

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M5-164

DIST. 4 REGION

W.P. No. 409-85-04

CONT. No.

W. O. No.

STR. SITE No. 10-230

HWY. No. 403

LOCATION HWY 403 & REG. RD 22  
(TREMAYNE RD.)

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

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

DIST. No. 4  
CONT. No.  
WP. No.409-85-04  
REGIONAL ROAD 22 (TREMAINE RD.)  
OVERPASS  
HIGHWAY 403  
GENERAL ARRANGEMENT

R.V. Anderson Associates Limited  
consulting engineers and architect 3341-20



### GENERAL NOTES

- CLASS OF CONCRETE**
  - DECK & PIER COLUMN - 35 MPa
  - REMAINDER - 30 MPa
- CLEAR COVER TO REINFORCING STEEL**
  - FOOTINGS - 100±25
  - ABUTMENTS AND WINGWALLS - FRONT FACE - 80±20  
BACK FACE - 70±20
  - PIER - 80±20
  - DECK - TOP - 70±20  
BOTTOM - 50±10  
SIDES - 60±10
  - REMAINDER (UNLESS OTHERWISE NOTED) - 70±20
- REINFORCING STEEL**
  - REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX "C" DENOTE COATED BARS.
- CONSTRUCTION NOTE**
  - IF THE ACTUAL BEARING HEIGHTS ARE DIFFERENT FROM THE ASSUMED BEARING HEIGHTS GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT THE ACTUAL HEIGHTS.

### LIST OF DRAWINGS

- GENERAL ARRANGEMENT
- BORE HOLE LOCATIONS AND SOIL STRATA
- FOOTING LAYOUT AND DETAILS
- NORTH ABUTMENT
- SOUTH ABUTMENT
- REINFORCED EARTH RETAINING WALLS - PLAN, ELEVATIONS, DETAILS & SCHEDULE
- REINFORCED EARTH RETAINING WALLS - TYPICAL DETAILS
- PIER AND BEARING DETAILS
- DECK LAYOUT AND SKEW ELEVATIONS
- TRANSVERSE STRESSING
- LONGITUDINAL STRESSING I
- LONGITUDINAL STRESSING II
- DECK REINFORCING I
- DECK REINFORCING II
- BARRIER WALLS I
- BARRIER WALLS II
- 8000mm APPROACH SLAB
- JOINT ANCHORAGE AND ARMOURING
- DETAILS OF CONC. SLOPE PAVING (NOT IN CONTRACT)
- AS CONSTRUCTED ELEV. AND DIM.
- STANDARD DETAILS
- ELECTRICAL EMBEDDED WORK
- QUANTITIES - STRUCTURE

### LIST OF ABBREVIATIONS

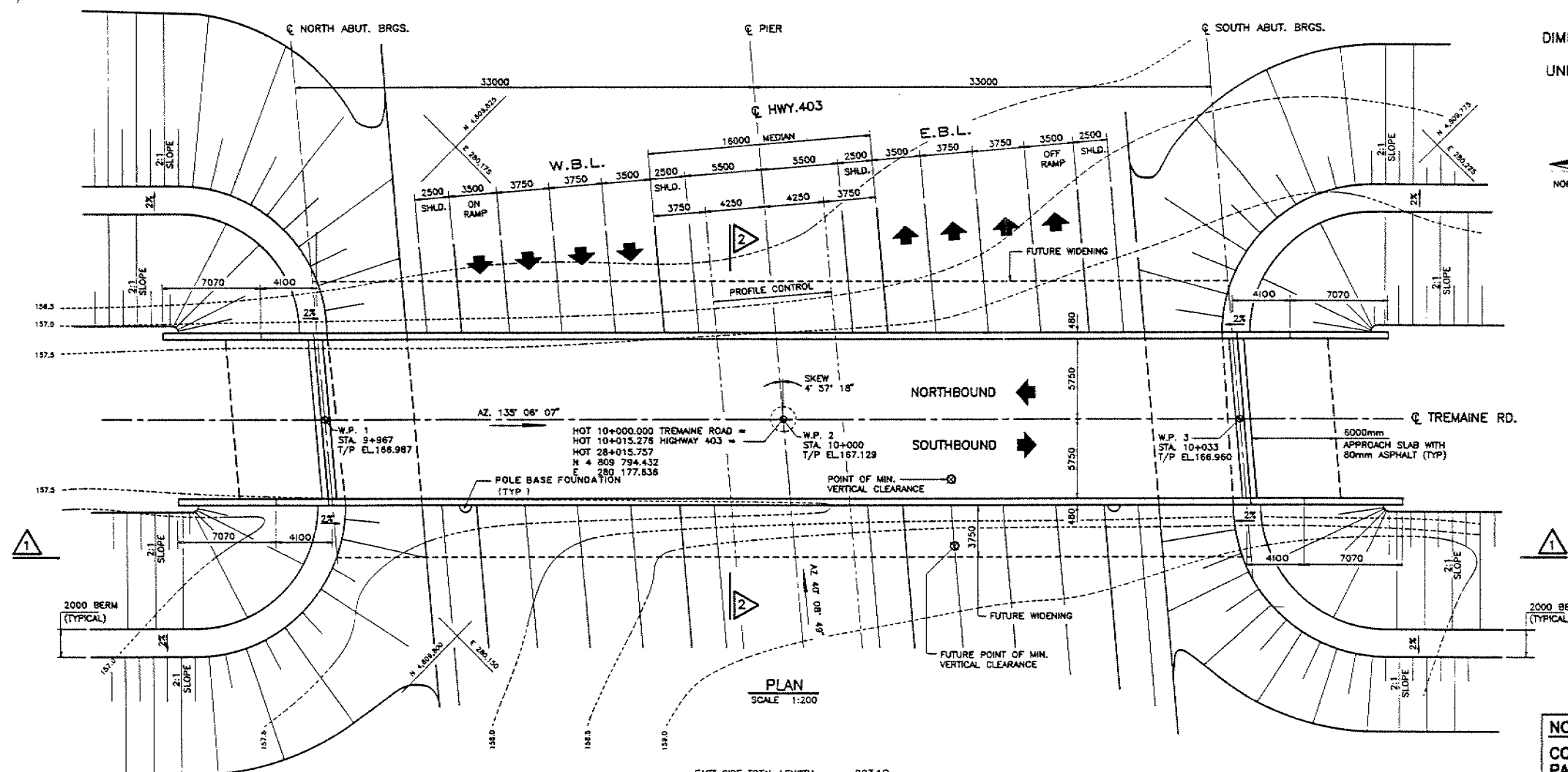
- W.P. DENOTES WORKING POINT.
- T/P DENOTES TOP OF PAVEMENT.
- T/F DENOTES TOP OF FOOTING.

