 1.8 m and 4.1 m. The moisture content ranged from 10 to 20 per cent with the average being 12 per cent. The grain size distribution for this deposit is shown in envelope form on Figure 2 in the Appendix.

N values ranged from 11 to 137 blow/0.3 m with most values being about 30 blows/0.3 m, with

lower values being recorded due to localized compact zones. Generally the deposit is dense.

4.4 Limestone Bedrock

Bedrock was cored in the five structure boreholes. The upper 1.5 m to 3 m of the rock was found to be fractured, with low core recoveries (as low as 50%) and RQD values of less than 40%. Below this fractured or weathered zone, core recoveries increased to over 90% and the RQD's improved to between 74% and 89%.

5.0 GROUNDWATER CONDITIONS

Groundwater observations are summarized below:

Borehole	W.L. Depth (m)	W.L. Elev.(m)	Date
1	0.5	86.6	1991 10 10
2	1.0	86.3	1991 10 26
3	1.1	86.5	1991 10 26
4	2.1	86.5	1991 10 05
5	1.7	86.5	1991 10 16
6	1.2	87.0	1991 10 10
7	4.1	85.5*	1991 10 03

* Not stabilized

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

It is proposed to construct southbound lanes to upgrade existing Highway 16 to a 4 lane freeway standard. This will entail raising Regional Road 13 and carrying it across the four lanes of the proposed new Highway by means of an underpass. At this location Regional Road 13 is situated at about elevation 89.5 m. The profile grade will be raised by 6.5 m to about elevation 96 m. The proposed underpass will have two 37.5 m post-tensioned spans.

It is presumed that a detour of the present Regional Road 13 will be built to facilitate the construction of the new underpass.

The foundation investigation shows the subsoils consist of silty sand (glacial till) in some areas of the site overlying a generally compact to dense gravelly sand (glacial till) deposit, underlain by bedrock at depths of less than 4 m. The groundwater table was at elevation $86.5 \pm$ m at the time of this investigation.

6.2 Structure Foundations

The subsurface conditions are generally favourable for the use of spread footing foundations provided certain precautions are implemented as discussed in specific terms below.

All footings should be provided with an earth cover of 1.8 m to the underside for protection against frost action.

Spread Footings

The proposed grade of Highway 416 at this underpass is 89.2 m. Providing 1.8 m cover for frost penetration places the footings for the abutments below elevation 87.4 m.

Abutment footings of 3 m width may be designed for the following capacities:

Factored Capacity at ULS	900 kPa
Capacity at SLS Type II	350 kPa

These capacities may be realized at the following elevations:

East Abutment (South Corner)	86.3 m
East Abutment (North Corner)	86.8 m
West Abutment (South Corner)	87.4 m
West Abutment (North Corner)	87.3 m

The centre pier will likely be placed in the median for which the proposed elevation is 88.0 m. With 1.8 m frost protection, the footings must be placed below elevation 86.2 m. The pier may be designed for the following capacities:

Factored Capacity at ULS	1200 kPa
Capacity at SLS Type II	500 kPa

These capacities may be realized at the elevations 86.2 m.

Consideration should also be given to placing the abutments on a compacted Granular A pad. The following capacities are recommended.

Factored Capacity at ULS	900 kPa
Capacity at SLS Type II	350 kPa

The minimum thickness of the pad below the base of the footing should be 0.75 m. The geometry of this option is shown on Figure 3 in the Appendix.

Before placement of the granular A pads, the upper 150 mm of soil at the surface should be stripped in order to remove any topsoil.

To avoid elaborate dewatering, consideration may be given to constructing the spread footings within oversized excavations with perimeter drainage. A 1.0 m clear horizontal space should be provided between footings and the perimeter drain excavation slope. The perimeter drain should consist of 150 mm diameter perforated corrugated plastic drain pipe, placed with its invert at least 750 mm below the base of the footing. The drain should be backfilled with free coarse clean granular material.

Total and differential settlements of the footings, designed and constructed as specified above, are expected to be elastic and immediate in nature and not in excess of 20 to 25 mm and 10 to 15 mm respectively.

To compute resistance against sliding the following unfactored values should be used:

Friction ϕ'	35°
Cohesion, c'	0 kPa

Unit Weight of Backfill	As per Section 6.3 of this report.
-------------------------	------------------------------------

Deep Foundations

If the recommended factored capacities given above for spread footings are inadequate then a deep foundation consisting of caissons taken down to bedrock may be considered as an alternative.

Caissons should be drilled a minimum of 1.5 m into the bedrock at the north east abutment where the fractured zone is quite thick. At other locations, caissons should be socketed 0.5 m into the bedrock. Such caissons may be designed for ULS factored capacities of 3,000 kPa.

6.3 Earth Pressures

Earth pressures should be computed as per subsection 6-6.1.2.2 of the OHBD Code. A yielding foundation condition ie. the active case may be assumed. The Granular A or B backfill should be in accordance with special provision No. 109F03 (latest revision). The following parameters are recommended for the granular backfill:

	Granular A	Granular B
Angle of internal friction ϕ'	35.0°	30.0°
Unit Weight (kN/m ³), γ	22.8	21.2

Surcharge effects, if any should be computed as per Clause 6-6.1.2.4 of the OHBD Code.

6.4 Approach Embankments

Stability problems are not anticipated for the proposed approach fills which may be constructed to the steepest side slopes as dictated by the nature of the material used (2H:1V for granular material). Settlements of such embankments are expected to be immediate and elastic in nature, and in the order of 30 mm.

