

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 3165-151

DIST. 9 REGION

W.P. No. 124-87-01

CONT. No. 89-107

W. O. No.

STR. SITE No. 3-39

HWY. No. 417

LOCATION Richmond Rd. Underpass
Interchange Widening

No. of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

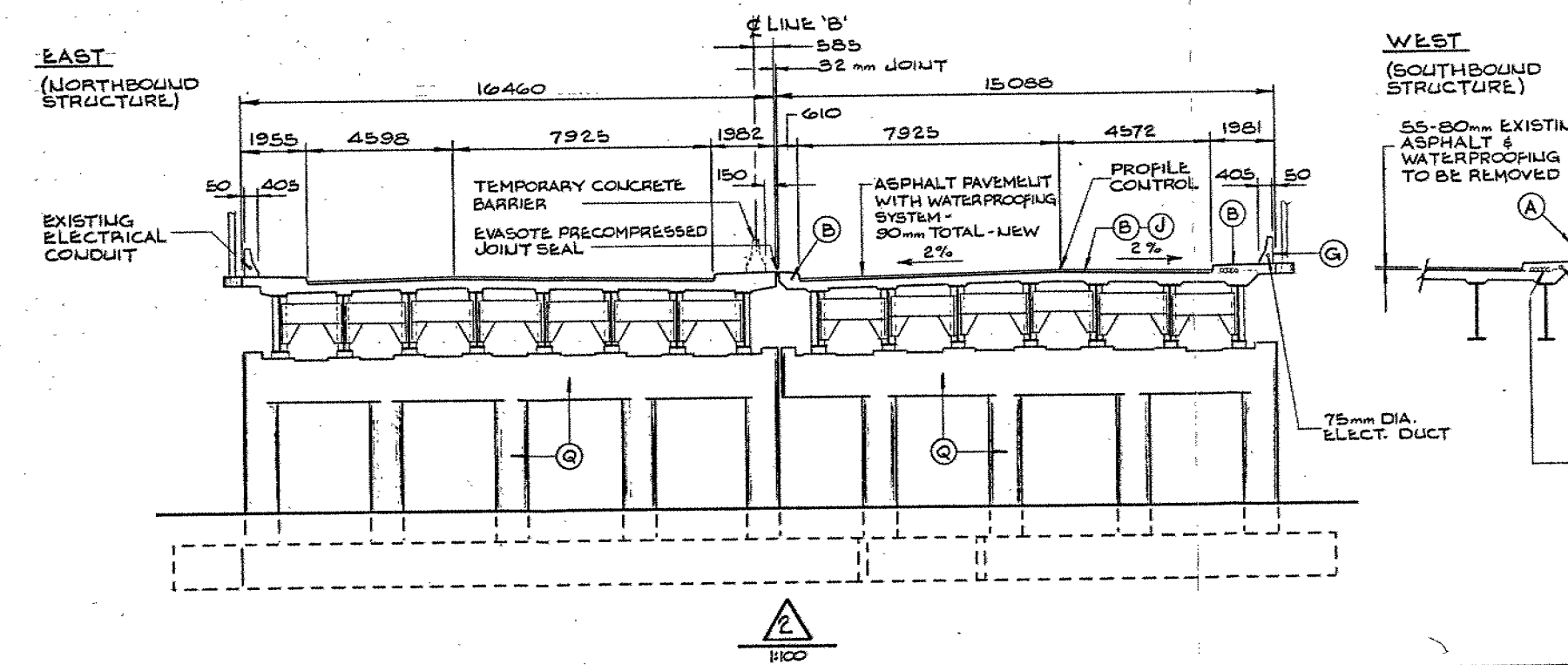
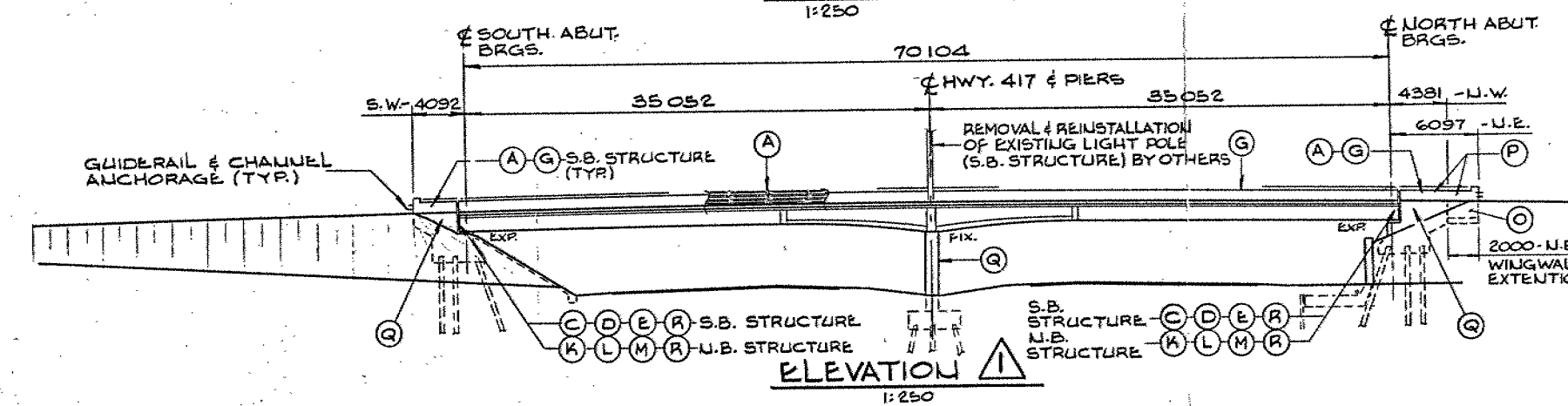
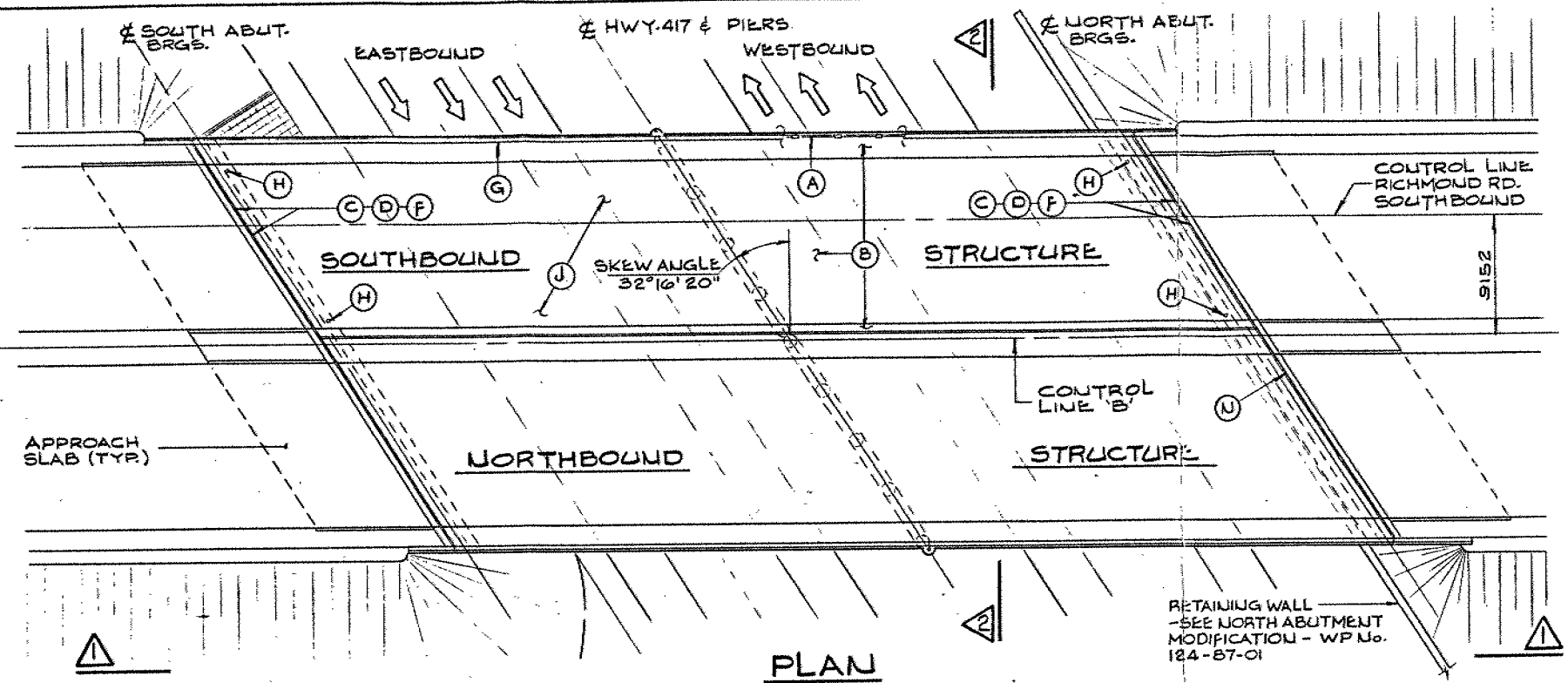


Ministry of
Transportation and
Communications

FILE No. _____ DATE _____

REMARKS

O.Q.W & RICHMOND RD
GEOCRES # 3165-7
WP 909-64
CONT. 66-298



METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DISTRICT No 9
CONT No
WP No 202-86-01

RICHMOND RD. UNDERPASS
STRUCTURE REHABILITATION
GENERAL ARRANGEMENT

DELCAN ENGINEERS PLANNERS ARCHITECTS

WORK DESCRIPTION

- SOUTHBOUND STRUCTURE REHABILITATION (4 LANES TRAFFIC ON NORTHBOUND DECK)**
- A. REMOVE EXISTING STEEL RAILING AND END POSTS.
 - B. REMOVE ASPHALT AND WATERPROOFING ON DECK. REMOVE AND RECONSTRUCT CONCRETE SIDEWALK. REMOVE DETERIORATED CONCRETE FROM MEDIAN AND REPAIR. REMOVE DETERIORATED CONCRETE FROM DECK AND PATCH.
 - C. REMOVE EXISTING EXPANSION JOINT AND CONCRETE AT END OF DECK AND TOP OF BALLAST WALLS. REMOVE EXISTING ABUTMENT DIAPHRAGMS.
 - D. REMOVE DETERIORATED CONCRETE FROM BALLAST WALL AND REPAIR.
 - E. INSTALL NEW DIAPHRAGMS (JACKING BEAMS), JACK STRUCTURE AND REPLACE BEARINGS.
 - F. INSTALL EXPANSION JOINT ASSEMBLY.
 - G. INSTALL NEW BARRIER WALL AND RAILING.
 - H. INSTALL DECK DRAINAGE TUBES.
 - J. WATERPROOF AND REPAVE DECK.
- MISCELLANEOUS REPAIRS - NORTHBOUND STRUCTURE (4 LANES TRAFFIC ON SOUTHBOUND DECK)**
- K. REMOVE EXISTING DIAPHRAGMS.
 - L. REMOVE DETERIORATED CONCRETE FROM BALLAST WALL AND REPAIR.
 - M. INSTALL NEW DIAPHRAGMS (JACKING BEAMS), JACK STRUCTURE AND REPLACE BEARINGS.
 - N. INSTALL EXPANSION JOINT ASSEMBLY AT NORTH ABUTMENT.
 - O. CONSTRUCT NORTHEAST WINGWALL EXTENSION.
 - P. INSTALL NEW BARRIER WALL AND RAILING ON NORTHEAST WINGWALL.
- MISCELLANEOUS REPAIRS - NORTHBOUND AND SOUTHBOUND STRUCTURES**
- Q. REMOVE UNSOUND CONCRETE FROM PIER, ABUTMENTS, AND WINGWALLS AND REPAIR.
 - R. SURFACE PREPARATION AND COATING OF STRUCTURAL STEEL AT ENDS OF GIRDERS ONLY.

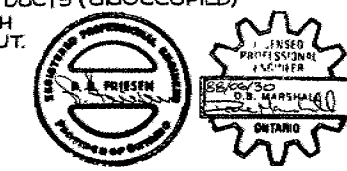
GENERAL NOTES

- CLASS OF CONCRETE**
- ALL CONCRETE SHALL BE 30 MPa.
- REINFORCING STEEL**
- REINFORCING STEEL SHALL BE GRADE 400. BAR MARKING SUFFIX 'C' SHALL BE COATED BARS.
- CLEAR COVER TO REINFORCING STEEL**
- DECK: TOP
BOTTOM AND SIDES
REMAINDER UNLESS OTHERWISE NOTED
- CONSTRUCTION NOTES**
1. FOR STAGING DETAILS AND MAINTENANCE OF SEE STAGING DRAWINGS.
 2. BEARING SEATS SHALL BE FINISHED LEVEL AND SPECIFIED ELEVATIONS TO A TOLERANCE OF ±3mm.
 3. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS, ELEVATIONS, AND DETAILS OF THE WORK ON SITE AND REPORT ANY DISCREPANCIES TO THE ENGINEER BEFORE PROCEEDING WITH THE REPAIRS. PRIOR TO FABRICATION OF THE JOINT AS DIMENSIONS AND ELEVATIONS SHALL BE ADJUSTED TO SUIT PROPOSED WORK.