### APPLICABLE STANDARD DRAWINGS

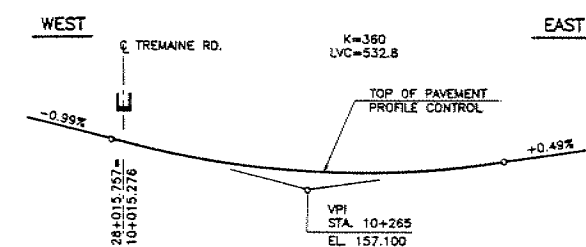
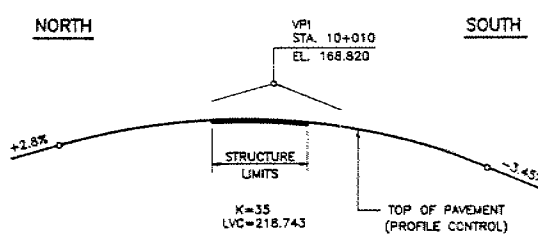
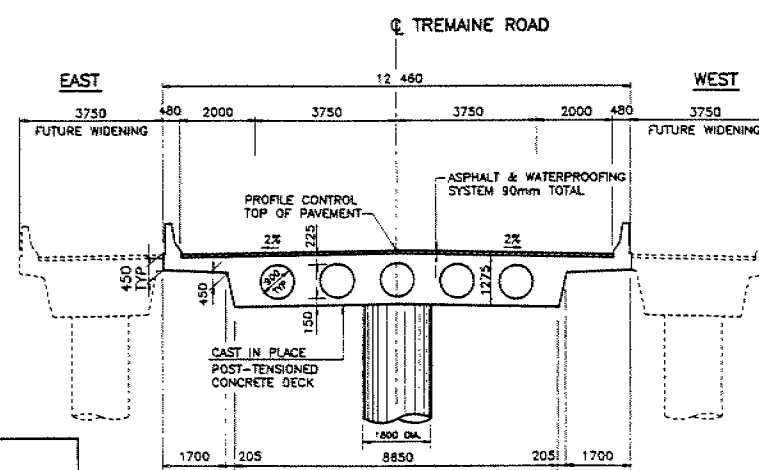
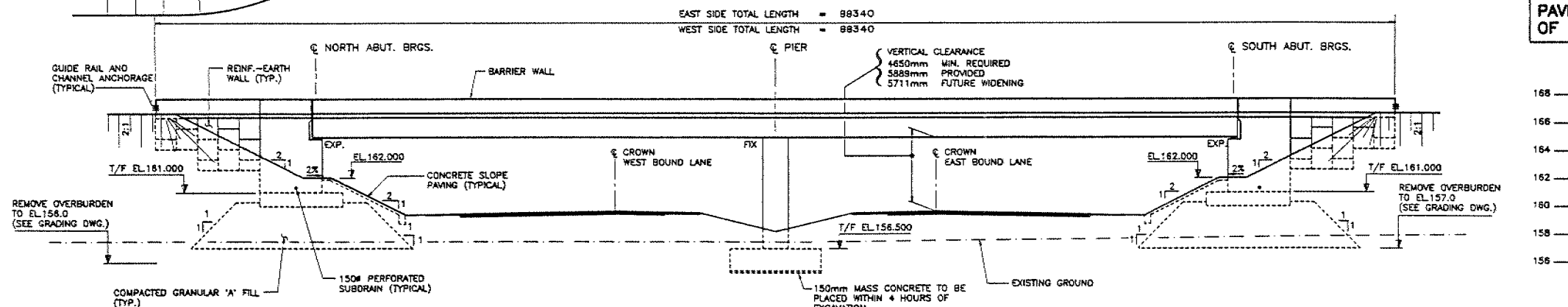
- DD 3503 MINIMUM GRANULAR BACKFILL REQUIREMENTS.