6.5 Construction Considerations

Boiling of the glacial till in excavations below the prevailing groundwater table should be avoided. Dewatering may be accomplished by means of oversize excavations as described earlier. If and as necessary, a special provision should be included in the contract documents for potential dewatering of these footings. Dewatering is not required for abutment footings placed on Granular A pads.

Unsurcharged temporary excavations within the glacial till strata, above the water table, can be designed for 1:1 slopes. Below the water table the slope should be flattened to 2:1. All excavations should comply with the requirements for safety as per the current regulations of the Ontario Occupational Health and Safety Act.

7.0 CLOSURE

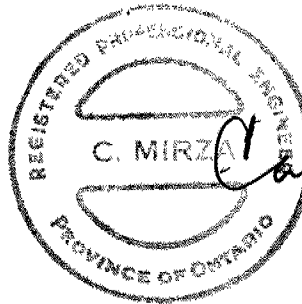
The field work for this investigation was carried out by A. C. Abel. The drilling equipment was rented from F.E. Johnston and Marathon Drilling companies, Ottawa.

Respectfully submitted:
STRATA ENGINEERING CORP.

ACA/abel

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Project Engineer

ACA/lr



C. Mirza
C. Mirza, P. Eng.
Senior Principal

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APPENDIX

Explanation of Terms Used in Report

Record of Boreholes 1 to 7

Figures 1, 2A, 2B & 3

Drawing 3718902-A

EXPLANATION OF TERMS USED IN REPORT

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

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	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 No1										METRIC			
W P 371-89-02			LOCATION N: 4 994 962 ; E: 371 550				ORIGINATED BY A.A.						
DIST 9 HWY 416			BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Penetration Test				COMPILED BY A.K.						
DATUM Geodetic			DATE 1990 10 10				CHECKED BY C.M.						
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT Wp W WL			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	SHEAR STRENGTH kPa	WATER CONTENT (%)			
87.1	Ground Surface												
0.0	Sandy Silt trace Gravel (Glacial Till)		1	SS	15								W.L. on 1990 10 10
85.1	Compact occ. Cobbles and Boulders Brown		2	SS	23								9 23 (68)
2.0	Gravelly Sand to Sandy Gravel with Silt (Glacial Till)		3	SS	28								
	occ cobbles & Boulders Compact to Very Dense		4	SS	84								33 38 (29)
83.2	Brown		5	SS	100	7.5cm							
3.9	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No2

METRIC

W P 371-89-02 LOCATION N: 4 994 930.0; E: 371 492.8 ORIGINATED BY A. A.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Penetration Test COMPILED BY A.K.
 DATUM Geodetic DATE 1990 10 09 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L			
87.3	Ground Surface													GR SA SI CL
0.0	Gravelly Sand to Sandy Gravel with Silt (Glacial Till) Compact to Very Dense occ. Cobbles & Boulders Brown		1	SS	11		87.0							W.L. on 1990 10 26
85.5			2	SS	70/2	1cm		86.0						32 31 (37)
1.8	Limestone Bedrock Poor Quality - - Fractured		3	FX RC	Rcc 89%			85.0						RQD = 38%
	Excellent Quality		4	BX RC	Rec 98%									RQD = 89%
83.9	Sound						84.0							
3.4	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No3

METRIC

W P 371-89-02 LOCATION N: 4 994 908.6; E: 371 461.0 ORIGINATED BY A.A.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger , Dynamic Cone Penetration Test COMPILED BY A.K.
 DATUM Geodetic DATE 1990 10 09 CHECKED BY C.M.

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	SHEAR STRENGTH kPa					
87.6	Ground Surface													GR SA SI CL
0.0	Gravelly Sand to Sandy Gravel (some Silt (Glacial Till)) Occ. Cobbles & Boulders Dense Brown		1	SS	47		87.0							W. L. on 1990 10 26 42 42 (16) 64 29 (7)
			2	SS	39		86.0							
			3	BX	Boulder		85.0							
			4	SS	30		84.0							
83.8			5	SS	50		83.0							
3.8	Limestone Bedrock Fractured Very Poor to Poor Quality		6	BX RC	Rec 57%		82.0							RQD = 13%
			7	BX RC	Rec 88%		81.0							RQD = 9%
			8	BX RC	Rec 98%									RQD = 36%
80.7														
6.9	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

METRIC

W P 371-89-02 LOCATION N: 4 994 895 ; E: 371 425.2 ORIGINATED BY A.A.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Penetration Test COMPILED BY A.K.
 DATUM Geodetic DATE 1990 10 05 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L 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						
88.6	Ground Surface										
0.0	Gravelly Sand to Sandy Gravel with Silt (Glacial Till) occ. Cobbles & Boulders Very Dense to Dense Brown		1	SS	98						
			2	SS	96/23cm						
			3	SS	40						
84.6											
4.0	Limestone Bedrock Fractured Poor Quality		4	BX RC	Rec 88%						
			5	BX RC	Rec 90%						
	Sound		6	BX RC	Rec 90%						
	Good Quality		7	BX RC	Rec 90%						
81.6											
7.0	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION



Ministry
of
Transportation
Ontario

RECORD OF BOREHOLE No5

METRIC

W P 371-89-02 LOCATION N: 4 994 954.4; E: 371 485.0 ORIGINATED BY A.A.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Penetration Test COMPILED BY A.K.
DATUM Geodetic DATE 1990 10 10 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	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	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
87.7	Ground Surface								o UNCONFINED + FIELD VANE • QUICK TRIAXIAL x LAB VANE	WATER CONTENT (%) 10 20 30				
0.0	Gravelly Sand to Sandy Gravel some Silt (Glacial Till)		1	SS	25		87.0							
	occ. Cobbles & Boulders		2	SS	32		86.0							
	Compact to Very Dense		3	SS	12		85.0							
	Brown		4	SS	50									
84.4			5	BX RC	Rec 50%		84.0							
3.3	Limestone Bedrock		6	BX RC	Rec 55%		83.0							
	Fractured Poor Quality		7	BX RC	Rec 81%		82.0							
	Sound Excellent Quality		8	BX RC	Rec 96%		81.0							
79.8							80.0							
7.9	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 6

METRIC

W P 371-89-02 LOCATION N: 4 994 914.8; E: 371 415.4 ORIGINATED BY A.A.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, wash Casing COMPILED BY A.K.
 DATUM Geodetic DATE 1990 10 04 CHECKED BY C.M.

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	SHEAR STRENGTH kPa						WATER CONTENT (%)	
								○ UNCONFINED							+ FIELD VANE
88.2	Ground Surface												GR SA SI CL		
0.0	Gravelly Sand to Sandy Gravel trace Silt (Glacial Till) Occ. Cobbles & Boulders Compact Brown											76 19 (5)			
			1	SS	43										
			2	SS	25										
			3	BX	Rec										
			4	SS	20										
84.1	Limestone Bedrock Poor Quality ----- Excellent Quality														
4.1			6	BX	Rec										
			7	BX	RC	96%									
			8	BX	RC	100%									
81.2															
7.0	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No7