- LIST OF DRAWINGS**
1. GENERAL ARRANGEMENT
 2. BEARING REPLACEMENT I
 3. BEARING REPLACEMENT II
 4. CONCRETE RESTORATION I
 5. CONCRETE RESTORATION II
 6. CONCRETE RESTORATION III
 7. CONCRETE RESTORATION IV
 8. JOINT ANCHORAGE AND ARMOURING
 9. BARRIER WALL ON SIDEWALK
 10. RAILING FOR BARRIER WALL
 11. BRIDGE SITE NUMBER DATA
 12. REINFORCING STEEL SCHEDULE
 13. STANDARD DETAILS
 14. QUANTITIES - STRUCTURE
 15. QUANTITIES - STRUCTURE
 16. ELECTRICAL DETAILS

APPLICABLE STANDARD DRAWINGS

OPSD-308.02 BRIDGE DECK WATERPROOFING.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS

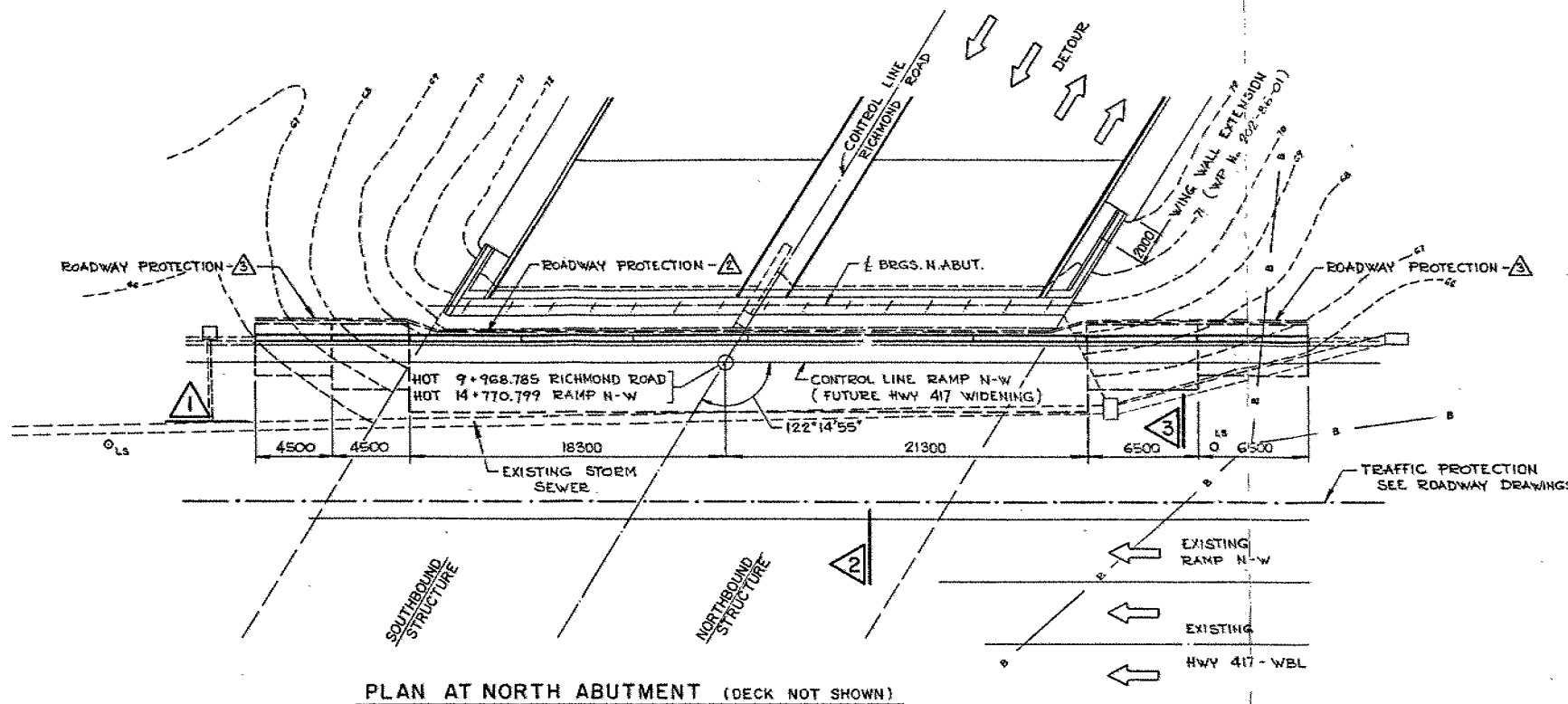
DATE	BY	DESCRIPTION
1983	DESIGN B.P.F.	CHECK D.B.M. LOADING OHBDC 1983
	DRAWING K.R.S.	CHECK B.R.F. SITE No 3-39/R2

SUPERSTRUCTURE REHABILITATION TO OHBDC 1983
OHBD A LOAD

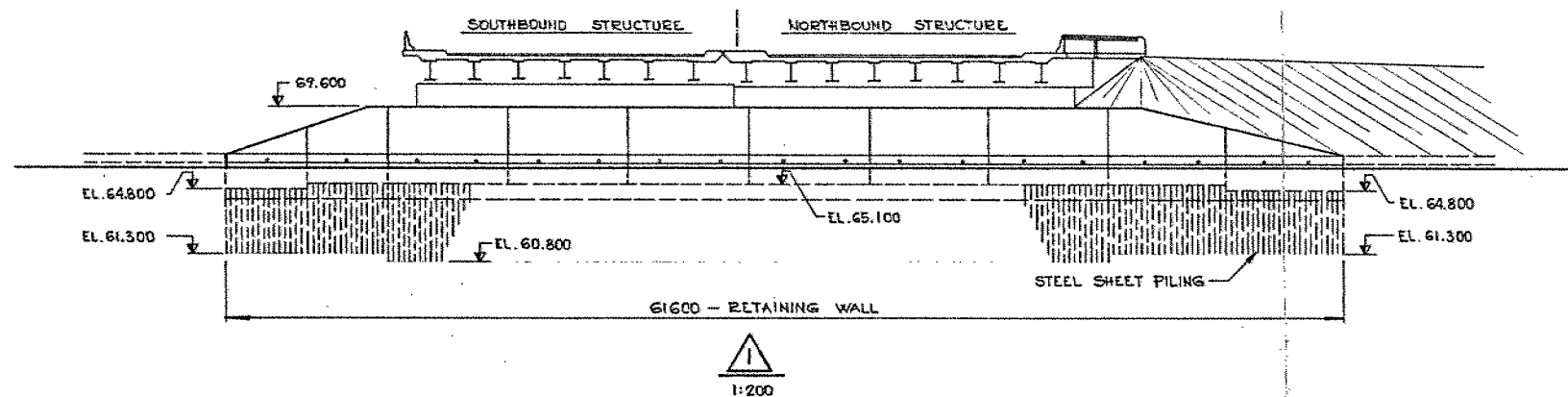
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DISTRICT No 9
CONT No
WP No 124-87-01
RICHMOND RD. UNDERPASS
NORTH ABUT. MODIFICATION
GENERAL ARRANGEMENT

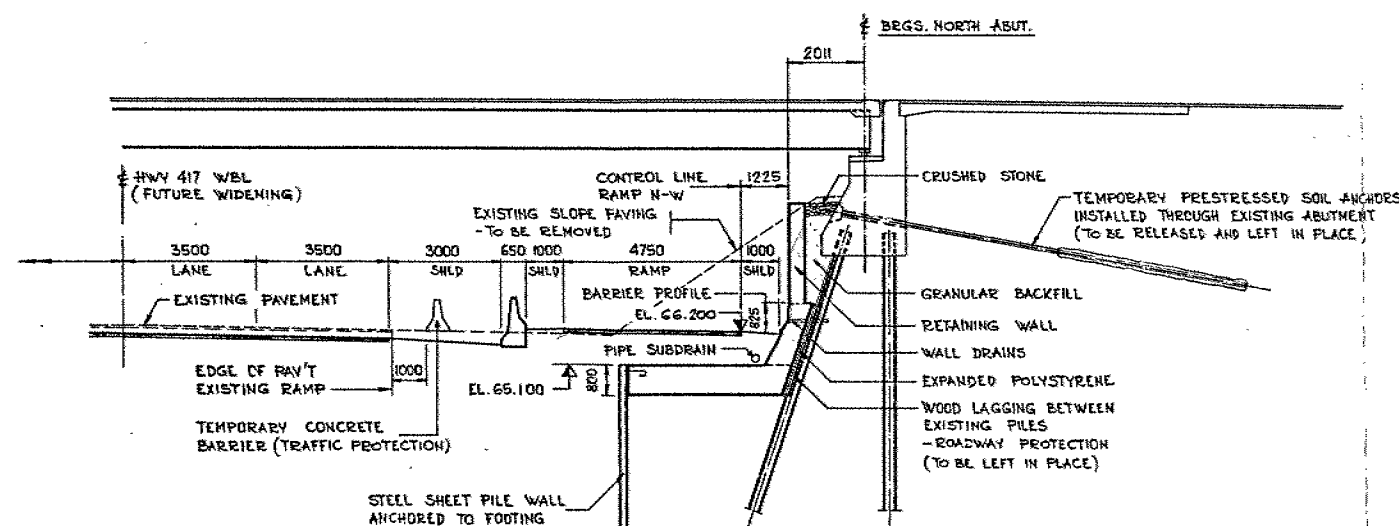
DELCAN ENGINEERS
PLANNERS
ARCHITECTS



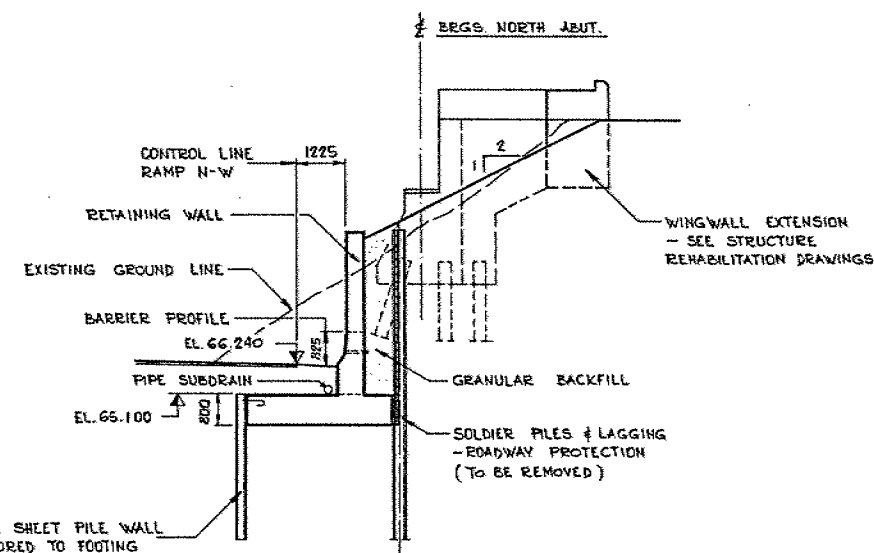
PLAN AT NORTH ABUTMENT (DECK NOT SHOWN)
1:200



1
1:200



2
1:100



3
1:100

WORK DESCRIPTION

1. DETOUR ALL TRAFFIC OVER NORTHBOUND STRUCTURE.
2. INSTALL TRAFFIC PROTECTION ALONG HWY 417.
3. REMOVE CONCRETE SLOPE PAVING.
4. INSTALL PRESTRESSED SOIL ANCHORS THROUGH EXISTING ABUTMENT.
5. DRIVE SOLDIER PILES FOR ROADWAY PROTECTION EAST AND WEST OF ABUTMENT.
6. PROGRESSIVELY EXCAVATE AND INSTALL LAGGING FOR ROADWAY PROTECTION AND GROUT VOIDS BEHIND LAGGING.
7. CONSTRUCT RETAINING WALL.
8. PLACE GRANULAR BACKFILL AND CRUSHED STONE PAVING.
9. CONSTRUCT NORTH-EAST WINGWALL EXTENSION AS PART OF STRUCTURE REHABILITATION (WP NO. 202-86-01).
10. REGRADE APPROACH FILL SLOPES TO SUIT RETAINING WALL.

GENERAL NOTES

CLASS OF CONCRETE

FOOTINGS 20 MPa
REMAINDER 30 MPa

REINFORCING STEEL

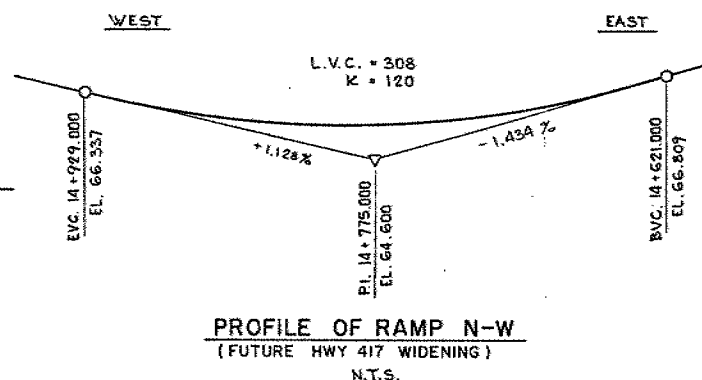
REINFORCING STEEL SHALL BE GRADE 400 UNLESS SPECIFIED. BAR MARKS WITH SUFFIX 'C' SHALL BE USED.

CLEAR COVER TO REINFORCING STEEL

FOOTINGS 100±
RETAINING WALL: FRONT FACE 80±
BACK FACE 70±
REMAINDER UNLESS OTHERWISE NOTED 70±

CONSTRUCTION NOTES

1. FOR STAGING DETAILS AND MAINTENANCE SEE STAGING DRAWINGS.
2. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS, ELEVATIONS, AND DETAILS EXISTING WORK ON SITE AND REPORT DISCREPANCIES TO THE ENGINEER BEFORE PROCEEDING WITH THE WORK. DIMENSIONS AND ELEVATIONS SHALL BE ADJUSTED AS REQUIRED TO SUIT PROPOSED WORK.



PROFILE OF RAMP N-W
(FUTURE HWY 417 WIDENING)
N.T.S.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	GSS	CHECK	JWH
DRAWING	WK	CHECK	GSS
		LOADING	CHRD-A-83
		SITE No	3-39/ES

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 89-107



Ministry of
Transportation and
Communications

INDEX

<u>Page No:</u>	<u>Description</u>
1	Index
2	Abbreviations & Symbols
3	Foundation Investigation Report for Richmond Rd. Underpass W.P. 124-87-01, Site 3-39 Hwy. 416/417, Dist. 9, Ottawa

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

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
Richmond Road Underpass, North and South Abutments
Reconstruction Hwy. 416/417
WP 124-87-01, Site 3-39
District 9, Ottawa

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above-mentioned site during the period of August 2 to August 9, 1988. The reconstruction of Highway 417 in the vicinity of the above structure will require modification of the north abutment and construction of a retaining wall in front of the forward slopes of the south abutment.

As described in our previous Foundation Investigation Report (WP 909-64, May 1966), three boreholes (BH's #1, #2 and #3) were drilled and sampled in March of 1966 as part of the foundation investigation for the structure widening of the Richmond Road underpass of the Hwy. 417 extension. These boreholes were advanced using conventional diamond drilling equipment with dynamic cone penetration tests. In addition, one separate dynamic cone penetration test was carried out (BH #4). These boreholes extended to a maximum depth of 28.3 metres below the ground surface. The results obtained from these boreholes (BH #1 to #3) are utilized in this report.

During the August of 1988, five additional boreholes (BH's #5 to #6C) were advanced and sampled as part of this project by means of hollow stem augers with washboring techniques and using a conventional diamond drill (B casing and BX Rock Core barrel) adopted for soil and rock sampling purposes. These borehole extended down to depths 2.4 and 26.1 metres below the existing ground surface. Originally, it was envisaged that two additional boreholes would be put down at the abutment locations (one each abutment). However, during the site investigation, it was found that the bedrock surface is erratic in the vicinity of the north abutment. Three additional boreholes (BH's 6A, 6B and 6C) were drilled to delineate the bedrock surface in this area.

This report contains factual information together with discussion and recommendations pertaining to the subsurface conditions, structure foundations, retaining walls and related earthworks for the structure as shown on Drawing No. 2.

SITE DESCRIPTION AND GEOLOGY

The proposed structure site is located on the existing Hwy. 417 at the existing Richmond Road in the City of Nepean, Ottawa-Carleton Municipality. The topography of the area is generally flat to gently undulating with the land in the immediate vicinity being used for commercial purposes. Residential development exists north and south of the site.

Physiographically, the site lies in the area known as the Ottawa Valley clay plains founded in the Lowlands of the St. Lawrence. The subsoil consists of clay plains interrupted by ridges of rock or sand. Fault scarps are also evident within the area, an illustration of the numerous normal faults that dominate the region. The bedrock in the area is of the Rockcliffe and Gull River formations of the middle Ordovician period. It consists of interbedded fine grained quartz sandstone, silty dolostone, and limestone. The overburden was deposited during and immediately following the Wisconsin glaciation at which time the area was depressed from the effect of the glaciation. Following the retreat of the glacier, the brackish waters of the Champlain Sea flooded the area and then gradually receded as the land rebounded with the deposition of sediments to it's present level.

FIELD INVESTIGATION AND LABORATORY ANALYSES

The fieldwork for the site investigation was carried out between August 2 and August 9, 1988 and consisted of five (5) sampled boreholes accompanied by dynamic cone penetration tests. Continuous flight hollow stem auger equipment and washboring techniques with B Casing were used to advance the boreholes in the overburden. Soil samples were retrieved at selected intervals by a split spoon sampler or shelly tube in accordance with the Standard Penetration Test (ASTM D1586). Samples were identified in the field and then returned to the laboratory for appropriate testing. Bedrock was proven, at a number of locations, minimum 1.2 m using conventional rock coring methods.