REVISIONS	DATE	BY	DESCRIPTION
DESIGN T.A.R.	CHK. T.A.R.	CODE	OHBOC-83 (LOAD CLASS A) (DATE MAY 91)
DRAWN L.O.S.	CHK. H.R.V.	SITE	10-230 STRUCT. SCHEME DWG. 1



**NOTE**  
CONCRETE SLOPE  
PAVING NOT PART  
OF THIS CONTRACT



**BENCH MARK**  
GEODETIC DATUM  
EL. 158.290  
NAIL IN ROOT OF 0.3m DIA TREE  
9.65m LT. 10+045.20

SCALE 1:100

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

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

CONT. No.  
WP. No. 409-85-04  
REGIONAL ROAD 22 (TREMAINE RD)  
UNDERPASS  
HIGHWAY 403  
FOOTING LAYOUT AND DETAILS

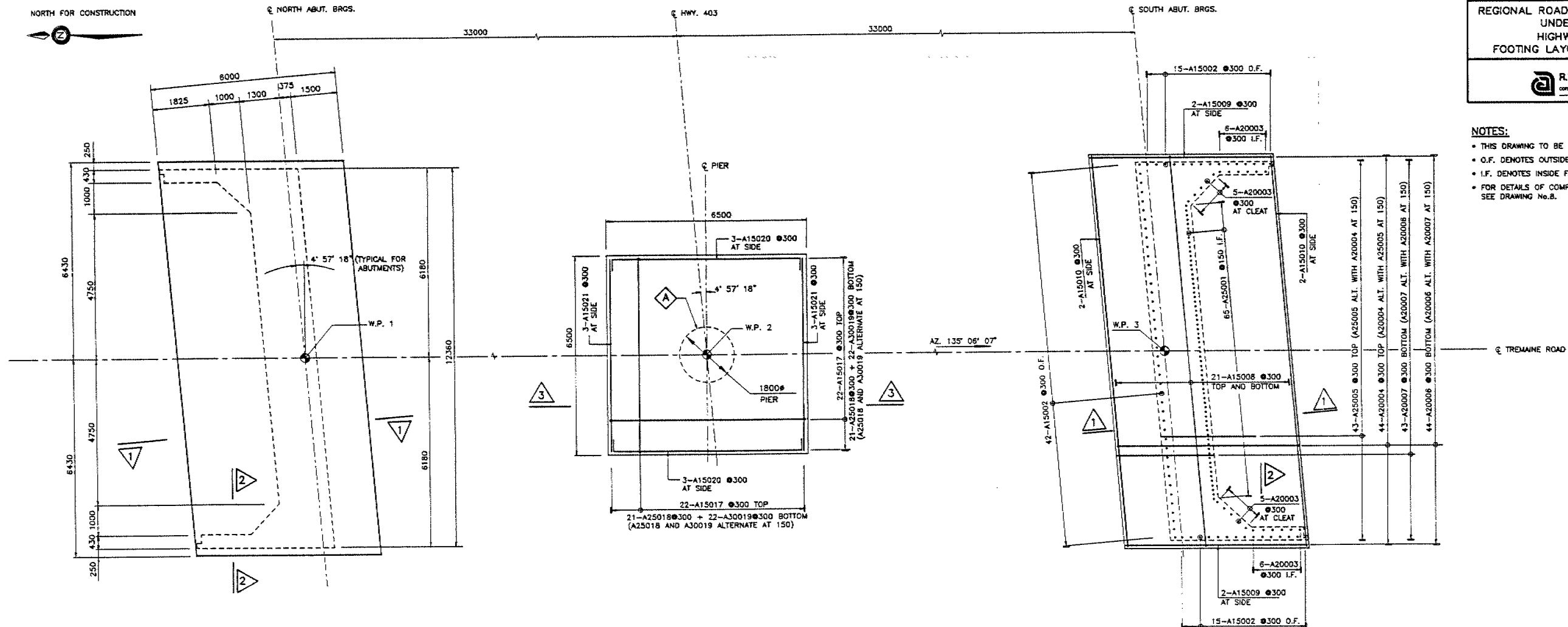


SHEET

**R.V. Anderson Associates Limited**  
consulting engineers and architects 3341-20

**NOTES:**

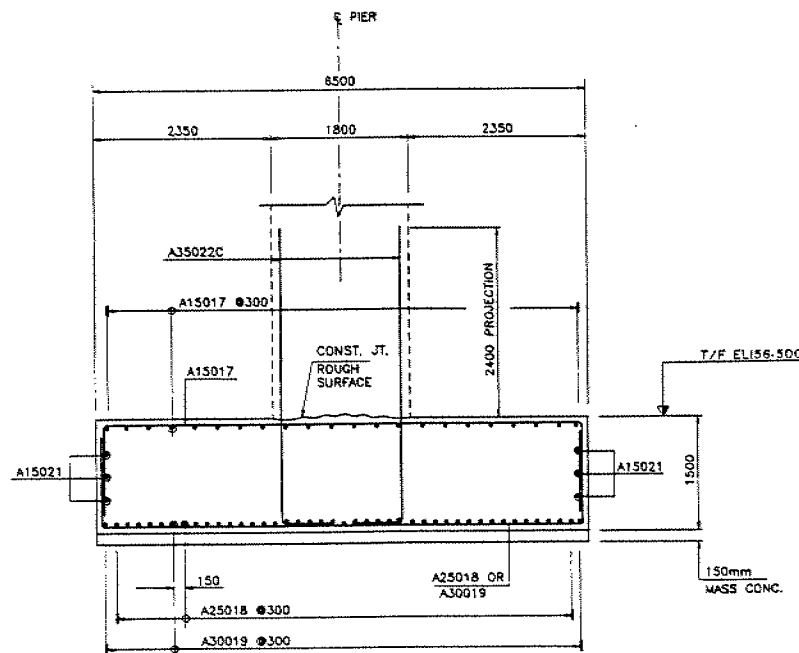
- THIS DRAWING TO BE READ IN CONJUNCTION WITH DWGS. 3 & 4.
- O.F. DENOTES OUTSIDE FACE.
- I.F. DENOTES INSIDE FACE.
- FOR DETAILS OF COMPACTED GRANULAR 'A' CORE FOR ABUTMENT SEE DRAWING No. 8.