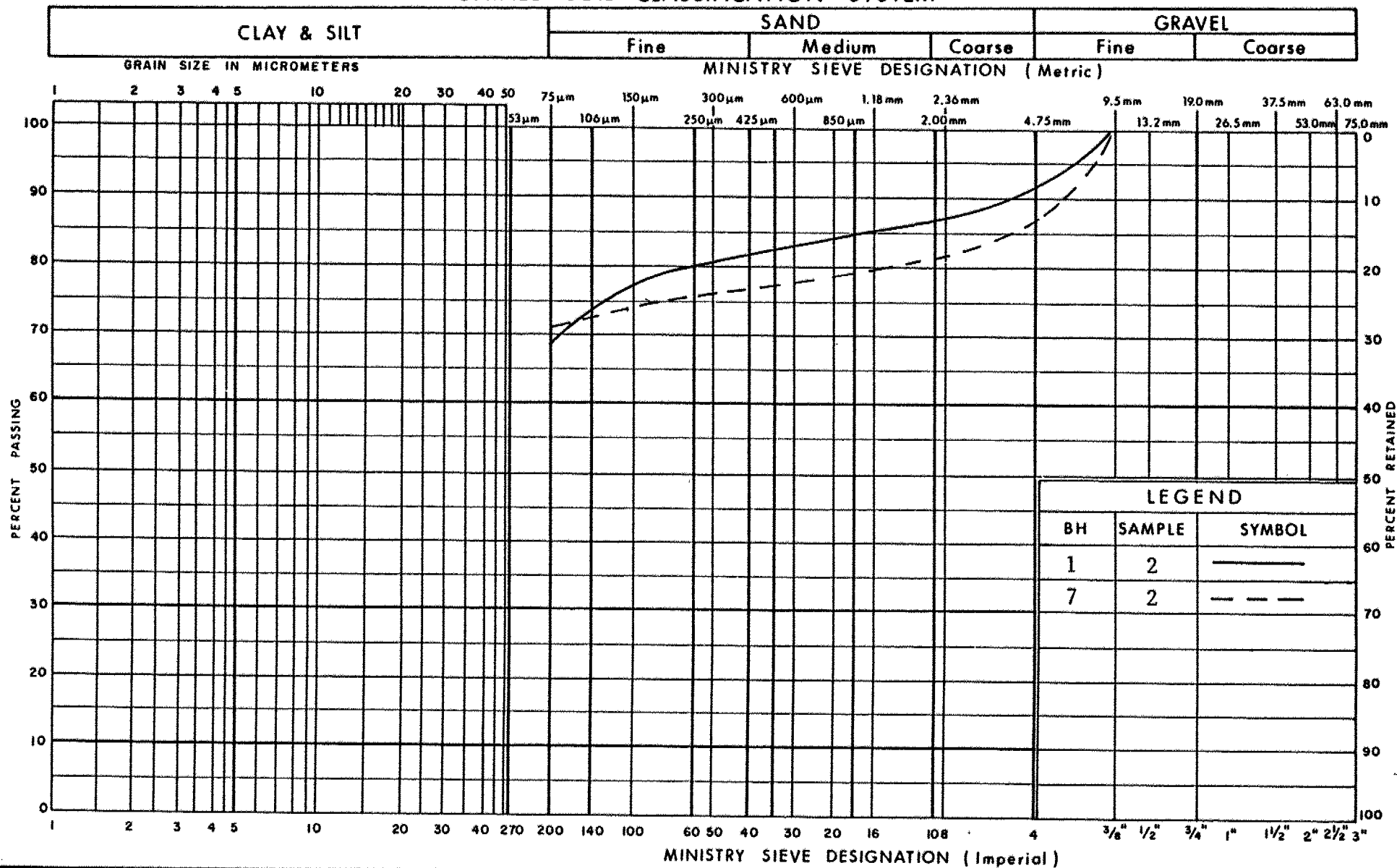
METRIC

W P 371-89-02 LOCATION N: 4 994 895 ;E: 371 370 ORIGINATED BY A.A.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Penetration Test COMPILED BY A.K.
 DATUM Geodetic DATE 1990 10 03 CHECKED BY G.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L			
SHEAR STRENGTH kPa								WATER CONTENT (%)						
○ UNCONFINED + FIELD VANE														
● QUICK TRIAXIAL x LAB VANE														
89.7	Ground Surface													
0.0	Sandy Silt some Gravel (Glacial Till) Dense Brown		1	SS	42		89.0							
			2	SS	31		88.0							14 15 (71)
87.5			3	SS	37		87.0							
2.2	Gravelly Sand to Sandy Gravel with Silt (Glacial Till) Compact to Very Dense Brown Occ. Cobbles & Boulders		4	SS	25		86.0							W. L. on 1990 10 03
							85.0							28 41 (31)
84.6			5	SS	137									
0.0	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Sandy Silt some to trace Gravel
(Glacial Till)