Water levels were obtained in the open boreholes until approximate stabilized levels were observed. Survey information related to location and elevation of boreholes was provided by Eastern Region Surveys and plans.

To identify the behaviour, gradation, properties and characteristics of the soil, various laboratory testing were performed as follows:

- Atterberg Limit Tests
- Grain Size Analyses
- Natural Moisture Contents
- Unconfined Compression Test
- Consolidation Tests

Laboratory test results have been summarized and are included in the Appendix of this report.

SUBSURFACE CONDITIONS

The subsoil conditions are generally quite variable across the site. The upper 14 metres of the subsoil consists of interbedded layers of clayey silt and sandy silt or silty sand to sand. The consistency of the clayey silt layers varies from soft to hard, whereas the denseness of the sand layers may be described as loose to very dense. The stratigraphy is quite irregular and reference should be made to the individual borehole log sheets. Beneath this layered deposit and immediately above the bedrock is a deposit of sandy silt to sand. The denseness of this deposit generally varies from loose to very dense.

It should be noted that in the vicinity of south abutment near BH #1 a layer of silty clay to clayey silt was encountered. In certain areas Sand fill was encountered near the road way at four boreholes (BH's #6, #6A, #6B and #6C). Isolated concrete slabs and asphalt material were also present immediately beneath the surface (BH's #6 and #6C).

A detailed description of the subsurface conditions encountered is given below.

Fill Material

The fill material was encountered in the vicinity of both approaches. This fill consists of brown clayey silt to sand and gravel. The thickness of this layer varies from 1.1 metres at BH #5 to 5.8 metres at BH #6C. Through visual observation, it is apparent that the fill material is similar to the surface material which was found adjacent to the site.

Clayey Silt with Interbedded Layers of Sandy Silt

This deposit occurred from ground surface to a depth of 11.6 to 14.7 metres. The thickness of the individual layers varies between 1.0 and 5.1 metres.

The results from the Atterberg Limit Test performed on this material are summarized as follows:

<u>Property</u>	<u>Range (%)</u>
Natural Moisture Content (w)	13-30
Liquid Limit (w_L)	22.0-30
Plastic Limit (w_p)	10.5-14.5
Plasticity Index (I_p)	11-16
Unit Weight (kN/m^3)	20.3

From the plasticity chart (Figure 1), it is evident that the layer can be classified as an inorganic clayey silt with interbedded Sandy Silt with low plasticity (CL).

Grain size distribution tests were carried out on these materials. Figure 2 in the Appendix shows the results in an envelope form.

Undrained shear strength measurements were determined by laboratory tests and the result varies from 2.1 to 143 kPa. The consistency of the clayey silt layers can be described as soft to very stiff.

The results (e-log P curves) of one consolidation test on representative sample indicated that the clayey silt has been preconsolidated in the the past to an effective pressure of 645 kPa in excess of the existing effective overburden pressure. The details of the results area as follows:

<u>Parameters</u>	<u>Ranges</u>
Preconsolidation pressure, P_c (kPa)	645
Initial Voild Radio (e_o)	0.79
Compression Index (C_c)	0.43

Silty Sand to Sand

This deposit encountered at various depths from ground surface to bedrock. However, below a depth of about 14.0 metres, this granular deposit extended as a continuous layer to bedrock. The thickness of the upper layers varies from 0.9 to 8.6 metres, whereas the thickness of the lower extensive deposit ranges from 3.0 to 13.7 metres.

This deposit contains minor variations in gravel content throughout its thickness. Generally, the deposit contains trace of gravel, but at some locations, considerable gravel was encountered. Grain size distribution analysis indicate that the soil varies between a silty sand to sand. This layer is basically non-plastic. Figure 3 in the Appendix shows the results of grain size distribution tests in an envelope form.

In this stratum, the 'N' values generally ranged from 2 to over 100 blows/0.3 m indicating a state of compaction described as very loose to very dense.

However, at certain locations no resistance was encountered and the samples penetrated by its own weight. This may be attributed to 'boiling' of subsoil due to unbalanced hydrostatic head and consequently do not represent the undisturbed denseness of the soil.

Bedrock

Fine grained, greenish grey to light grey sandstone bedrock was exposed at the ground surface (Appr. elev. 67.0 metres) east of BH #6B. In BH #6B, bedrock was encountered beneath the sand and gravel fill at a depth of 1.2 metres (elev. 66.6). At other locations, the granular deposit is directly underlain by bedrock. The bedrock was proven at various locations by obtaining up to 3.1 m of rock core. Bedrock consists mainly of sandstone or silty dolostone of Rockcliffe and Gull River Formation. Minor beds of shale and silty sandstone were also found interbedded in the rock formation at BH #6. Detailed description of the rock are attached in the Appendix entitled "Description of Rock Core".

Core recoveries and rock quality designation (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Based on the results, the rock can be classified as medium strong to strong rock and predominantly unweathered on the south side and slightly fractured on the north side.

It should be noted that the bedrock surface drops sharply from elevation 66.6 m at BH #6B to elevation 57.9 m at BH #6 and further drops to 44.8 m at BH #3 as shown on sections in Drawing 2. It should be also noted that the sandstone bedrock changes to shaly bedrock at three boreholes (BH #1, #2 and #3) and further to silty dolostone at BH #5. This suggests the presence of a geologic discontinuity such as local fault scarps or local faults. The bedrock surface is gently declined toward westly and southerly as shown on sections.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Groundwater level in the boreholes was found to range between 62.6 m at BH #5 and 64.9 m at BH #6 which corresponds to depths of 3.3 metres to 7.1 metres below the existing ground surface.



Tae C. Kim
Tae C. Kim, P.Eng.
Foundation Engineer

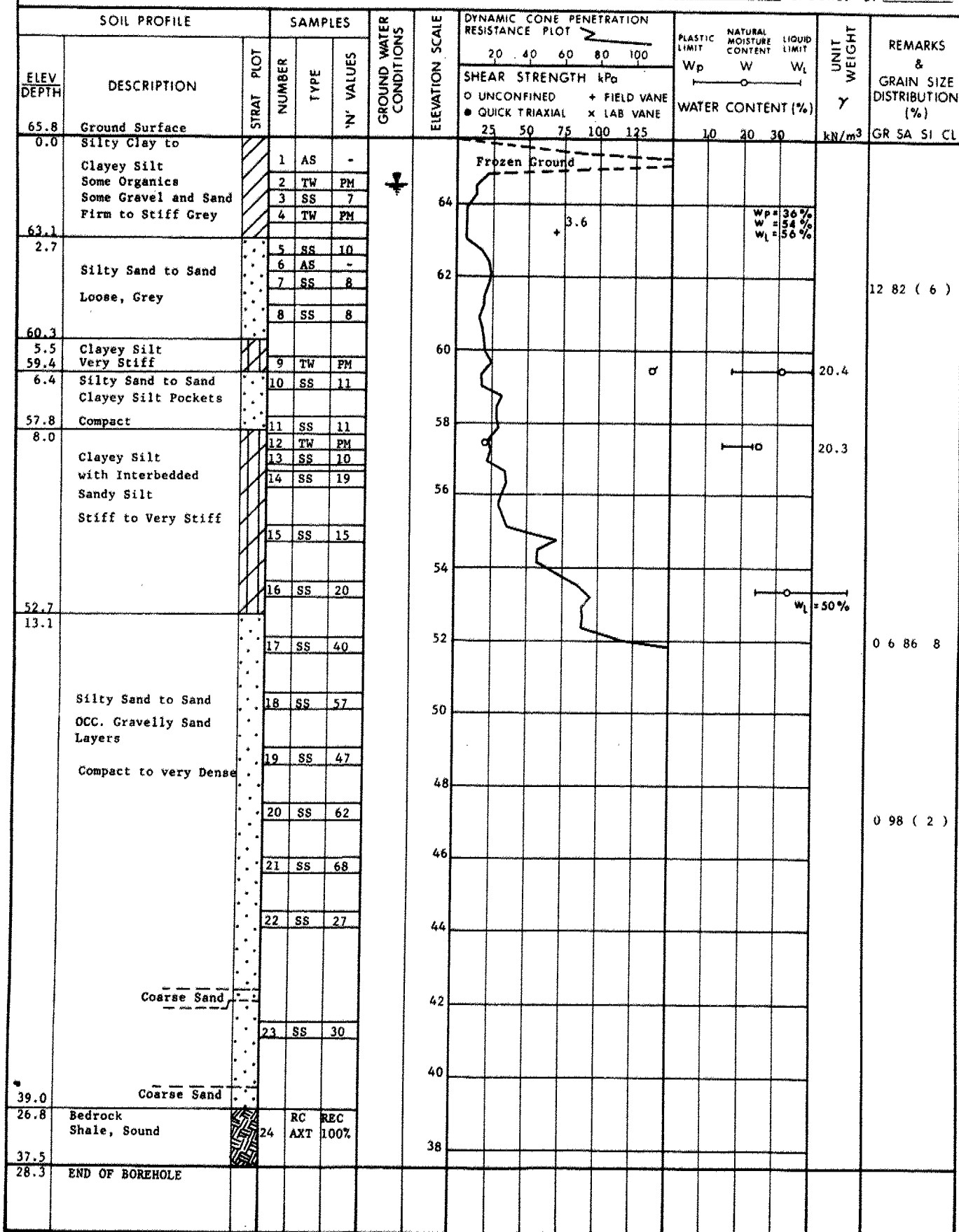
M. Devata
Murty Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

RECORD OF BOREHOLE No 1 (Formerly WP 909-64) METRIC

W P 124-87-01 LOCATION Co-Ords N 5022 813.1; E 359 153.5 ORIGINATED BY PLW
 DIST 9 HWY 417 BOREHOLE TYPE Washboring & Diamond Drill COMPILED BY LP
 DATUM Geodetic DATE 1966 03 02 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 2 (formerly WP 909-64) METRIC

W P 124-87-01 LOCATION Co-Ords N 5022 845.7; E 359 182.2 ORIGINATED BY PLW
 DIST 9 HWY 417 BOREHOLE TYPE Washboring & Diamond Drilling COMPILED BY LP
 DATUM Geodetic DATE 1966 03 07 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	25 50 75 100 125					
65.6	Ground Surface													
0.0	Silty Sand to Sand Compact to Very Loose		1	SS	11	*								
63.4			2	SS	3									
2.2	Clayey Silt with Interbedded Sandy Silt		3	TW	PM									
61.3	Firm to Stiff		4	SS	10									
4.3	Silty Sand to Sand Compact		5	SS	14									
60.0			6	TW	PM									
5.6	Clayey Silt with Interbedded Sandy Silt - Very Stiff		7	SS	6									
59.0	Silty Sand to Sand Loose		8	TW	PM									
57.4			9	SS	12									
8.2	Clayey Silt with Interbedded Sandy Silt Stiff		10	SS	-									
55.9	Silty Sand to Sand Loose		11	TW	PM									
54.4			12	SS	OW									
11.2	Clayey Silt with Interbedded Sandy Silt Very Stiff		13	SS	OW									
52.6			14	SS	OW									
13.0	Silty Sand to Sand OCC. Silt Layers Very Loose to Dense		15	SS	26									
			16	SS	45									
	Coarse Sand OCC. Gravel													
41.9														
23.7	Bedrock Shale, Sound		17	RC AXT	REC 98%									
40.3														
25.3	END OF BOREHOLE													
Notes: O.W. = Own Weight * Hole caved in at Elev. 65.1m Water level not established														

RECORD OF BOREHOLE No 3 (Formerly WP 909-64) METRIC

W P 124-87-01 LOCATION Co-Orda N 5022 875.0; E 359 183.5 ORIGINATED BY PLW
 DIST 9 HWY 417 BOREHOLE TYPE Washboring & Diamond Drilling COMPILED BY LP
 DATUM Geodetic DATE 1966 03 10 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

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					
65.9	Ground Level													
0.0	Clayey Silt with Interbedded Sandy Silt Soft to Firm		1	SS	4	*								
64.1			2	TW	PM									
1.8			3	SS	14									
			4	SS	31									
	Silty Sand to Sand Some Gravel		5	SS	18									
			6	SS	26									
	Compact to Very Dense		7	SS	12									
			8	SS	11									
			9	SS	62									
55.5	Clayey Silt with Interbedded Sandy Silt		10	SS	31									
10.4			11	TW	PM									
54.3	Very Stiff to Hard		12	SS	35									
11.6			13	SS	31									
	Silty Sand to Sand		14	SS	56									
	Dense to Very Dense		15	SS	48									
44.8														
21.1	Bedrock		16	RC	REC									
43.7	Shale Sound			AXT	100%									
22.2	END OF BOREHOLE													
	* Hole caved in at Elev. 64.8m Water Level Not Established													

RECORD OF BOREHOLE No 5

METRIC

W P 124-87-01 LOCATION Co-Ords N 5022 814.9; E 359 202.4
 DIST 9 HWY 417 BOREHOLE TYPE H-S Auger, 'B'- Casing BX Rock Core & Cone Test
 DATUM Gonderic DATE 88 08 02-03
 ORIGINATED BY MS
 COMPILED BY MS
 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	25 50 75 100 125					
65.9	Ground Surface													
0.0	Clayey Silt (Fill)													GR SA SI CL
64.8														
1.1	Silty Sand to Sand		1	SS	11									
	Trace to Some Clay		2	SS	6									
			3	SS	4									
	Loose to Compact		4	SS	14									
61.5			5	SS	11									
4.4	Clayey Silt with Interbedded Sandy Silt Occ. Silty Clay Layers Firm to Very Stiff		6	SS	5									0 77 13 10
			7	TW	PH									
			8	TW	PH									0 4 71 25
			9	SS	25									0 13 69 18
57.3														
8.6	Silty Sand to Sand Compact to Dense		10	SS	30									0 68 21 11
			11	SS	15									
54.2														
11.7	Clayey Silt with Interbedded Sandy Silt Firm to Very Stiff		12	SS	25									
			13	SS	4									0 23 60 17
51.2														
14.7	Silty Sand to Sand Occ. Clayey Silt Layers Occ. Gravelly Sand Loose to Very Dense		14	SS	8									
			15	SS	4									
	Clayey Silt		16	SS	90/	15cm								0 73 20 7
41.8														
24.1	Bedrock		17	RC	REC 93%									RQD = 75%
	Silty Dolostone		18	RC	REC 90%									RQD = 56%
39.8														
26.1	END OF BOREHOLE													

RECORD OF BOREHOLE No 6

METRIC

W P 124-87-01 LOCATION Co-Ords N 5 022 884.2; E 359 214.1 ORIGINATED BY MS
 DIST 9 HWY 417 BOREHOLE TYPE B-Casing, BX Rock Core COMPILED BY MS
 DATUM Geodetic DATE 88 08 09 CHECKED BY TCK