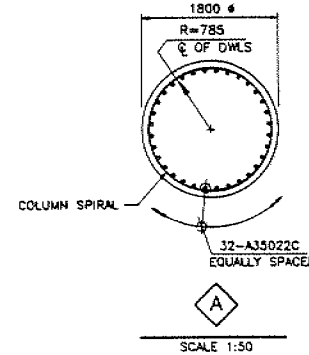
**PLAN**

SCALE 1:75

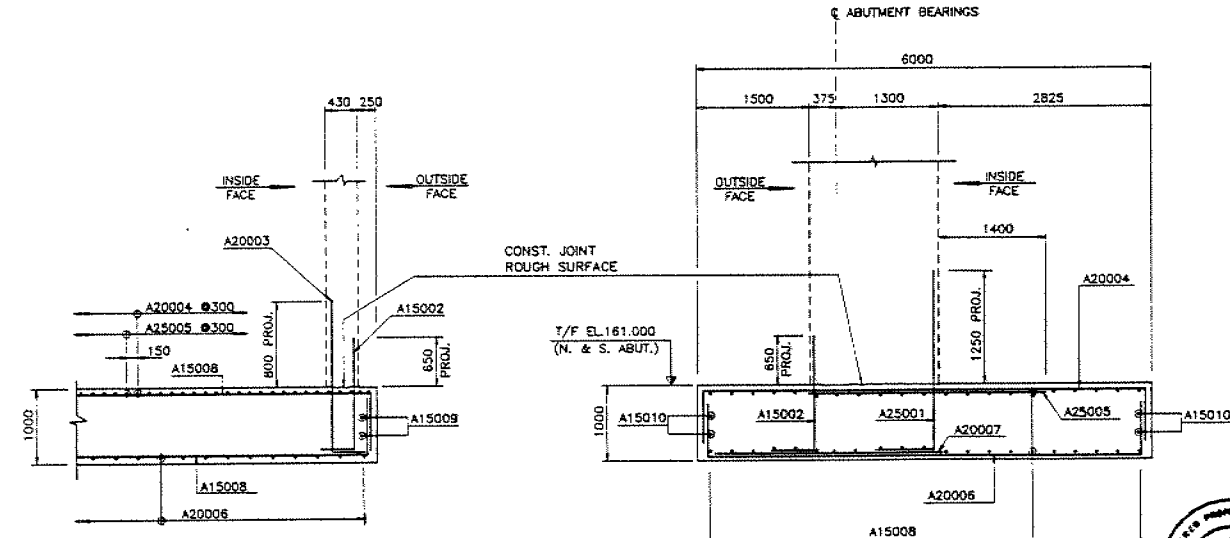
NOTE: NORTH AND SOUTH ABUTMENTS ARE SIMILAR  
IN DIMENSIONS AND REINFORCING EXCEPT  
AS NOTED ON DRAWING.



SCALE 1:50



SCALE 1:50



SCALE 1:50

SCALE 1:50

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN T.A.R. CHK. J.H.R.V. CDBE 08B0C-83 LOAD CLASS A DATE MAY 1991  
DRAWN L.O.S. CHK. T.A.R. SITE 10-230 STRUCT. SCHEME DWG. 3





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## **FOUNDATION DESIGN SECTION**

# **foundation investigation and design report**

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 409-85-04 DIST 4

HWY 403 STR SITE 10-230

Bridge Structure  
Hwy. 403 - Regional Road No. 22  
(Tremaine Road) Underpass

DISTRIBUTION

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FOUNDATION INVESTIGATION REPORT  
For  
Bridge Structure  
Hwy. 403 - Regional Road No. 22  
(Tremaine Road) Underpass  
W.P. 409-85-04, Site No. 10-230  
District 4, Burlington

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above mentioned site where a single two span structure is proposed to carry the existing Regional Road No. 22 over the proposed Hwy. 403.

The fieldwork was carried out between 90 04 03 and 90 04 04. Seven boreholes (BH 1 to BH 7) were advanced and sampled as part of this project by means of hollow stem augers with a conventional diamond drill (NW casing and NQ core barrel) adopted for rock sampling purposes. These boreholes extended down to depths of 7.7 and 11.7 m below the existing ground surface.

This report contains factual information obtained from this investigation pertaining to structure foundations, approach embankments and related earthworks for the bridge structure as shown on Dwg. No. 4098504-A.

SITE DESCRIPTION AND GEOLOGY

The site is located on the proposed alignment of Hwy. 403 where it crosses the existing Regional Road No. 22 in the City of Burlington, Regional Municipality of Halton. The proposed structure is located approximately 1.5 km north of the existing Hwy. 5. The topography in the area is generally flat to gently undulating with ground surface sloping to the southeast. Land use in the vicinity of the site is primarily agricultural and dairy farming.

Physiographically, the site is located in the "Peel Plain" region (Ref. Chapman and Putnam, 1984) which is characterized by a glacial till containing large amount of paleozoic shale. Underlying the glacial deposit are the red Queenston shale from which the till's reddish colour is derived.

### SUBSURFACE CONDITIONS

The subsoil conditions are generally uniform across the site. The overburden consists of a deposit of cohesive glacial till composed of a heterogeneous mixture of clayey silt, sand and gravel underlain by shale and siltstone bedrock. The maximum thickness of this deposit was found to be about 5.4 m at BH 5. A thin layer of non-cohesive sandy silt was encountered at BH 2 within the cohesive till deposit. The thickness of this layer was found to be about 0.8 m.