FIG No 1

W P 371-89-02

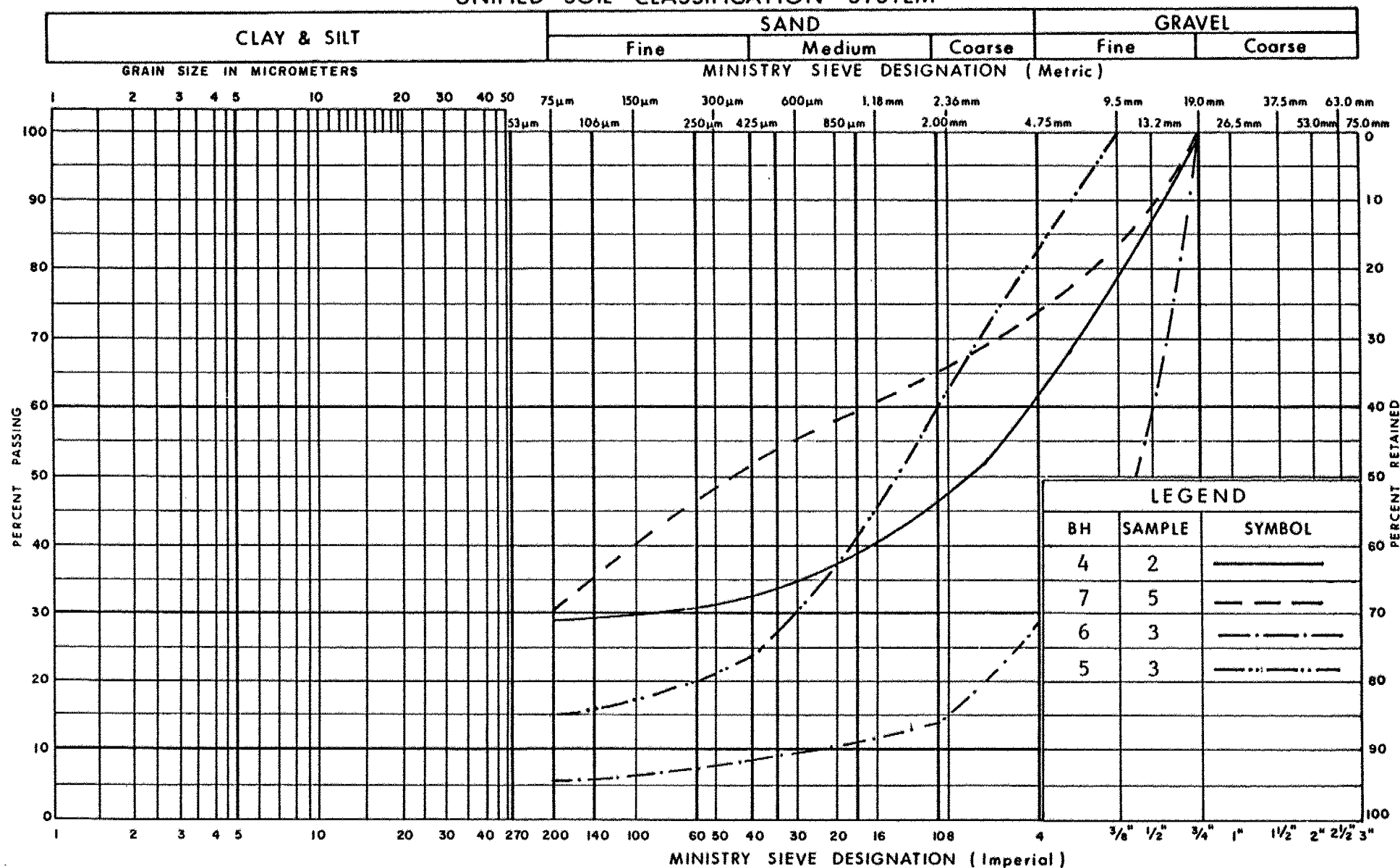
Regional Rd. 13



Ontario

Ministry of
Transportation

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

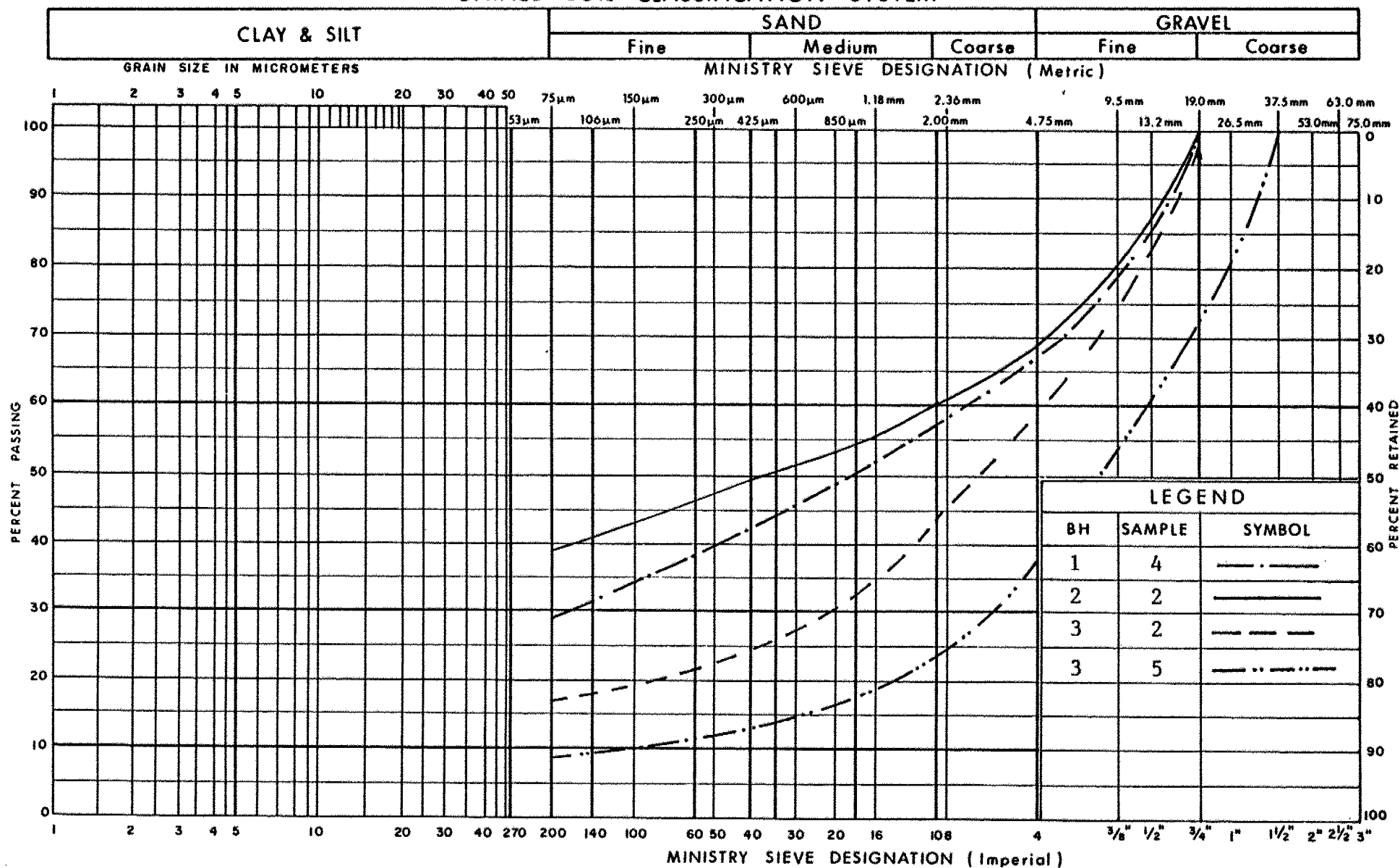
Gravelly Sand to Sandy Gravel
with to trace Silt (Glacial Till)

FIG No 2A

W P 371-89-02

Regional Rd. 13

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

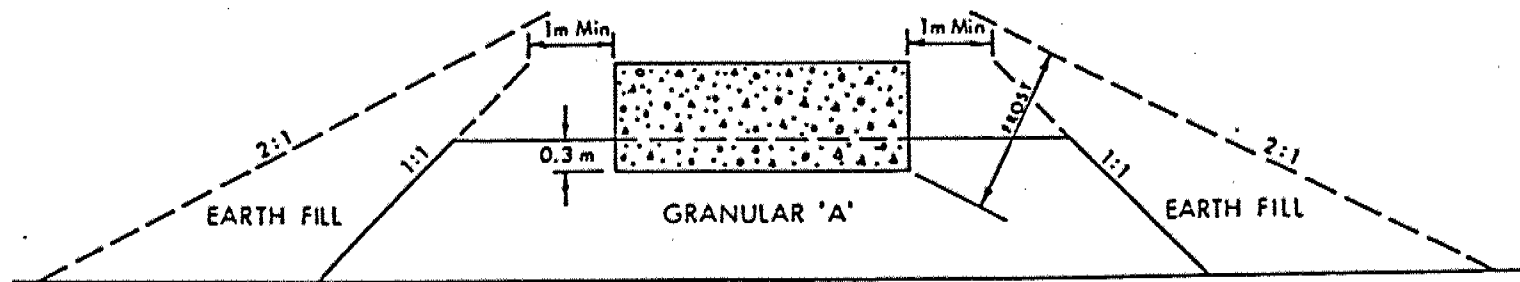
GRAIN SIZE DISTRIBUTION

Gravelly Sand to Sandy Gravel
With to trace Silt (Glacial Till)