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
72.5	Ground Surface																
0.0	Concrete Slab		1	RC			72										GR SA SI CL
71.9																	
0.6																	
	Sand Fill						70										
							68										
66.4																	
6.1	Silty Sand to Sand Compact		2	SS	10		66										
			3	SS	23												
63.9							64										0 46 36 18
8.6	Clayey Silt with interbedded Silty Sand Stiff to very Stiff		4	SS	11												
			5	SS	29		62										0 46 37 17
60.9																	
11.6	Silty Sand to Sand Trace of Clay Very Dense		6	SS	63		60										
			7	SS	52												
57.9							58										0 78 16 6
14.6	Bedrock Sandstone, Shale and Silty Sandstone		8	RC	REC 89%												RQD = 8%
			9	RC	REC 87%		56										RQD = 8%
54.8																	
17.7	END OF BOREHOLE																

+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6A

METRIC

W P 124-87-01 LOCATION Co-Ords N 5 022 884.5; E 359 213.8 ORIGINATED BY MS
 DIST 9 HWY 417 BOREHOLE TYPE H-S Auger COMPILED BY MS
 DATUM Geodetic DATE 88 08 04 CHECKED BY TCK

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 (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
72.5	Ground Surface										
0.0	Sand Fill		1	SS	30	*	72				
	Dense to very Dense		2	SS	43		70				
67.0			3	SS	66		68				
5.5	END OF BOREHOLE (Probable Concrete Slab) * Borehole Dry										

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 68

METRIC

W P 124-87-01 LOCATION Co-Ords N 5022 887.8; E 359235.6 ORIGINATED BY MS
 DIST 9 HWY 417 BOREHOLE TYPE H-S Auger, BX Rock Core COMPILED BY MS
 DATUM Geodetic DATE 88 08 05 CHECKED BY TCK

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					
67.8	Ground Surface																
0.0																	
66.6	Sand and Gravel (Fill)					*											GR SA SI CL
1.2	Bedrock		1	RC	REC	76%											
65.4	Sandstone		2	RC	REC	65%	66										RQD = 0%
2.4	END OF BOREHOLE																RQD = 0%
	* Borehole Dry																

OFFICE REPORT ON SOIL EXPLORATION

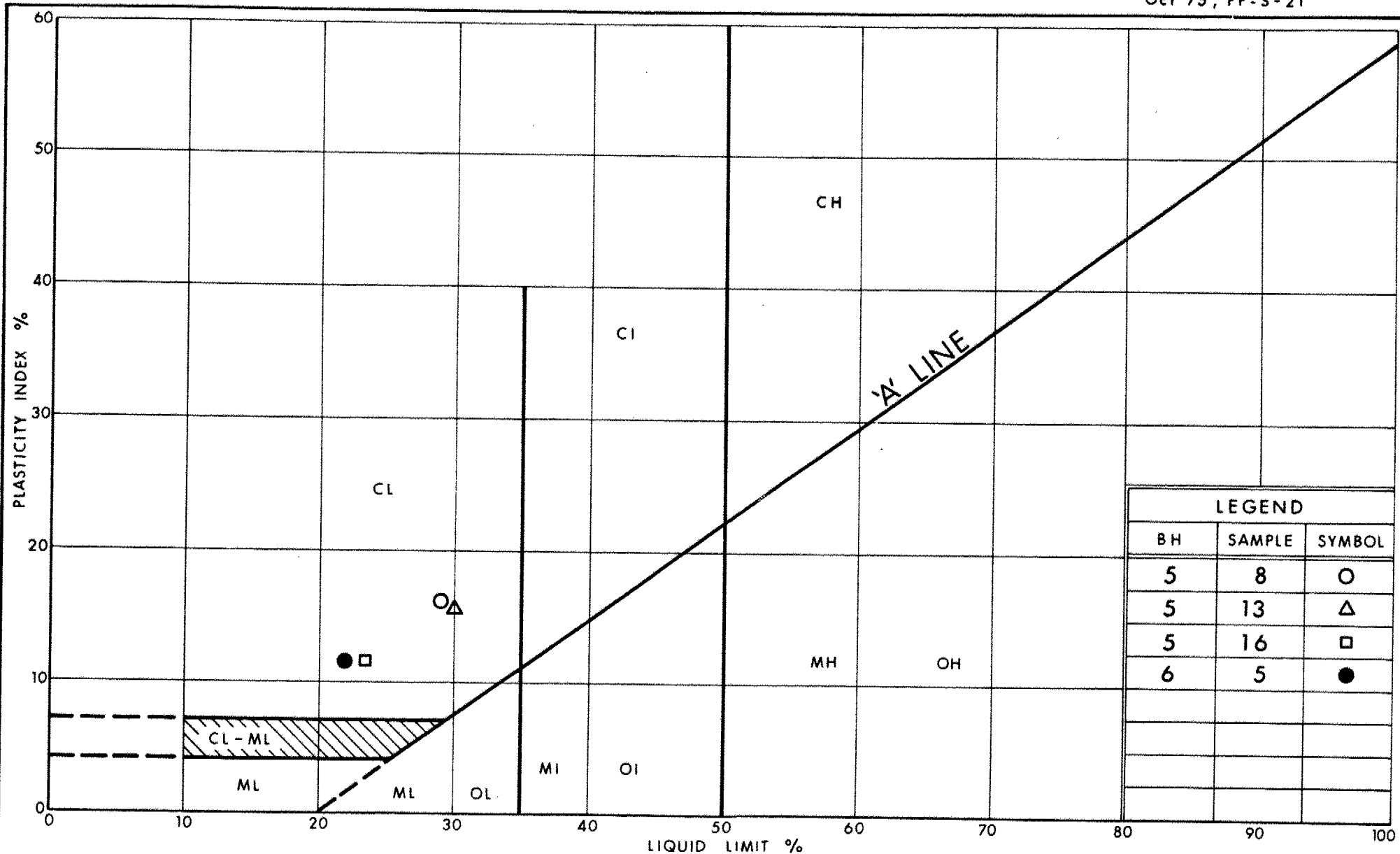
RECORD OF BOREHOLE No 6C

METRIC

W P 124-87-01 LOCATION Co-Orde N 5022 897.4; E 359 221.2 ORIGINATED BY MS
 DIST 9 HWY 417 BOREHOLE TYPE H-S Auger, 'B' Casing, BX Rock Core COMPILED BY MS
 DATUM Geodetic DATE 88 08 05 CHECKED BY TCK

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
72.4	Ground Surface																
71.8	Asphalt					*											
0.6	Clayey Silt to Sand (Fill)		1	AS	-												
			2	SS	11												
			3	SS	60	15cm											
66.0			4	SS	39												
6.4	Silty Sand to Sand																
65.1																	
7.3	Bedrock																
63.7	Sandstone		5	RC	REC 89%											RQD = 0%	
8.7	END OF BOREHOLE *Water Level Not Established																

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
Transportation

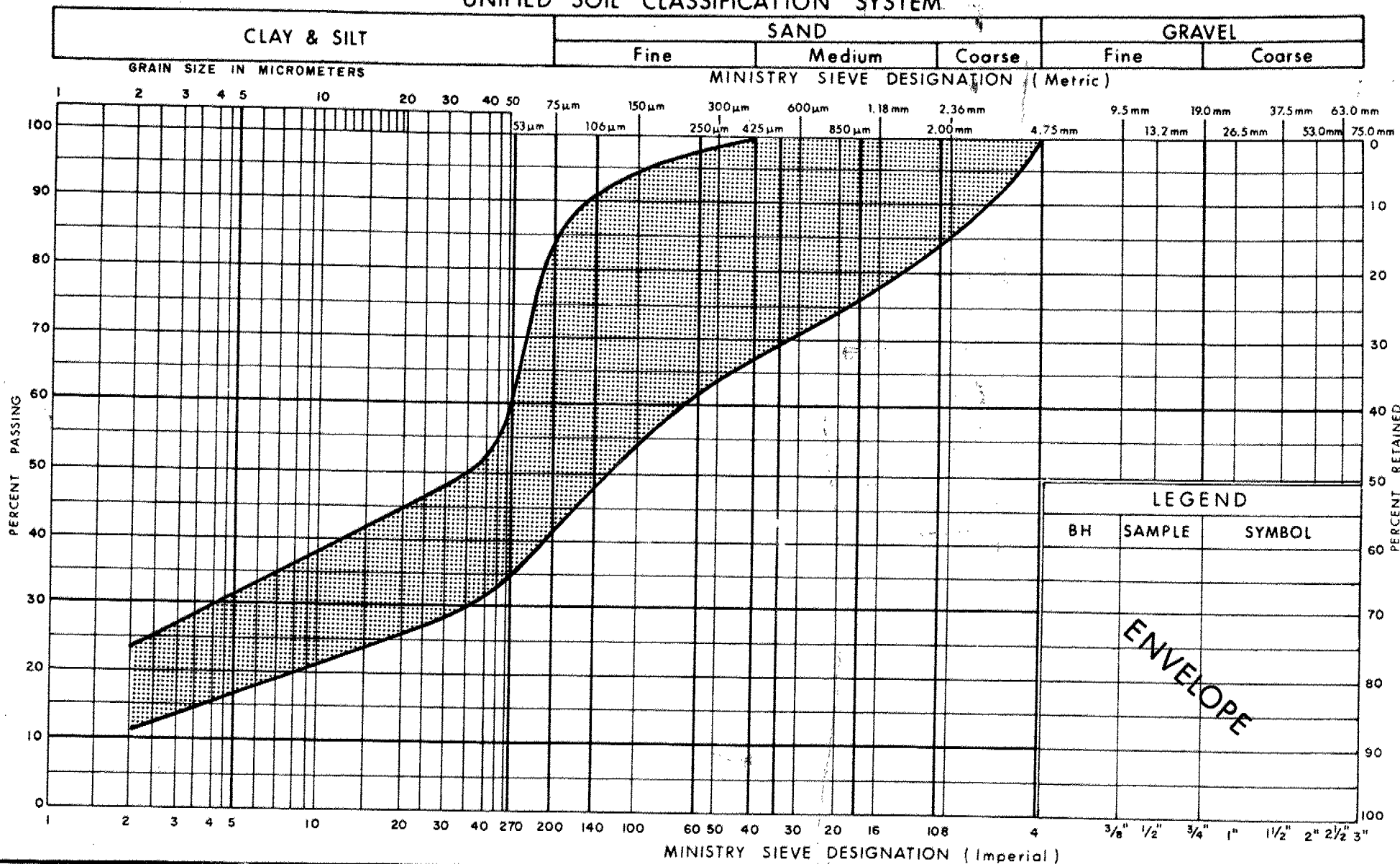
PLASTICITY CHART

CLAYEY SILT, WITH INTERBEDDED SANDY SILT

FIG No 1

W P 124-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

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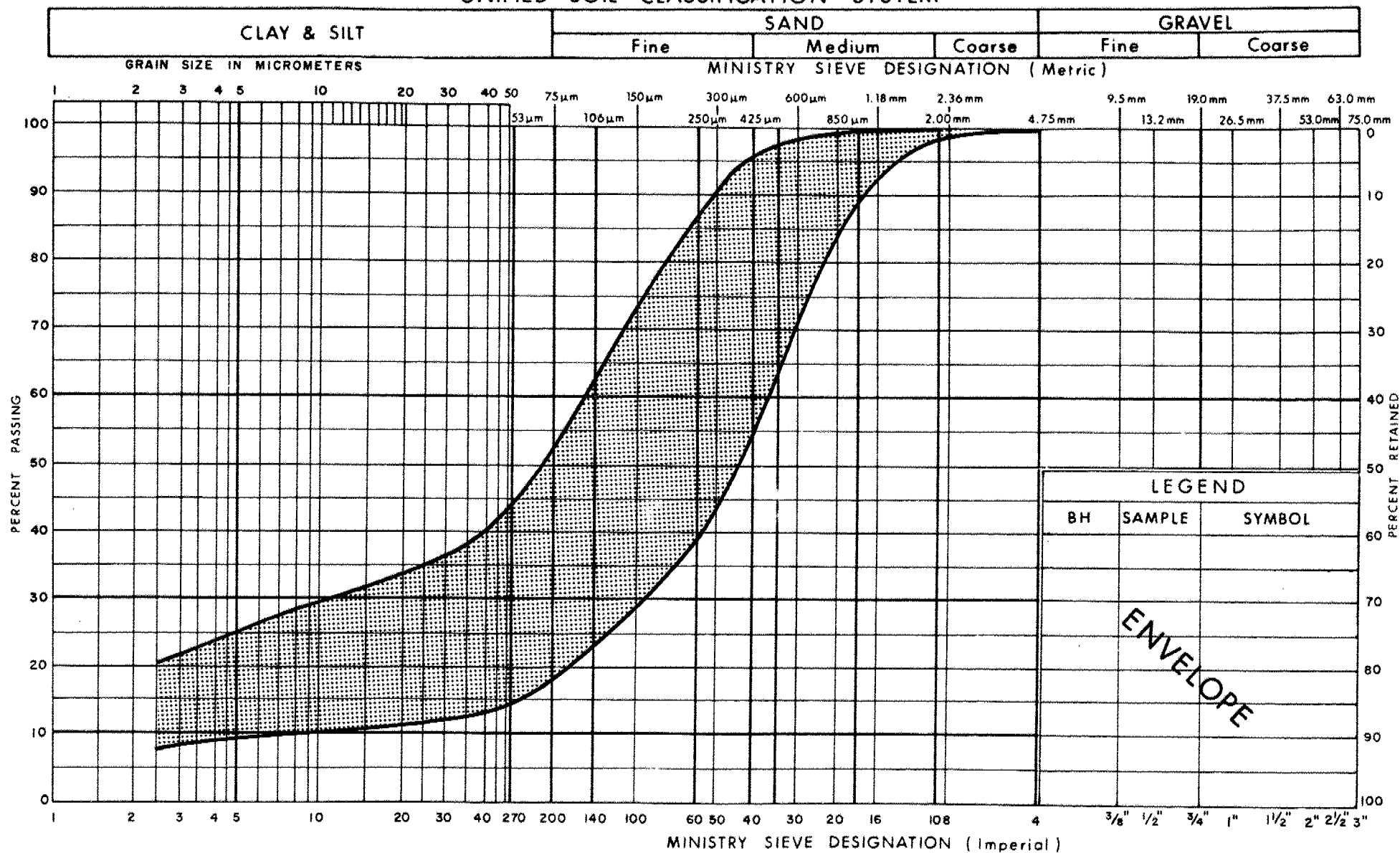
GRAIN SIZE DISTRIBUTION

CLAYEY SILT, WITH INTERBEDDED SANDY SILT

FIG No 2

W P 124-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION SILTY SAND TO SAND

FIG No 3

W P 124-87-01

DESCRIPTION OF ROCK CORE - WP 124-87-01

CORE RECOVERY				CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
5	RC17 24.08-24.84	93	75	24.08-26.06	SILTY DOLOSTONE , medium light grey to dark grey; very fine grained; thick bedded; medium strong rock; very close to close spaced fractures: horizontal bedding joints, smooth to irregular, planar; near vertical joint set, rough, planar, closed.
	RC18 24.84-26.06	90	56		
6b	RC1 1.22- 1.80	76	0	1.22- 2.39	SANDSTONE , greenish grey to light grey; fine grained; medium bedded with course grained beds up to 20 cm thick; medium strong rock; unweathered; very close spaced fractures: horizontal, rough planar.
	1.80- 2.39	65	0		
6c	RC5 7.32- 8.71	89	0	7.32- 8.71	SANDSTONE , light grey, streaked medium grey; fine to medium grained; medium bedded with thin beds of SHALE up to 6 cm thick (10%); medium strong rock; unweathered; very close spaced fractures: horizontal, rough, planar.
6	RC8 14.63-16.15	89	8	14.63-16.15	SANDSTONE , light grey streaked medium dark grey; fine grained; medium bedded with course grained beds up to 1 cm thick; medium strong rock; unweathered; very close spaced fractures: horizontal, rough planar.
	RC9 16.15-17.68	87	8	16.15-17.17	SHALE , medium dark grey, streaked light grey; very fine grained; thinly bedded; medium strong to weak rock; unweathered; very close spaced fractures: horizontal bedding joints, irregular, planar closed.
				17.17-17.68	SANDSTONE, SILTY SANDSTONE , medium light grey streaked greenish grey; medium to fine grained; thin bedded with interbed of SHALE (9cm); medium strong rock; unweathered; very close spaced fractures: horizontal, rough, planar, closed.