The upper portion of the shale was found to be weathered down to approximate El. 149.1 m with a maximum thickness of about 3.4 m at BH 4.

Thin layer of road fill materials was encountered at all seven borehole locations. However, it should be noted that at BH's 2, 6 and 7 a thin layer of clayey silt topsoil was found immediately underneath the fill material with the maximum thickness of 1.6 m at BH 7.

The boundaries between the various soil types, in situ and laboratory test results are shown on the attached Record of Borehole sheets in the Appendix. The locations and elevations of the boreholes, along with a profile and sections showing soil stratigraphy based on borehole data, are shown on Dwg. No. 4098504-A.

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

#### Fill Material

All seven boreholes encountered some 1.4 m of fill material whose composition ranged from a brown reworked clayey silt to sand and gravel.

An Atterberg Limit test and a Grain Size Distribution analysis were carried out on clayey silt as shown on Figure 1 and 2. Through visual observation and a Atterberg Limit test, it is apparent that the fill material can be classified as a clayey silt to sand and gravel.

### Topsoil

Topsoil was encountered at three borehole locations. The maximum thickness of this layer is about 1.6 m at BH 7. Atterberg Limit tests and Grain Size Distribution analyses were carried out on this material (see Figures 1 and 2). Through the Atterberg Limit test and visual observation, the material can be classified as a clayey silt.

### Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)

This stratum encountered underneath the fill material or topsoil. This deposit consists of a heterogeneous mixture of clayey silt of low plasticity with varying amounts of sand and gravel. The thickness of this layer was found to be the maximum 5.4 m at BH 5.

Atterberg Limit tests were performed on these samples and the results are plotted on Figure 3 and summarized as follows:

<u>Property</u>	<u>Range (%)</u>	<u>Average (%)</u>
Natural Moisture Content (w)	7.5-26.5	13.0
Liquid Limit ( $w_L$ )	15.0-39.5	26.3
Plastic Limit ( $w_p$ )	10.5-22.5	14.4
Plasticity Index ( $I_p$ )	4.5-21.0	11.9

From the plasticity chart, it is evident that the layer can be classified as a heterogeneous mixture of clayey silt, sand and gravel with low plasticity (CL or CL-ML).

Grain Size Distribution tests were carried out on this cohesive glacial till material. Figure 4 in the Appendix shows the results. An increasing frequency of fragments of weathered shale was encountered within the lower portion of this till.

In this stratum, the 'N' value ranges from 13 to over 100 blows/0.3 m indicating the consistency of this deposit described as stiff to hard.



A thin layer of sandy silt (0.8 m thick) was encountered within the cohesive till deposit at BH 2. Grain Size Distribution test was carried out on this material. Figure 5 in the Appendix shows the results. This layer is basically non-plastic.

### Bedrock

In each of the borings, split spoon samples of the weathered portion of the bedrock were recovered before augering was terminated. Sound bedrock was proven in three boreholes by obtaining up to 3.0 m of NQ rock cores. The top of the bedrock ranged from El. 151.7 to 152.7 m which are corresponded to 6.3 m and 5.1 m below the existing ground surface. The upper 1.1 m to 3.4 m is in a highly weathered state, with layers of broken shale and red clayey silt to silt.

The bedrock is a red shale with green siltstone (approximately 80% shale, 20% siltstone) of the Queenston formation. Detailed description of the rock are attached in the Appendix entitled "Rock Core Description".

The Core Recovery (CR) and Rock Quality Designation (RQD) values were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Core Recoveries (RC) range between 77 and 100 percent and Rock Quality Designation (RQD) values range from 0 to 45 percent. Based on these results, the rock can be classified as weak to very weak and slightly weathered.

### GROUNDWATER CONDITIONS

Groundwater conditions were observed through the measurements of water levels in the open boreholes. Two boreholes were dry or the water levels were close to the boundary between the till and weathered bedrock surface at the time of site investigation. However, groundwater level in BH 2 and BH 3 after a couple of hours later was found to be higher than that of others with approximate El. 156.6 m at BH's 2 and 3 which correspond to depths of 1.0 m and 1.1 m below the existing ground surface. These high groundwater levels are probably attributed to some water bearing sand layers within cohesive glacial till. Groundwater level in the other boreholes was found to be approximate elevation between 150.0

m at BH 4 and 154.7 m at BH 7 which correspond to depths of 8.0 m and 3.2 m below the existing ground surface. Upon completion of rock coring, the induced drill water remained perched within the borehole, indicating a low permeability both for the till and shale strata.

## DISCUSSION AND RECOMMENDATIONS

The recommendations in this report apply to the bridge structure and related approaches.

It is proposed to construct underpass structure that will carry the existing Regional Road No. 22 over the proposed Hwy. 403 eastbound and westbound lanes. The proposed structure is a single two span bridge. A proposed Regional Road No. 22 profile grade, ranging from 167.0 m with an existing ground level of about 158.0 m (Hwy. 403 profile grade of about 159.5 m), will necessitate approximately 9.0 m fill above the existing ground surface.

In consideration of the proximity of competent glacial till from the ground surface across the site, recommendations pertaining to the foundations of the new structure and related earth work are summarized.

### Structure Foundations

#### South Abutment

In consideration of the competent nature of the subsoils, the structure may be supported on spread footings composed of compacted Granular 'A' core as high as possible.

In this case, existing fill materials and topsoils should be excavated down to an elevation 157.0 m and the excavation can be backfill with compacted Granular 'A' core to an elevation where a minimum 1.2 m cover is provided to the footings. The Details of this scheme are shown on Figure 6.