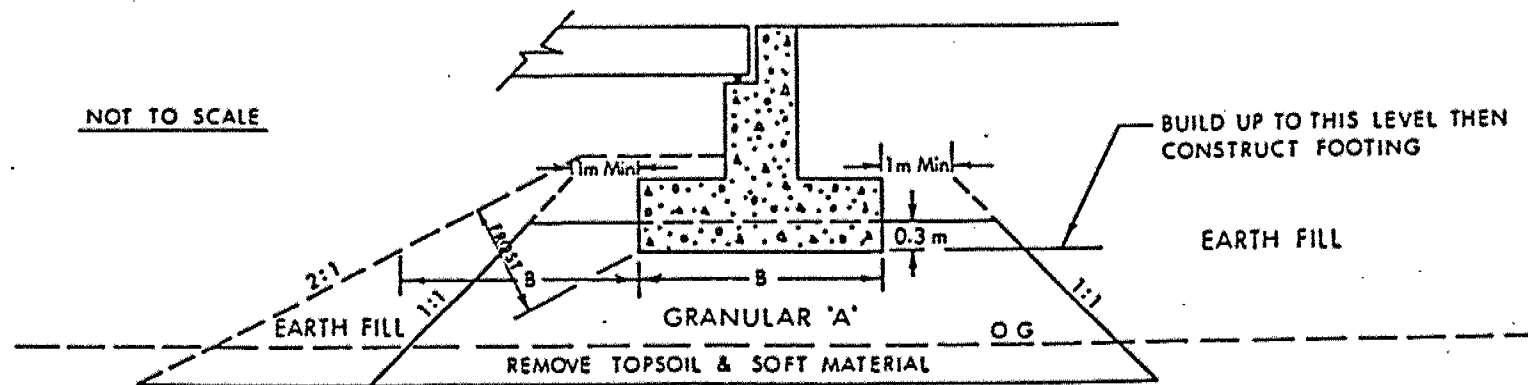
FIG No 2B

W P 371-89-02

Regional Rd. 13



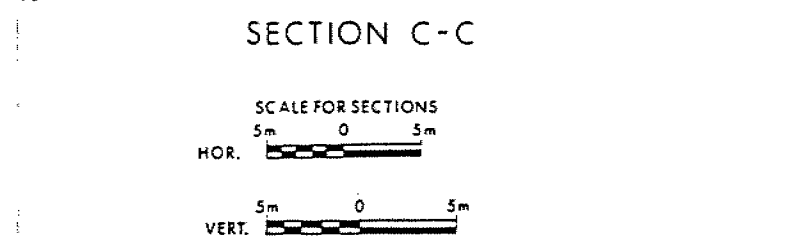
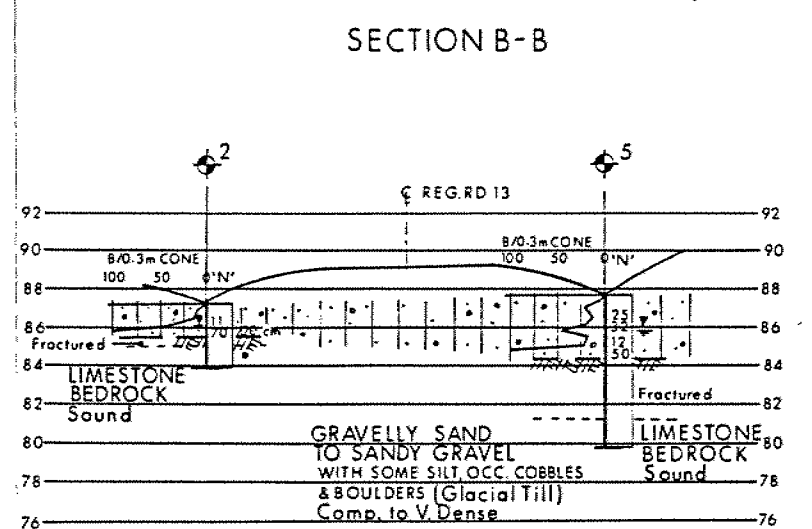