NOTE: Depths are approximated in zones of poor core recovery.

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT. 89-107

WP 124-87-01

DIST 9

HWY 416/417

STR SITE 3-39

Richmond Road Underpass
North and South Abutments

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File

FOUNDATION INVESTIGATION REPORT
For
Richmond Road Underpass, North and South Abutments
Reconstruction Hwy. 416/417
WP 124-87-01, Site 3-39
District 9, Ottawa

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above-mentioned site during the period of August 2 to August 9, 1988. The reconstruction of Highway 417 in the vicinity of the above structure will require modification of the north abutment and construction of a retaining wall in front of the forward slopes of the south abutment.

As described in our previous Foundation Investigation Report (WP 909-64, May 1966), three boreholes (BH's #1, #2 and #3) were drilled and sampled in March of 1966 as part of the foundation investigation for the structure widening of the Richmond Road underpass of the Hwy. 417 extension. These boreholes were advanced using conventional diamond drilling equipment with dynamic cone penetration tests. In addition, one separate dynamic cone penetration test was carried out (BH #4). These boreholes extended to a maximum depth of 28.3 metres below the ground surface. The results obtained from these boreholes (BH #1 to #3) are utilized in this report.

During the August of 1988, five additional boreholes (BH's #5 to #6C) were advanced and sampled as part of this project by means of hollow stem augers with washboring techniques and using a conventional diamond drill (B casing and BX Rock Core barrel) adopted for soil and rock sampling purposes. These borehole extended down to depths 2.4 and 26.1 metres below the existing ground surface. Originally, it was envisaged that two additional boreholes would be put down at the abutment locations (one each abutment). However, during the site investigation, it was found that the bedrock surface is erratic in the vicinity of the north abutment. Three additional boreholes (BH's 6A, 6B and 6C) were drilled to delineate the bedrock surface in this area.

This report contains factual information together with discussion and recommendations pertaining to the subsurface conditions, structure foundations, retaining walls and related earthworks for the structure as shown on Drawing No. 1248701-A.

SITE DESCRIPTION AND GEOLOGY

The proposed structure site is located on the existing Hwy. 417 at the existing Richmond Road in the City of Nepean, Ottawa-Carleton Municipality. The topography of the area is generally flat to gently undulating with the land in the immediate vicinity being used for commercial purposes. Residential development exists north and south of the site.

Physiographically, the site lies in the area known as the Ottawa Valley clay plains founded in the Lowlands of the St. Lawrence. The subsoil consists of clay plains interrupted by ridges of rock or sand. Fault scarps are also evident within the area, an illustration of the numerous normal faults that dominate the region. The bedrock in the area is of the Rockcliffe and Gull River formations of the middle Ordovician period. It consists of interbedded fine grained quartz sandstone, silty dolostone, and limestone. The overburden was deposited during and immediately following the Wisconsin glaciation at which time the area was depressed from the effect of the glaciation. Following the retreat of the glacier, the brackish waters of the Champlain Sea flooded the area and then gradually receded as the land rebounded with the deposition of sediments to it's present level.

FIELD INVESTIGATION AND LABORATORY ANALYSES

The fieldwork for the site investigation was carried out between August 2 and August 9, 1988 and consisted of five (5) sampled boreholes accompanied by dynamic cone penetration tests. Continuous flight hollow stem auger equipment and washboring techniques with B Casing were used to advance the boreholes in the overbuden. Soil samples were retrieved at selected intervals by a split spoon sampler or shelby tube in accordance with the Standard Penetration Test (ASTM D1586). Samples were identified in the field and then returned to the laboratory for appropriate testing. Bedrock was proven, at a number of location, minimum 1.2 m using conventional rock coring methods.

Water levels were obtained in the open boreholes until approximate stabilized levels were observed. Survey information related to location and elevation of boreholes was provided by Eastern Region Surveys and plans.

To identify the behaviour, gradation, properties and characteristics of the soil, various laboratory testing were performed as follows:

- Atterberg Limit Tests
- Grain Size Analyses
- Natural Moisture Contents
- Unconfined Compression Test
- Consolidation Tests

Laboratory test results have been summarized and are included in the Appendix of this report.

SUBSURFACE CONDITIONS

The subsoil conditions are generally quite variable across the site. The upper 14 metres of the subsoil consists of interbedded layers of clayey silt and sandy silt or silty sand to sand. The consistency of the clayey silt layers varies from soft to hard, whereas the denseness of the sand layers may be described as loose to very dense. The stratigraphy is quite irregular and reference should be made to the individual borehole log sheets. Beneath this layered deposit and immediately above the bedrock is a deposit of sandy silt to sand. The denseness of this deposit generally varies from loose to very dense.

It should be noted that in the vicinity of south abutment near BH #1 a layer of silty clay to clayey silt was encountered. In certain areas Sand fill was encountered near the road way at four boreholes (BH's #6, #6A, #6B and #6C). Isolated concrete slabs and asphalt material were also present immediately beneath the surface (BH's #6 and #6C).

A detailed description of the subsurface conditions encountered is given below.

Fill Material

The fill material was encountered in the vicinity of both approaches. This fill consists of brown clayey silt to sand and gravel. The thickness of this layer varies from 1.1 metres at BH #5 to 5.8 metres at BH #6C. Through visual observation, it is apparent that the fill material is similar to the surface material which was found adjacent to the site.

Clayey Silt with Interbedded Layers of Sandy Silt

This deposit occurred from ground surface to a depth of 11.6 to 14.7 metres. The thickness of the individual layers varies between 1.0 and 5.1 metres.

The results from the Atterberg Limit Test performed on this material are summarized as follows:

<u>Property</u>	<u>Range (%)</u>
Natural Moisture Content (w)	13-30
Liquid Limit (w_L)	22.0-30
Plastic Limit (w_p)	10.5-14.5
Plasticity Index (I_p)	11-16
Unit Weight (kN/m^3)	20.3

From the plasticity chart (Figure 1), it is evident that the layer can be classified as an inorganic clayey silt with interbedded Sandy Silt with low plasticity (CL).

Grain size distribution tests were carried out on these materials. Figure 2 in the Appendix shows the results in an envelope form.

Undrained shear strength measurements were determined by laboratory tests and the result varies from 2.1 to 143 kPa. The consistency of the clayey silt layers can be described as soft to very stiff.

The results (e-log P curves) of one consolidation test on representative sample indicated that the clayey silt has been preconsolidated in the the past to an effective pressure of 645 kPa in excess of the existing effective overburden pressure. The details of the results area as follows:

<u>Parameters</u>	<u>Ranges</u>
Preconsolidation pressure, P_c (kPa)	645
Initial Voild Radio (e_o)	0.79
Compression Index (C_c)	0.43

Silty Sand to Sand

This deposit encountered at various depths from ground surface to bedrock. However, below a depth of about 14.0 metres, this granular deposit extended as a continuous layer to bedrock. The thickness of the upper layers varies from 0.9 to 8.6 metres, whereas the thickness of the lower extensive deposit ranges from 3.0 to 13.7 metres.

This deposit contains minor variations in gravel content throughout its thickness. Generally, the deposit contains trace of gravel, but at some locations, considerable gravel was encountered. Grain size distribution analysis indicate that the soil varies between a silty sand to sand. This layer is basically non-plastic. Figure 3 in the Appendix shows the results of grain size distribution tests in an envelope form.

In this stratum, the 'N' values generally ranged from 2 to over 100 blows/0.3 m indicating a state of compaction described as very loose to very dense.

However, at certain locations no resistance was encountered and the samples penetrated by its own weight. This may be attributed to 'boiling' of subsoil due to unbalanced hydrostatic head and consequently do not represent the undisturbed denseness of the soil.

Bedrock

Fine grained, greenish grey to light grey sandstone bedrock was exposed at the ground surface (Appr. elev. 67.0 metres) east of BH #6B. In BH #6B, bedrock was encountered beneath the sand and gravel fill at a depth of 1.2 metres (elev. 66.6). At other locations, the granular deposit is directly underlain by bedrock. The bedrock was proven at various locations by obtaining up to 3.1 m of rock core. Bedrock consists mainly of sandstone or silty dolostone of Rockcliffe and Gull River Formation. Minor beds of shale and silty sandstone were also found interbedded in the rock formation at BH #6. Detailed description of the rock are attached in the Appendix entitled "Description of Rock Core".

Core recoveries and rock quality designation (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Based on the results, the rock can be classified as medium strong to strong rock and predominantly unweathered on the south side and slightly fractured on the north side.

It should be noted that the bedrock surface drops sharply from elevation 66.6 m at BH #6B to elevation 57.9 m at BH #6 and further drops to 44.8 m at BH #3 as shown on sections in Drawing 1248701-A. It should be also noted that the sandstone bedrock changes to shaly bedrock at three boreholes (BH #1, #2 and #3) and further to silty dolostone at BH #5. This suggests the presence of a geologic discontinuity such as local fault scarps or local faults. The bedrock surface is gently declined toward westly and southerly as shown on sections.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Groundwater level in the boreholes was found to range between 62.6 m at BH #5 and 64.9 m at BH #6 which corresponds to depths of 3.3 metres to 7.1 metres below the existing ground surface.

DISCUSSION AND RECOMMENDATIONS

The recommendations in this report apply to the bridge foundations and related retaining walls.

In order to widen the Hwy. 417 in the vicinity of Richmond Road, it is proposed to modify the existing perched foundation at the north abutment location to a "closed-type" abutment. It is also proposed to construct a new retaining wall in front of the forward slopes of the south abutment.

To incorporate this, it is proposed to cut off the existing H-piles at new footing level at the north abutment. Additional piles would be driven to bedrock if required in order to support additional loads due to heavier concrete.

North Abutment

The existing structure is founded on the end-bearing 'H' piles driven to bedrock within the perched approached fills. In view of the weak nature of the subsoils, the proposed 'closed-type' abutment and associated wing walls should be founded on end-bearing 'H' piles driven to bedrock.

In order to modify the existing perched abutment to a 'closed-type' abutment, the bridge spans in the vicinity of the north abutment should be temporarily supported by shoring system. The approach fills at the north abutment location should be excavated down to the new pile cap elevation. The temporary slopes for the cuts should be 2 to 1 slopes or be temporarily supported during construction using a soldier pile-timber lagging cantilever wall system if necessary.

Additional piles would be driven to bedrock if it is required. In this case, for purposes of the O.H.B.D.C. the following design values are recommended:

<u>Pile Type</u>	<u>Axial Capacity at S.L.S. Type II (kN)</u>	<u>Factored Axial Capacity at U.L.S. (kN)</u>	<u>Pile Tip Elevation to bedrock "</u>
HP 310 x 79	900	1150	
HP 310 x 110	1150	1600	

New pile caps must be a minimum earth cover of 1.8 metres for frost protection.

In view of the limited clearance between the existing ground surface and underneath the bridge span (only 4.75 metres), pile driving operation and augering operation for large size hole (>0.6 m in diameter) would be impractical. Based on our review, a minimum clearance required would be about 9 metres for the augering operation and 4.5 metres for pile driving. It is therefore our opinion that other alternatives, such as a simple cantilever type of retaining walls or a tie back walls, may not be feasible at the north abutment location.

South Abutment

For the south abutment, it is proposed to construct a retaining wall in front of the forward slopes of the south abutments. A required height of this retaining wall will be about 1.7 m above ground surface. The proposed retaining walls may be founded on spread footings constructed within the sand deposit at an approximate elevation of 64.0 metres. For purpose of the O.H.B.D.C. the following design values are recommended:

Factored Bearing Capacity at U.L.S. : 200 kPa
Bearing Capacity at S.L.S. Type II : 100 kPa

All footings must be a minimum earth cover of 1.8 m for frost protection.

In order to satisfy the requirements of shallow foundations for the proposed retaining walls, a horizontal sliding, overturning movement and bearing capacity against active earth pressure were reviewed for the geometry shown on Figure 4. Based on the calculations, the base width required is estimated to be about 3.0 m. During the construction, the excavation area should be temporarily supported using a soldier pile - timber lagging cantilever wall system.

Alternatively, a simple cantilever type of walls utilizing soldier 'H' piles with concrete or steel laggings can be adopted for the south abutment. Based on our calculations, embedded depth of piles required is about 3 metres with 1.5 m spacing as shown on Figure 5.

Other Construction Considerations

Lateral Earth Pressures on Structures

Free draining material such as Granular 'A' or Granular 'B' is recommended as appropriate backfill to the abutments to prevent hydrostatic pressure build-up. Design parameters of the soil are given below:

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Angle of Internal Friction (ϕ)	35°	30°
Unit Weight (kN/m^3), γ	22.8	21.2
Coefficient of Active Earth Pressure (K_A) (Horizontal Ground behind wall)	0.27	0.33
Coefficient of Active Earth Pressure (K_A) (Sloping Ground behind wall, 2H to 1V slope)	0.43	0.6
Coefficient of Passive Earth Pressure (K_P)	6	5
Coefficient of Earth Pressure at Rest (K_0)	0.43	0.5

The earth pressure coefficient at rest is to be used in design if the walls are rigid and unyielding. Weep holes in the walls should be designed to drain any accumulation of water in the backfill.

Dewatering

Since the upper layer material is a granular deposit and in some areas the water level is approximately the same level or slightly above the proposed foundation level, it will be necessary to prevent the base of the excavation from 'boiling' due to an unbalanced excess hydrostatic head. It is our opinion that a positive dewatering scheme would be required. One method of achieving this is by carrying out the excavations by means of oversize perimeter ditches and constantly pumping out from the ditches.

MISCELLANEOUS

The fieldwork for this investigation was carried out during the period of 88 08 02 to 88 08 09 under the supervision of Mike Schnarr, Student Engineer. The equipment was owned and operated by F. E. Johnston Drilling Co. Ltd., Ottawa.