For the purposes of the O.H.B.D.C. the following values are recommended:

Factored Bearing Capacity at U.L.S. 900 kPa

Bearing Capacity at S.L.S. Type II 350 kPa

Alternatively, the closed-type of abutment can be supported on spread footings within very stiff to hard glacial till for the following recommended values:

Factored Bearing Capacity at U.L.S. (kPa)	Allowable Capacity at S.L.S. Type II (kPa)	Proposed Footing Elevation (m)
450	300	at or below 157
680	450	at or below 156

#### North Abutment

In consideration of the weak nature of the subsoil at this location, existing fill material, topsoils and weak cohesive glacial till should be excavated down to El. 156.0 m and the excavation can be backfilled with compacted Granular 'A' as high as possible as shown on Figure 6.

For the purposes of the O.H.B.D.C. the following values are recommended:

Factored Bearing Capacity at U.L.S. 900 kPa  
Bearing Capacity at S.L.S. Type II 350 kPa

Alternatively, the closed-type of abutments can be supported on spread footings within very stiff to hard glacial till for the following recommended values:

Factored Bearing Capacity at U.L.S. (kPa)	Allowable Capacity at S.L.S. Type II (kPa)	Proposed Footing Elevation (m)
450	300	at or below 156
750	500	at or below 155
1000	-	at or below 154

#### Piers

In consideration of the competent nature of subsoils, spread footings can be founded on native glacial till with the following design parameters:

Factored Bearing Capacity at U.L.S.	Allowable Capacity at S.L.S. Type II	Proposed Footing Elevation
<u>(kPa)</u>	<u>(kPa)</u>	<u>(m)</u>
750	500	at or below 155.5
1000	-	at or below 154.5

A footing width of 2.5 m with an embedded depth of 1.2 m was used in the calculation of the above capabilities. The magnitude of the differential settlement of the footings is anticipated to be within 25 mm, provided the subsoil is not disturbed by construction activities.

The design of shallow foundation founded on an unyielding type of medium such as glacial till, will be not governed by settlement since the Bearing Capacity at S.L.S. Type II is much larger than the Factored Bearing Capacity at the U.L.S.

#### Other Considerations

##### Sliding Resistance

Sliding resistance may be computed by assuming a coefficient of friction of 0.57 for cohesive till and Granular 'A' material to apply between the underside of footings and the founding soil.

##### 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 for purpose of the O.H.B.C.D.

	Granular <u>'A'</u>	Granular <u>'B'</u>
Angle of Internal Friction, $\phi$	35°	30°
Unit Weight (kN/m <sup>3</sup> ), $\gamma$	22.8	21.2
Coefficient of Active Earth Pressure (Ka)	0.27	0.33
Coefficient of Earth Pressure at Rest (Ko)	0.43	0.50

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

#### Dewatering

No major dewatering difficulties are anticipated for footing excavations in consideration of the relatively low permeability of the glacial till. However, if localized seepage or surface water to accumulate in excavations, it can be controlled by perimeter ditches and pumping from corner sumps.

#### Frost Protection

The footings should be placed so as to have a minimum earth cover of 1.2 m to allow for frost protection.

#### Approaches and Excavations

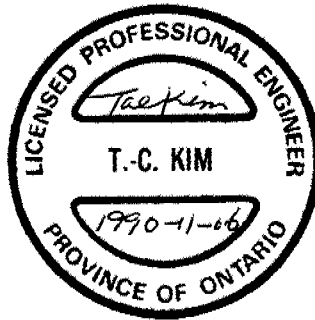
The base of all footing excavations should be covered immediately upon exposure with a working slab of lean concrete to protect the exposed glacial till from disturbing and softening within 4 hours of exposure. All organic and softened material should be stripped from within the plan limits of the immediate approach embankments prior to placement of any fill.

No stability problems are anticipated toward longitudinal direction for permanent embankment constructed to a 2H:1V geometry. Due to the fill height (9 m), toward transverse direction, it is recommended that the approach embankment should be constructed with a 2.0 m wide berm to the midheight of the slope, incorporating side slopes with 2H:1V. Berm should be constructed as an integral part of the main embankment up to the berm height.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Tae C. Kim, Sr. Foundation Engineer, John Petruzzello, Senior Technician and Frank Reynolds, Technician for Northwestern Region. The equipment was owned and operated by Marathon Drilling Co. Ltd. and Master Soil Investigation Co. Ltd., Toronto.

This report was written by Tae C. Kim, Sr. Foundation Engineer, reviewed by P. Payer, Senior Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.