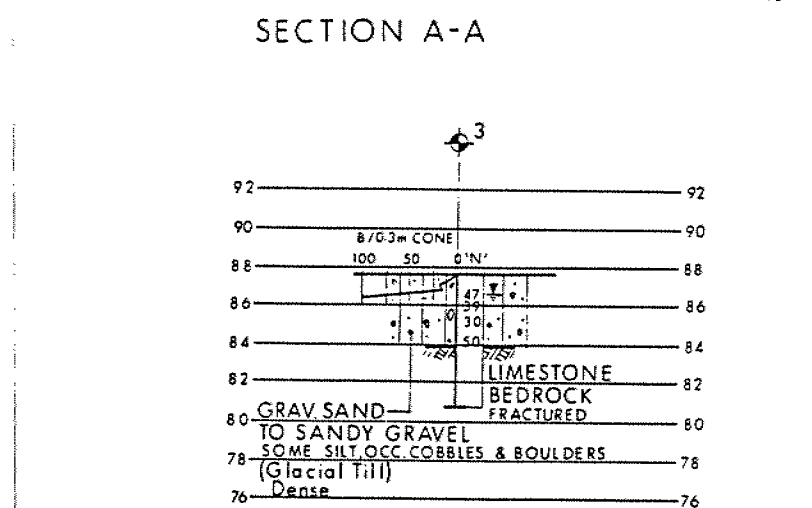
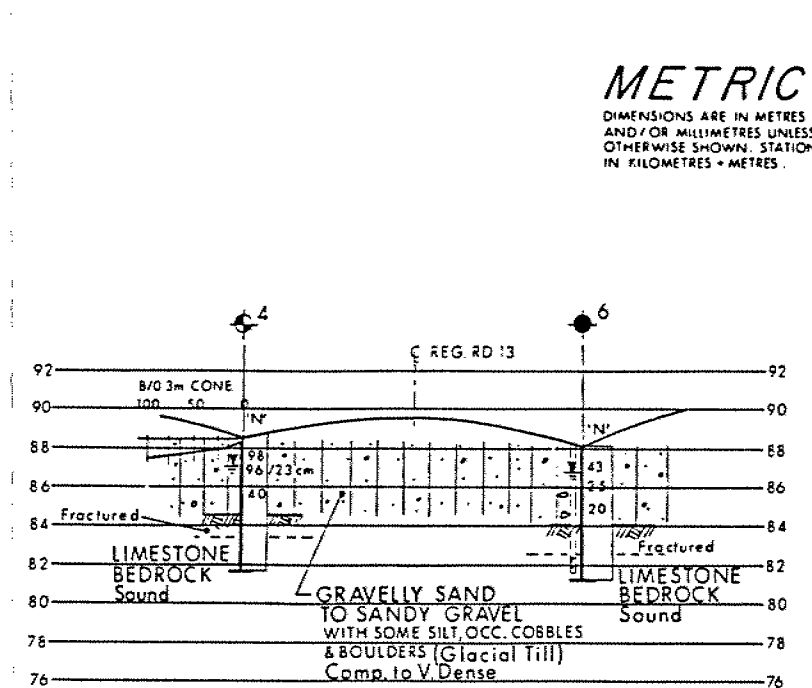
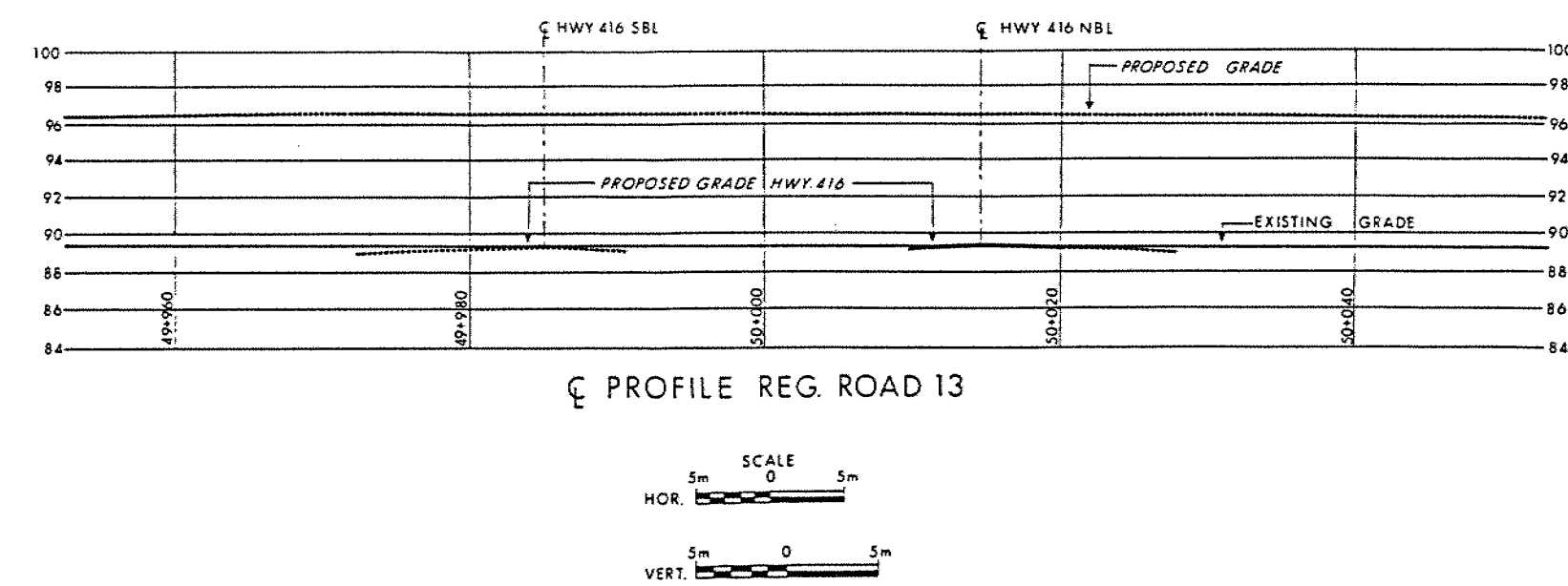
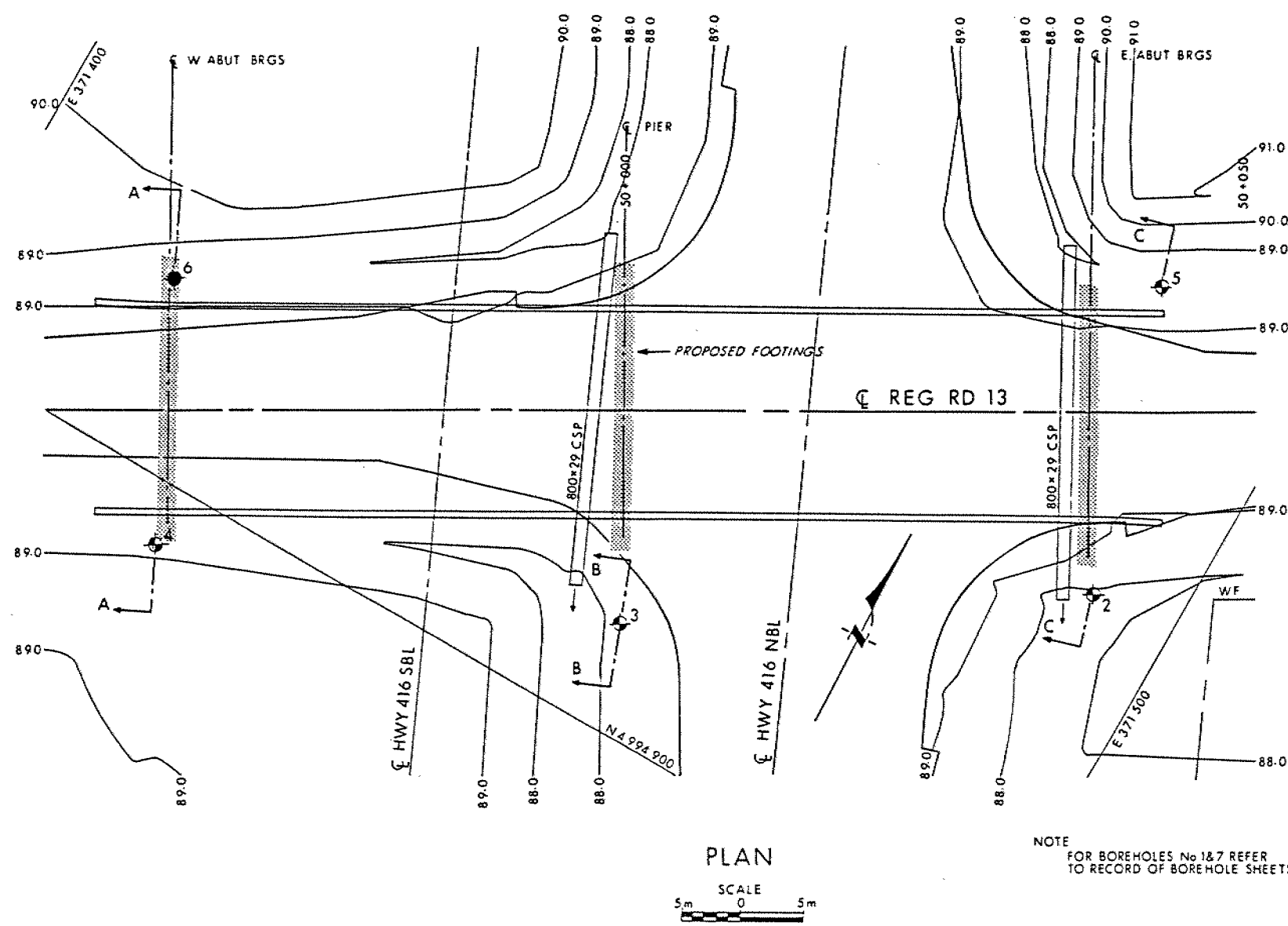
X SECTION