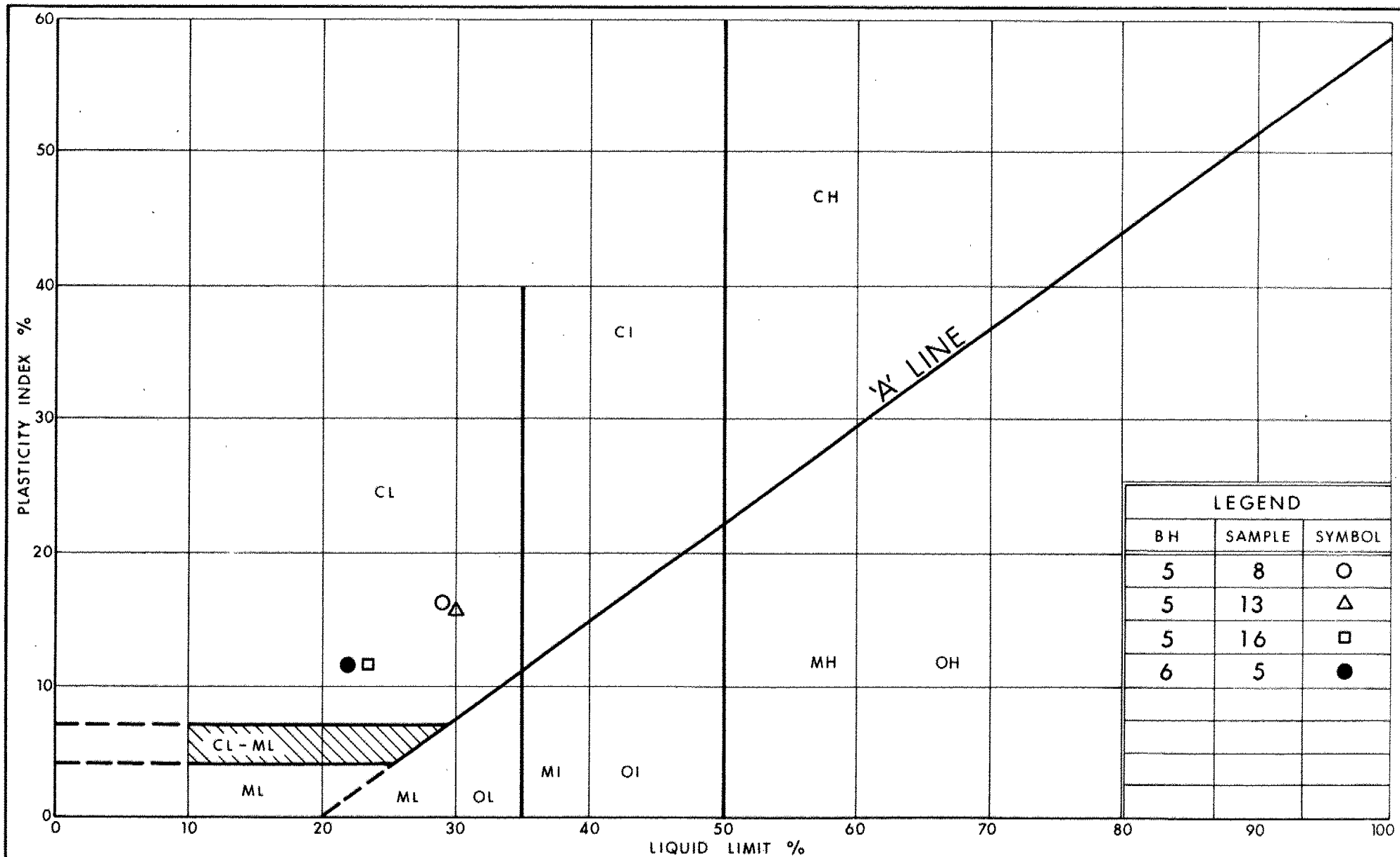
This report was written by Tae C. Kim, Foundation Engineer and reviewed by Murty Devata, Chief Foundation Engineer.