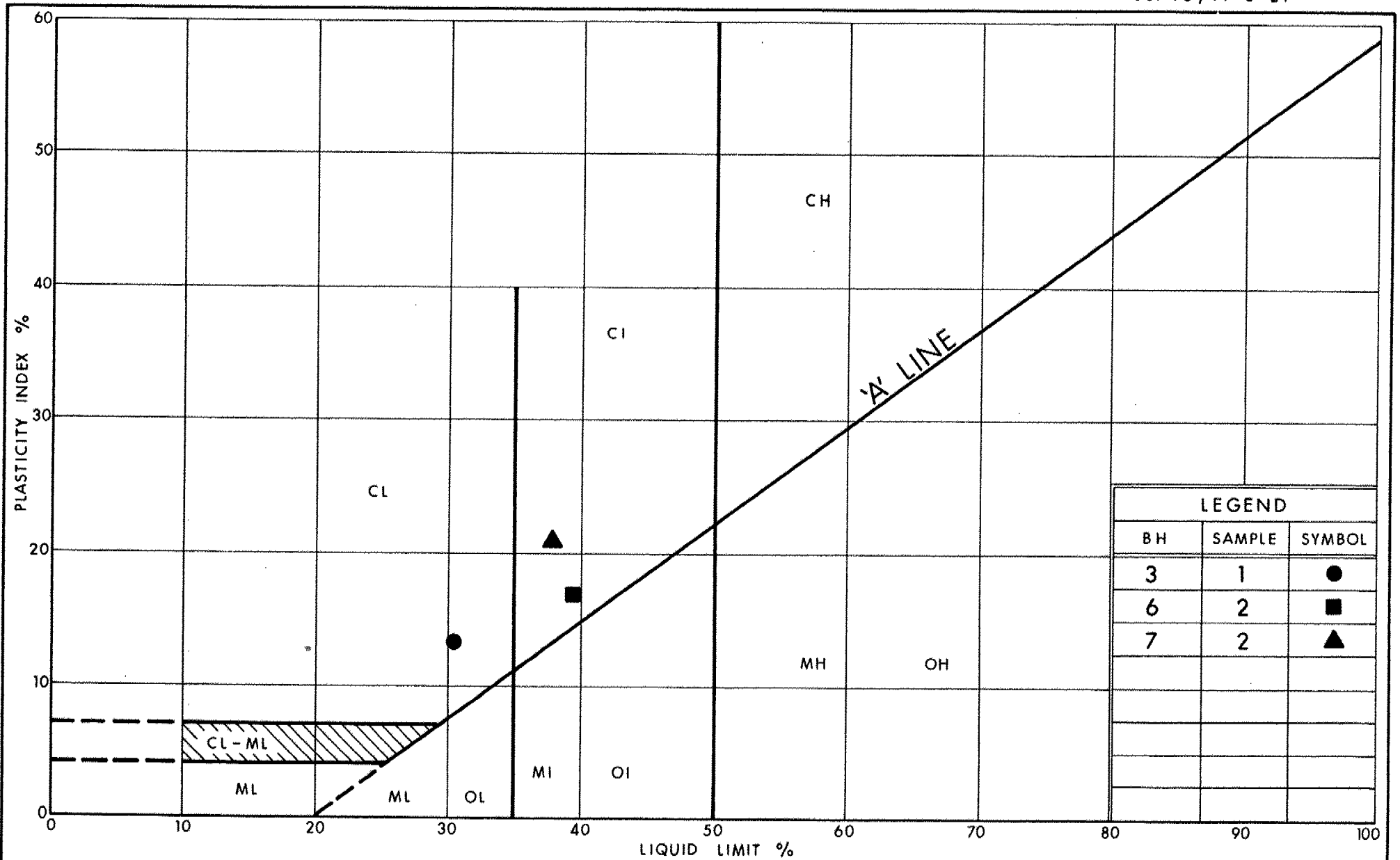


*Tae C. Kim*  
Tae C. Kim, P.Eng.  
Sr. Foundation Engineer

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

## APPENDIX





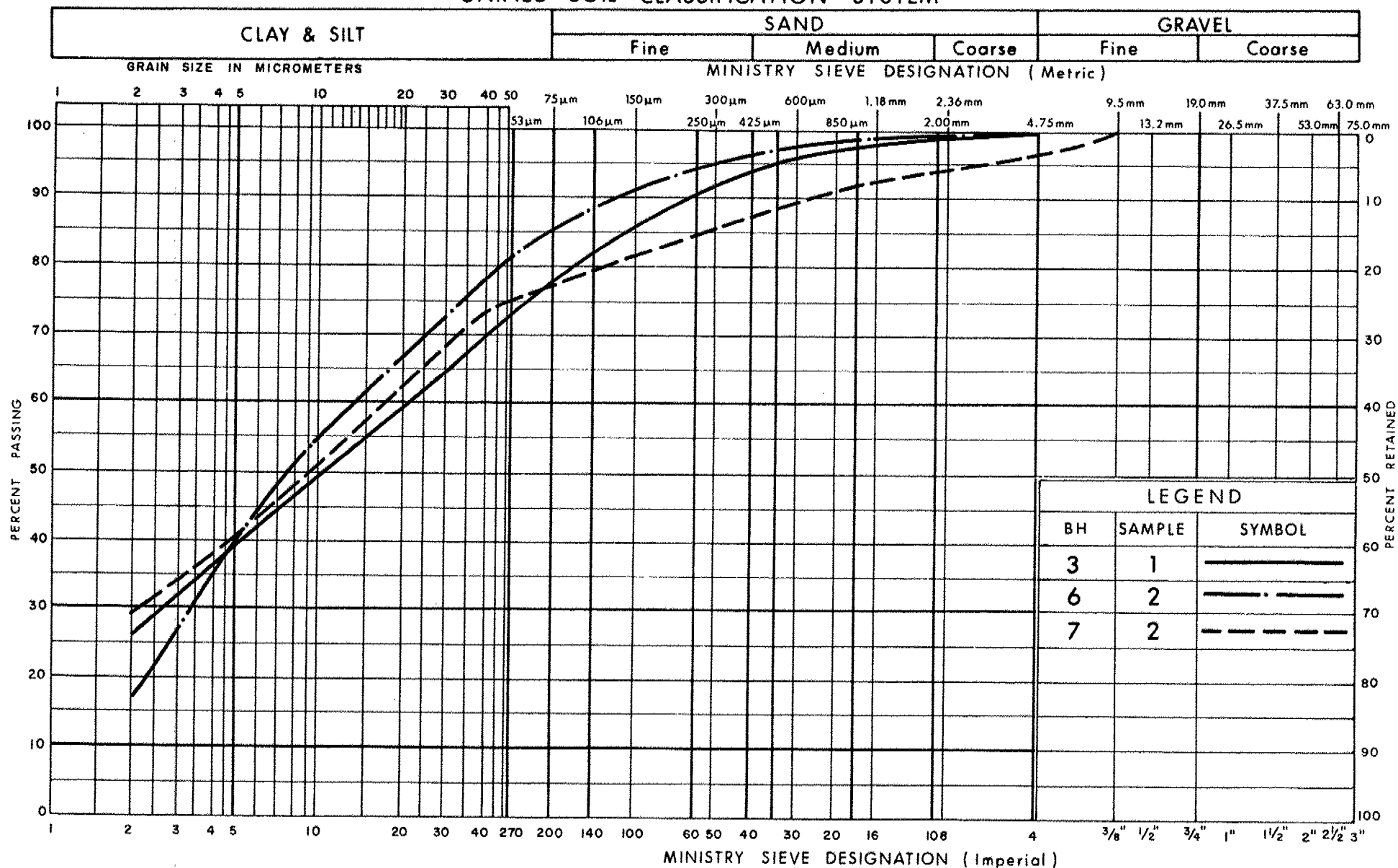
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# PLASTICITY CHART CLAYEY SILT (Fill and Topsoil)