LONGITUDINAL SECTION

NOTES:

- 1- REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2- PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M T C STANDARDS.
- 3- CONSTRUCT CONCRETE FOOTING.
- 4- PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.



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

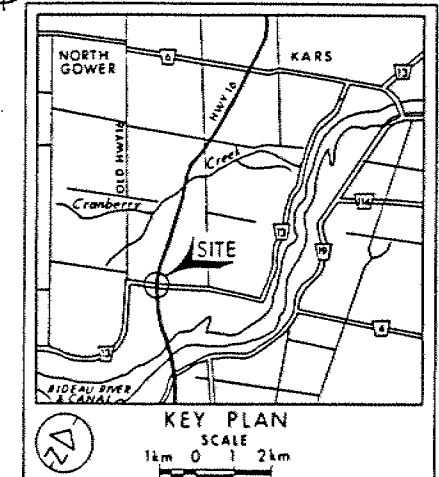
CONT No
WP No 371-89-02

REG RD 13 U'PASS

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

STRATA ENGINEERING CORP.



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)
- WE at time of investigation Oct 1990
- Stand Pipe

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	87.1	4 994 962.0	371 550.0
2	87.3	4 994 930.0	371 492.8
3	87.6	4 994 908.6	371 461.0
4	88.6	4 994 895.0	371 425.2
5	87.7	4 994 954.4	371 485.0
6	88.2	4 994 914.8	371 415.4
7	89.7	4 994 895.0	371 370.0

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

Geocres No 31G-207

HWY No	dist	DIST
371	0	0

SUBMITTAL	CHECKED	DATE	SITE
371	371	27 1992	3-574

DRAWN	AK	CHECKED	APPROVED	DWG
371	371	371	371	3718902-A

REF No E-55-416-5, 91 02