Tae C. Kim
Tae C. Kim, P.Eng.
Foundation Engineer

Murty Devata
Murty Devata, P.Eng.
Chief Foundation Engineer

APPENDIX



Ministry of
Transportation

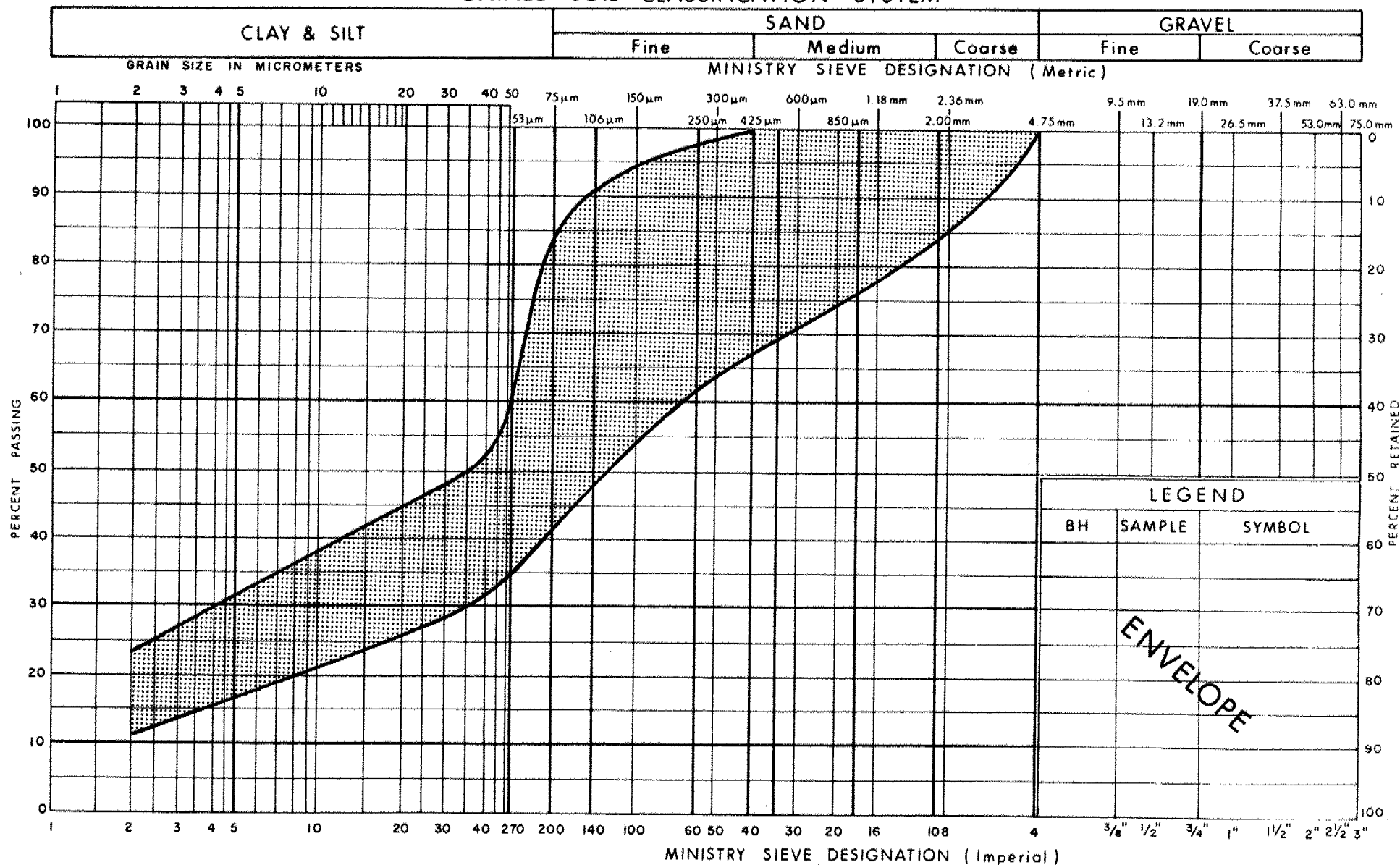
Ontario

PLASTICITY CHART CLAYEY SILT, WITH INTERBEDDED SANDY SILT

FIG No 1

W P 124-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

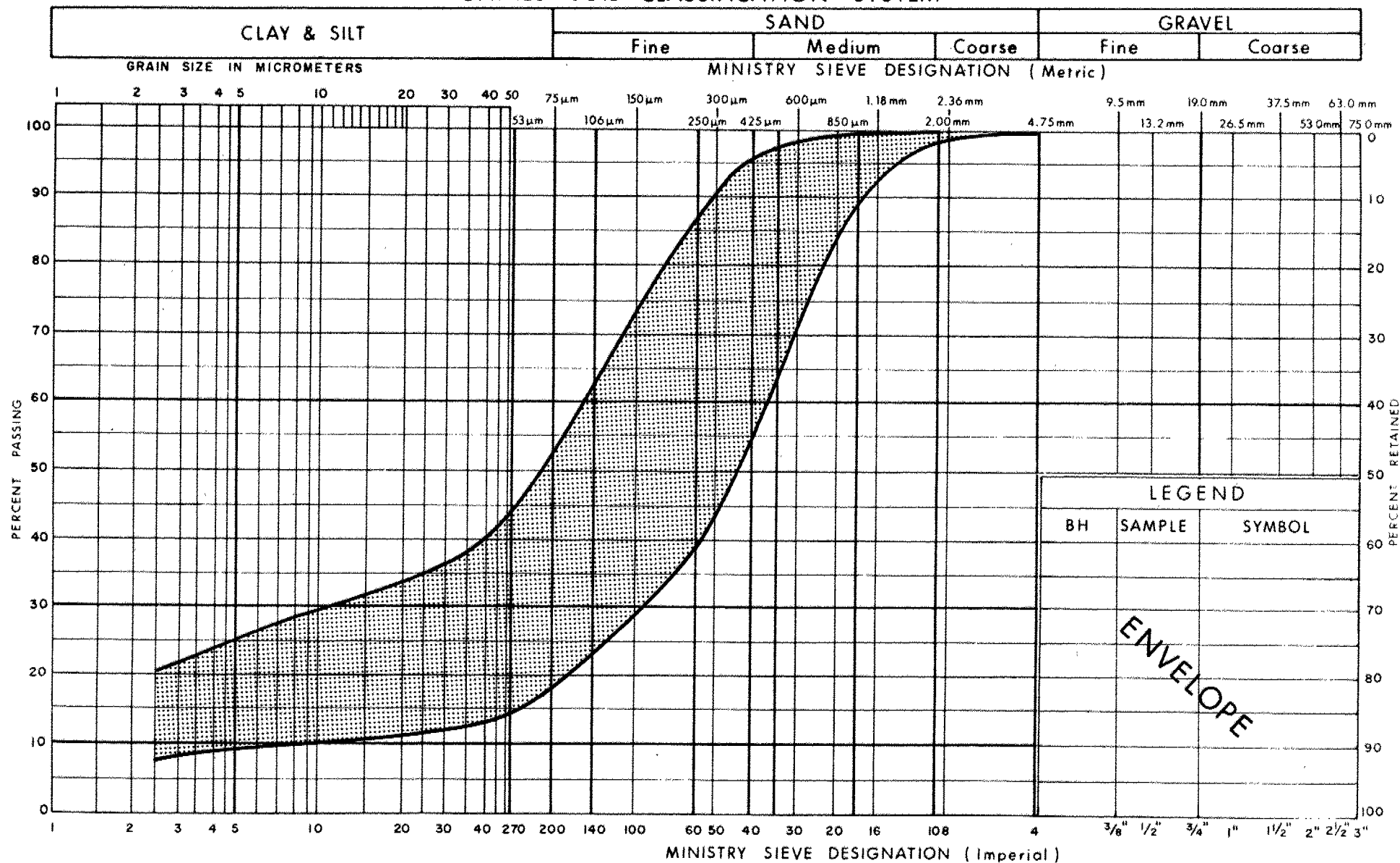
GRAIN SIZE DISTRIBUTION

CLAYEY SILT, WITH INTERBEDDED SANDY SILT

FIG No 2

W P 124-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM

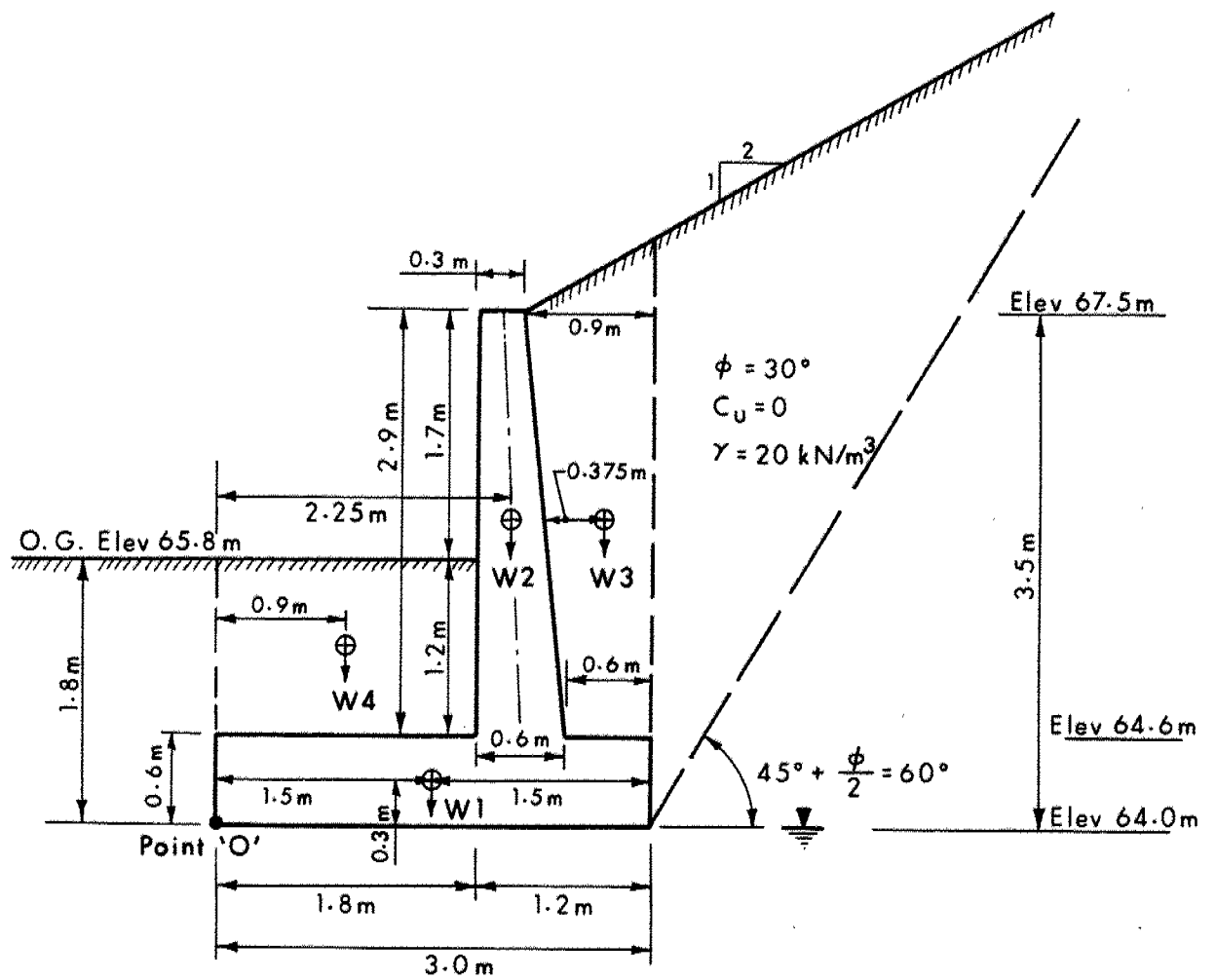

 Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

SILTY SAND TO SAND

FIG No 3

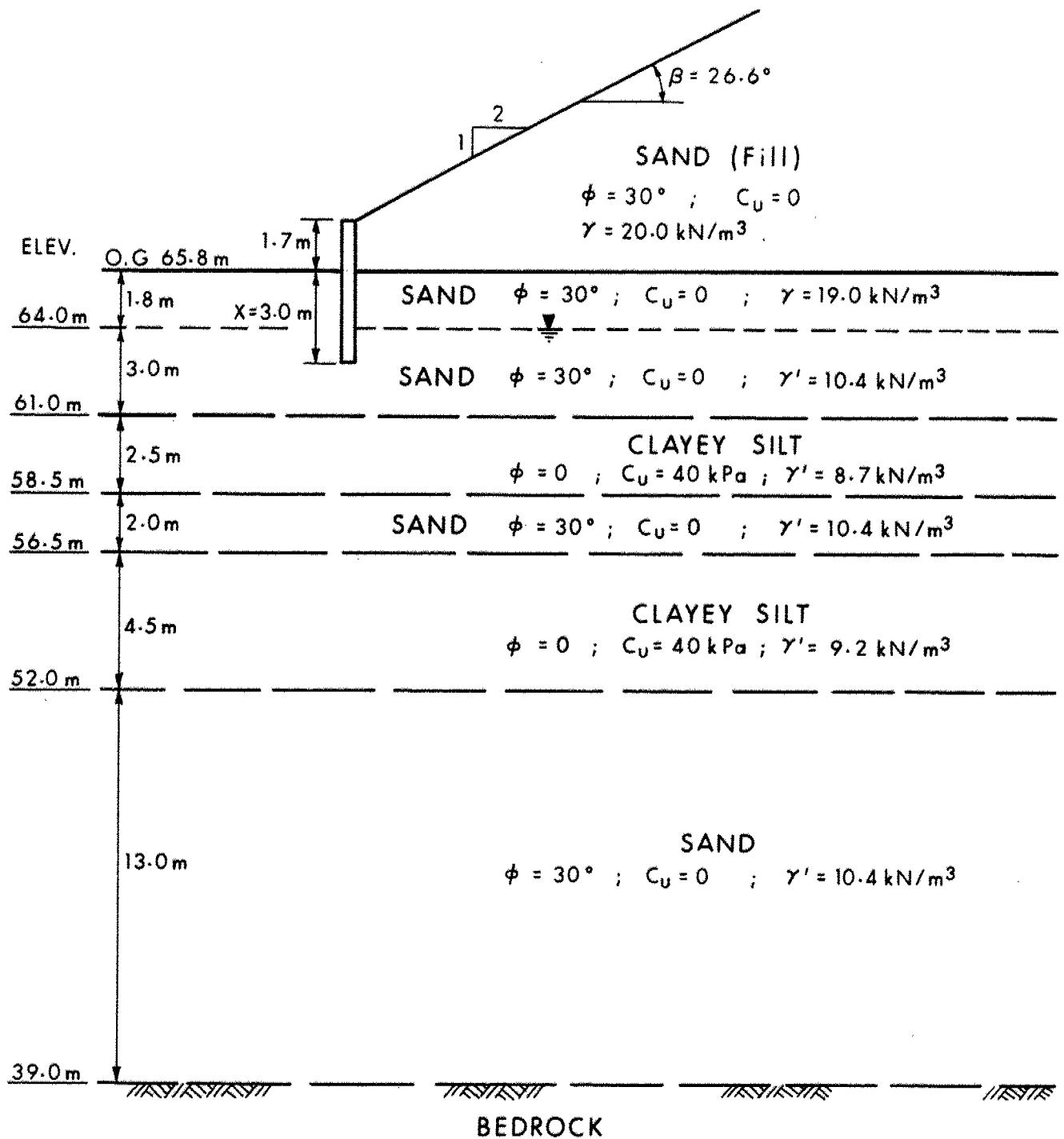
W P 124-87-01



RETAINING WALL

WP 124-87-01

Fig 4



CANTILEVER TYPE RETAINING WALL

WP 124-87-01

Fig 5

DESCRIPTION OF ROCK CORE - WP 124-87-01

CORE RECOVERY				CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
5	RC17 24.08-24.84	93	75	24.08-26.06	SILTY DOLOSTONE , medium light grey to dark grey; very fine grained; thick bedded; medium strong rock; very close to close spaced fractures: horizontal bedding joints, smooth to irregular, planar; near vertical joint set, rough, planar, closed.
	RC18 24.84-26.06	90	56		
6b	RC1 1.22- 1.80	76	0	1.22- 2.39	SANDSTONE , greenish grey to light grey; fine grained; medium bedded with course grained beds up to 20 cm thick; medium strong rock; unweathered; very close spaced fractures: horizontal, rough planar.
	1.80- 2.39	65	0		
6c	RC5 7.32- 8.71	89	0	7.32- 8.71	SANDSTONE , light grey, streaked medium grey; fine to medium grained; medium bedded with thin beds of SHALE up to 6 cm thick (10%); medium strong rock; unweathered; very close spaced fractures: horizontal, rough, planar.
6	RC8 14.63-16.15	89	8	14.63-16.15	SANDSTONE , light grey streaked medium dark grey; fine grained; medium bedded with course grained beds up to 1 cm thick; medium strong rock; unweathered; very close spaced fractures: horizontal, rough planar.
	RC9 16.15-17.68	87	8	16.15-17.17	SHALE , medium dark grey, streaked light grey; very fine grained; thinly bedded; medium strong to weak rock; unweathered; very close spaced fractures: horizontal bedding joints, irregular, planar closed.
				17.17-17.68	SANDSTONE, SILTY SANDSTONE , medium light grey streaked greenish grey; medium to fine grained; thin bedded with interbed of SHALE (9cm); medium strong rock; unweathered; very close spaced fractures: horizontal, rough, planar, closed.

NOTE: Depths are approximated in zones of poor core recovery.

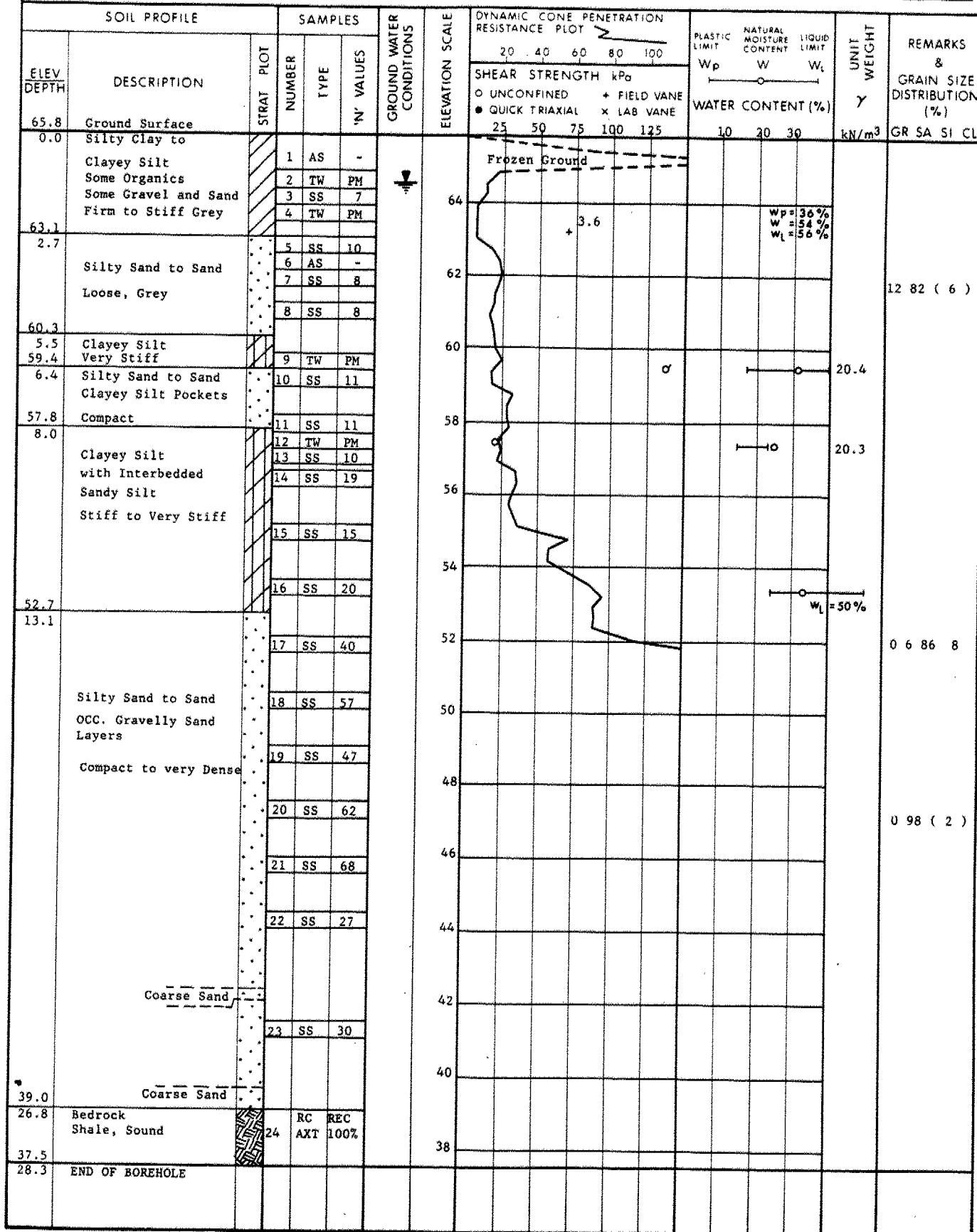
*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

RECORD OF BOREHOLE No 1 (Formerly WP 909-64) METRIC

W P 124-87-01 LOCATION Co-Ords N 5022 813.1; E 359 153.5 ORIGINATED BY PLW
DIST 9 HWY 417 BOREHOLE TYPE Washboring & Diamond Drill COMPILED BY LP
DATUM Geodetic DATE 1966 03 02 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION



+3, x5: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2 (Formerly WP 909-64) METRIC

W P 124-87-01 LOCATION Co-Ords N 5022 845.7; E 359 182.2 ORIGINATED BY PLW
DIST 9 HWY 417 BOREHOLE TYPE Washboring & Diamond Drilling COMPILED BY LP
DATUM Geodetic DATE 1966 03 07 CHECKED BY TCR

OFFICE REPORT ON SOIL EXPLORATION

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									
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%)					
							25 50 75 100 125					10 20 30			kn/m ³	GR SA SI CL	
65.6	Ground Surface																
0.0	Silty Sand to Sand Compact to Very Loose		1	SS	11												
63.4			2	SS	3												
2.2	Clayey Silt with Interbedded Sandy Silt Firm to Stiff		3	TW	PM									17.3			
61.3			4	SS	10												
4.3	Silty Sand to Sand Compact		5	SS	14												
60.0			6	TW	PM												
5.6	Clayey Silt with Interbedded Sandy Silt - Very Stiff		7	SS	6									19.2	0 12 62 26		
59.0																	
6.6	Silty Sand to Sand Loose																
57.4			8	TW	PM												
8.2	Clayey Silt with Interbedded Sandy Silt Stiff		9	SS	12									18.2			
55.9			10	SS	-										0 94 (6)		
9.7	Silty Sand to Sand Loose																
54.4			11	TW	PM									20.1			
11.2	Clayey Silt with Interbedded Sandy Silt Very Stiff		12	SS	OW										0 60 33 7		
52.6			13	SS	OW												
13.0	Silty Sand to Sand OCC. Silt Layers Very Loose to Dense		14	SS	OW												
			15	SS	26										0 98 (2)		
			16	SS	45												
	Coarse Sand OCC. Gravel																
41.9																	
23.7	Bedrock Shale, Sound		17	RC AXT	REC 98%												
40.3																	
25.3	END OF BOREHOLE																
Notes: O.W. = Own Weight																	
* Hole caved in at Elev. 65.1m Water level not established																	

RECORD OF BOREHOLE No 3 (Formerly WP 909-64) METRIC

W P 124-87-01 LOCATION Co-Ords N 5022 875.0; E 359 183.5 ORIGINATED BY PLW
 DIST 9 HWY 417 BOREHOLE TYPE Washboring & Diamond Drilling COMPILED BY LP
 DATUM Geodetic DATE 1966 03 10 CHECKED BY ICK

OFFICE REPORT ON SOIL EXPLORATION

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					
65.9	Ground Level													
0.0	Clayey Silt with Interbedded Sandy Silt					*								
64.1	Soft to Firm		1	SS	4									
1.8			2	TW	PM									
			3	SS	14									
			4	SS	31									
	Silty Sand to Sand		5	SS	18									
	Some Gravel		6	SS	26									
	Compact to Very Dense		7	SS	12									
			8	SS	11									
			9	SS	62									
55.5	Clayey Silt with Interbedded Sandy Silt		10	SS	31									
10.4			11	TW	PM									
54.3	Very Stiff to Hard		12	SS	35									
11.6			13	SS	31									
	Silty Sand to Sand		14	SS	56									
	Dense to Very Dense		15	SS	48									
44.8														
21.1	Bedrock		16	RC	REC									
43.7	Shale Sound			AXT	100%									
22.2	END OF BOREHOLE													
	* Hole caved in at Elev. 64.8m Water Level Not Established													

RECORD OF BOREHOLE No 5

METRIC

W P 124-87-01 LOCATION Co-Ords N 5022 814.9; E 359 202.4 ORIGINATED BY MS
 DIST 9 HWY 417 BOREHOLE TYPE H-S Auger, 'B'- Casing BX Rock Core & Cone Test COMPILED BY MS
 DATUM Geodetic DATE 88 08 02-03 CHECKED BY JCK

OFFICE REPORT ON SOIL EXPLORATION

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	100	W _p	W	W _L		
65.9	Ground Surface													
0.0	Clayey Silt (Fill)													GR SA SI CL
64.8			1	SS	11									
1.1	Silty Sand to Sand		2	SS	6									
	Trace to Some Clay		3	SS	4									
			4	SS	14									
	Loose to Compact		5	SS	11									
61.5			6	SS	5									0 77 13 10
4.4	Clayey Silt with		7	TW	PH									
	Interbedded Sandy Silt		8	TW	PH									0 4 71 25
	Occ.Silty Clay Layers													0 13 69 18
	Firm to Very Stiff		9	SS	25									
57.3			10	SS	30									0 68 21 11
8.6	Silty Sand to Sand		11	SS	15									
	Compact to Dense		12	SS	25									
54.2			13	SS	4									0 23 60 17
11.7	Clayey Silt with		14	SS	8									
	Interbedded Sandy Silt													
	Firm to Very Stiff		15	SS	4									0 73 20 7
51.2			16	SS	90/	15cm								0 58 32 10
14.7	Silty Sand to Sand													
	Occ.Clayey Silt Layers													
	Occ. Gravelly Sand													
	Loose to Very Dense													
	Clayey Silt													
41.8			17	RC	REC 93%									RQD = 75%
24.1	Bedrock		18	RC	REC 90%									RQD = 56%
39.8	Silty Dolostone													
26.1	END OF BOREHOLE													

*3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6

METRIC

W P 124-87-01 LOCATION Co-Ords N 5 022 884.2; E 359 214.1 ORIGINATED BY MS
DIST 9 HWY 417 BOREHOLE TYPE B-Casing, BX Rock Core COMPILED BY MS
DATUM Geodetic DATE 88 08 09 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60					
72.5	Ground Surface														
0.0	Concrete Slab		1	RC	-										
71.9															
0.6															
	Sand Fill														
66.4															
6.1	Silty Sand to Sand		2	SS	10										
	Compact		3	SS	23										
63.9															
8.6	Clayey Silt with interbedded Silty Sand Stiff to very Stiff		4	SS	11										
			5	SS	29										
60.9															
11.6	Silty Sand to Sand Trace of Clay Very Dense		6	SS	63										
			7	SS	52										
57.9															
14.6	Bedrock Sandstone, Shale and Silty Sandstone		8	RC	REC 89%										
			9	RC	REC 87%										
54.8															
17.7	END OF BOREHOLE														

RECORD OF BOREHOLE No 6A

METRIC

W P 124-87-01 LOCATION Co-Ords N 5 022 884.5; E 359 218.8 ORIGINATED BY MS
 DIST 9 HWY 417 BOREHOLE TYPE H-S Auger COMPILED BY MS
 DATUM Geodetic DATE 88 08 04 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	Wp	W	Wl		
72.5	Ground Surface																
0.0	Sand Fill		1	SS	30	*	72										
	Dense to very Dense		2	SS	43		70										
			3	SS	66		68										
67.0																	
5.5	END OF BOREHOLE (Probable Concrete Slab) * Borehole Dry																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6B

METRIC

W.P. 124-87-01 LOCATION Co-Ords N 5022 887.8; E 359235.6 ORIGINATED BY MS
 DIST 9 HWY 417 BOREHOLE TYPE H-S Auger, BX Rock Core COMPILED BY MS
 DATUM Geodetic DATE 88 08 05 CHECKED BY TCK

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	Wp	W		
67.8	Ground Surface															
0.0																
66.6	Sand and Gravel (Fill)					*										
1.2																
	Bedrock		1	RC	REC	76%										RQD = 0%
65.4	Sandstone		2	RC	REC	65%										RQD = 0%
2.4	END OF BOREHOLE															
	* Borehole Dry															

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

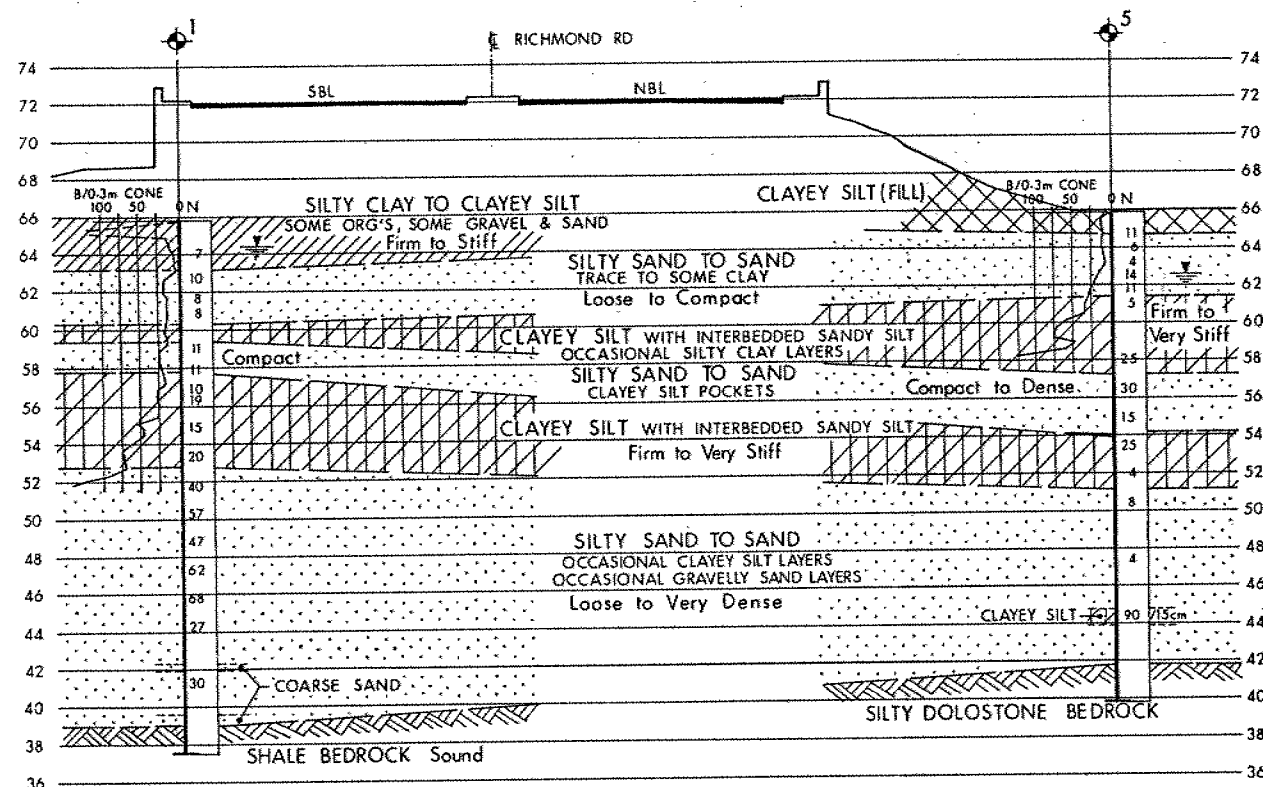
RECORD OF BOREHOLE No 6C

METRIC

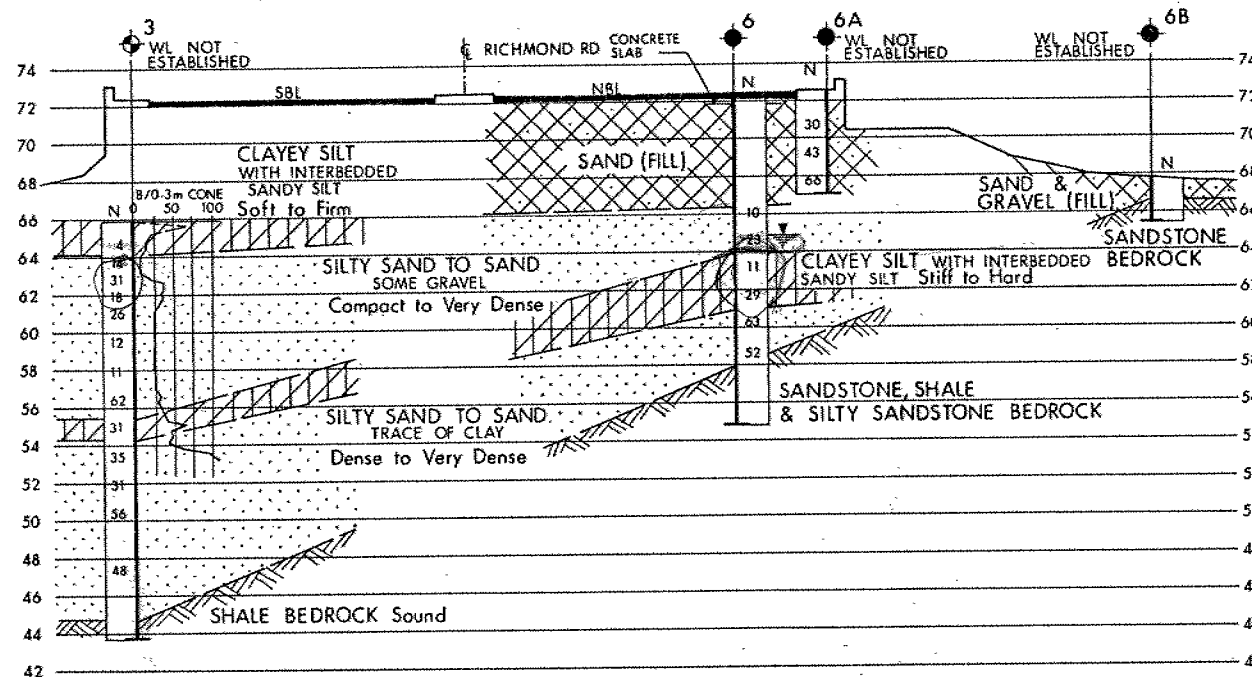
W P 124-87-01 LOCATION Co-Ords N 5022 897.4; E 359 221.2 ORIGINATED BY MS
 DIST 9 HWY 417 BOREHOLE TYPE H-S Auger, 'B' Casing, BX Rock Core COMPILED BY MS
 DATUM Geodetic DATE 88 08 05 CHECKED BY TCK

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 (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40					
72.4	Ground Surface													
71.8	Asphalt													
0.6	Clayey Silt to Sand (Fill)		1	AS	-									
			2	SS	11									
			3	SS	60	15cm								
66.0			4	SS	39									
6.4	Silty Sand to Sand													
65.1														
7.3	Bedrock													
63.7	Sandstone		5	RC	REC 89%									RQD = 0%
8.7	END OF BOREHOLE *Water Level Not Established													

OFFICE REPORT ON SOIL EXPLORATION



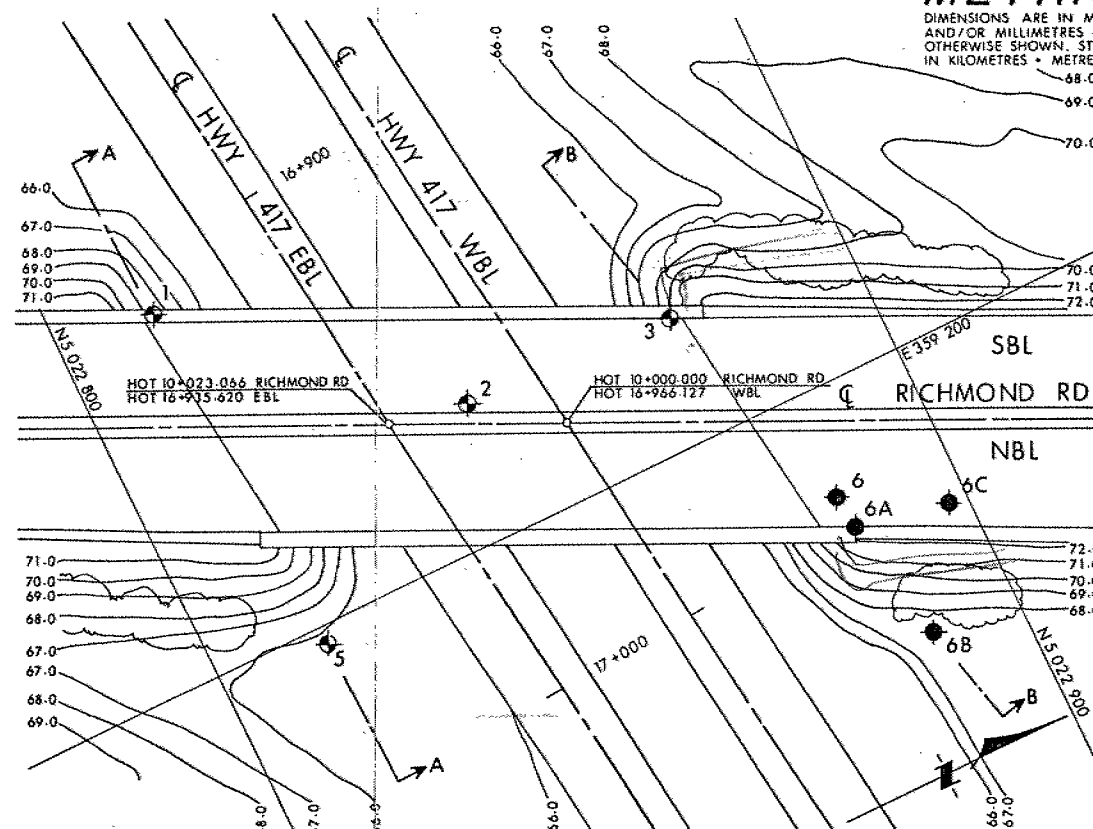
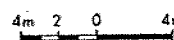
A-A



B-B

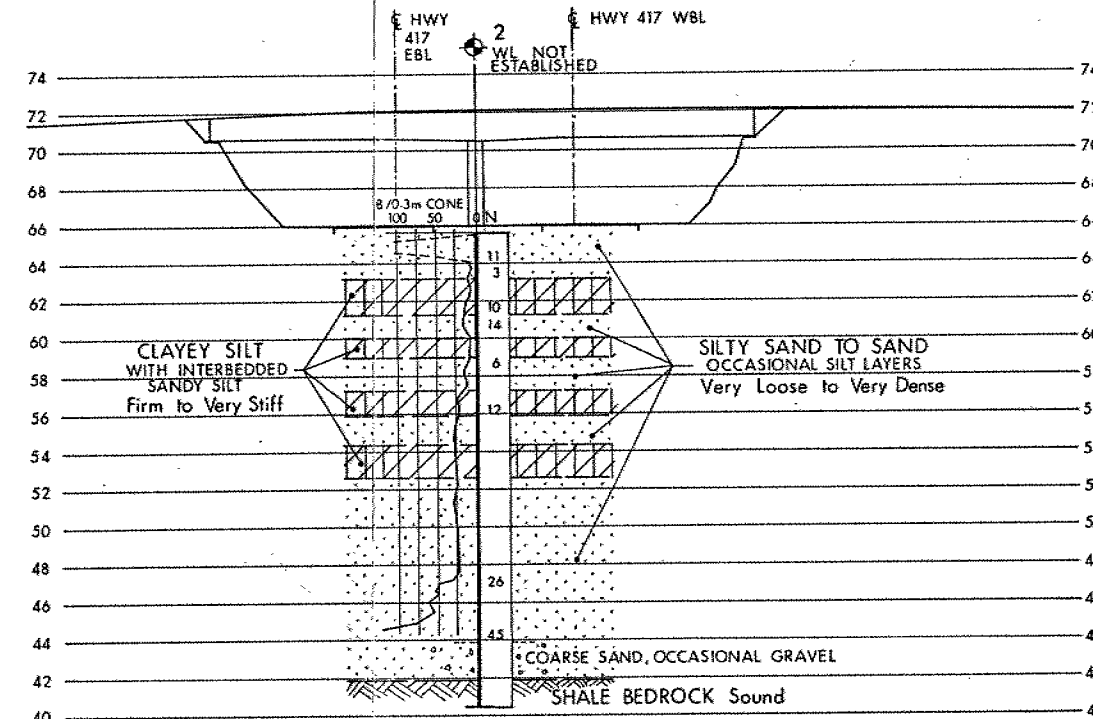
SECTIONS

SCALE



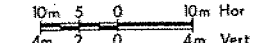
PLAN

SCALE



PROFILE RICHMOND RD

SCALE



METRIC

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

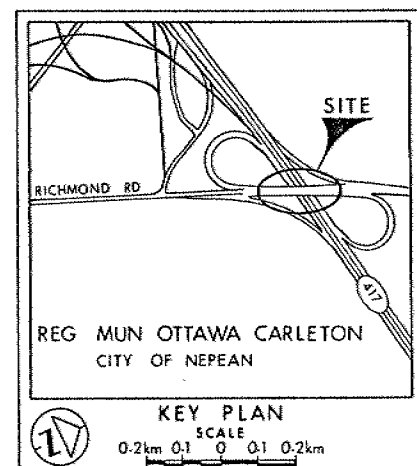
CONT No
WP No 124-87-01

RICHMOND ROAD

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



KEY PLAN

SCALE



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
66 03 and 88 08

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	65.8	5 022 813.1	359 153.5
2	65.6	5 022 845.7	359 182.2
3	65.9	5 022 875.0	359 183.5
5	65.9	5 022 814.9	359 202.4
6	72.5	5 022 884.2	359 214.1
6A	72.5	5 022 884.5	359 218.8
6B	67.8	5 022 887.8	359 235.6
6C	72.4	5 022 897.4	359 221.2

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

Geacres No 31G5-151

HWY No 417	SUBMITTAL CHECKED	DATE 88 11 15	DIST 9
DRAWN DT	CHECKED	APPROVED	SITE 3-39
			DWG 1248701-A