FIG No 1

W P 409-85-04

## UNIFIED SOIL CLASSIFICATION SYSTEM



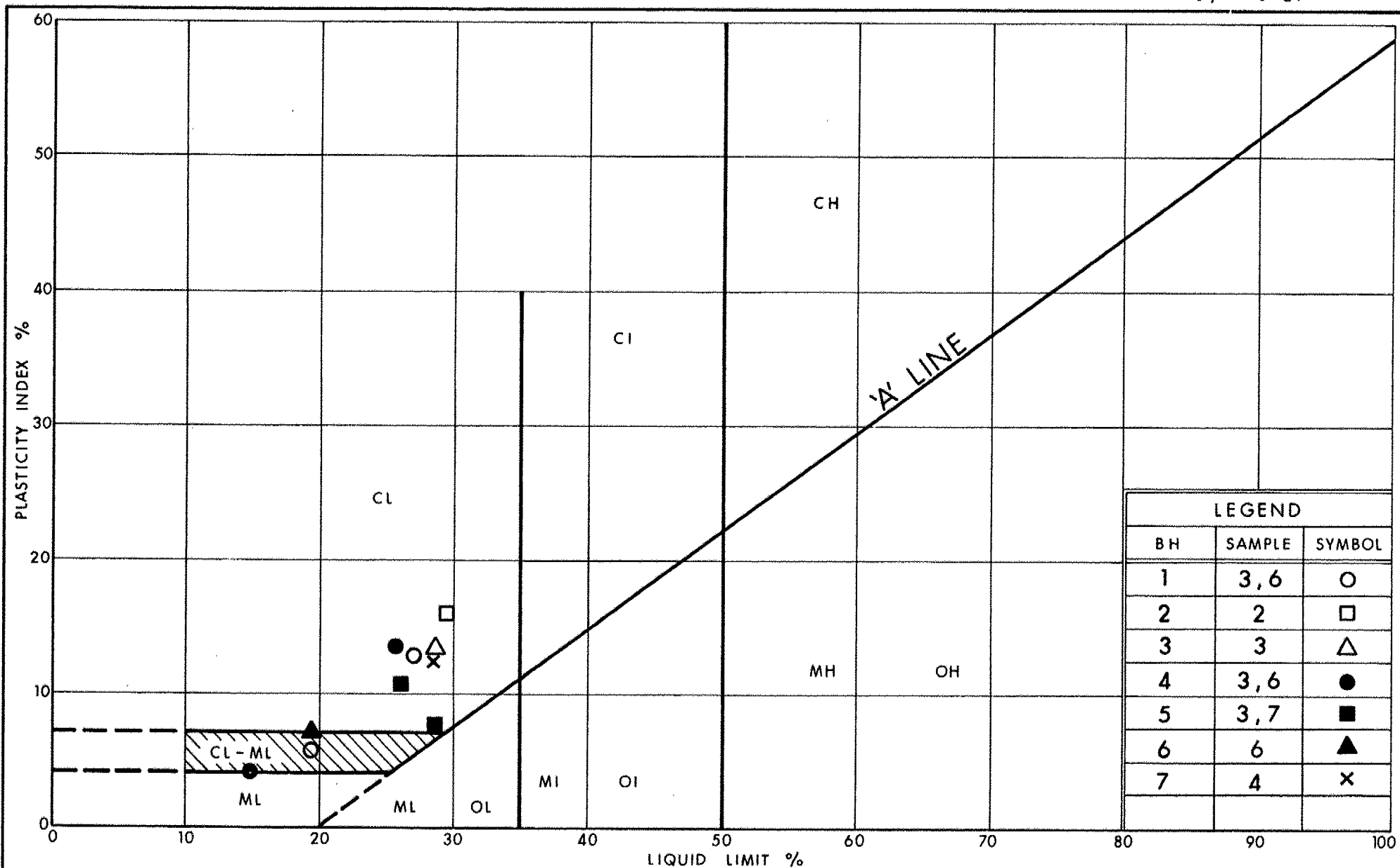
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## GRAIN SIZE DISTRIBUTION

### CLAYEY SILT (Fill and Topsoil)

FIG No 2

W P 409-85-04



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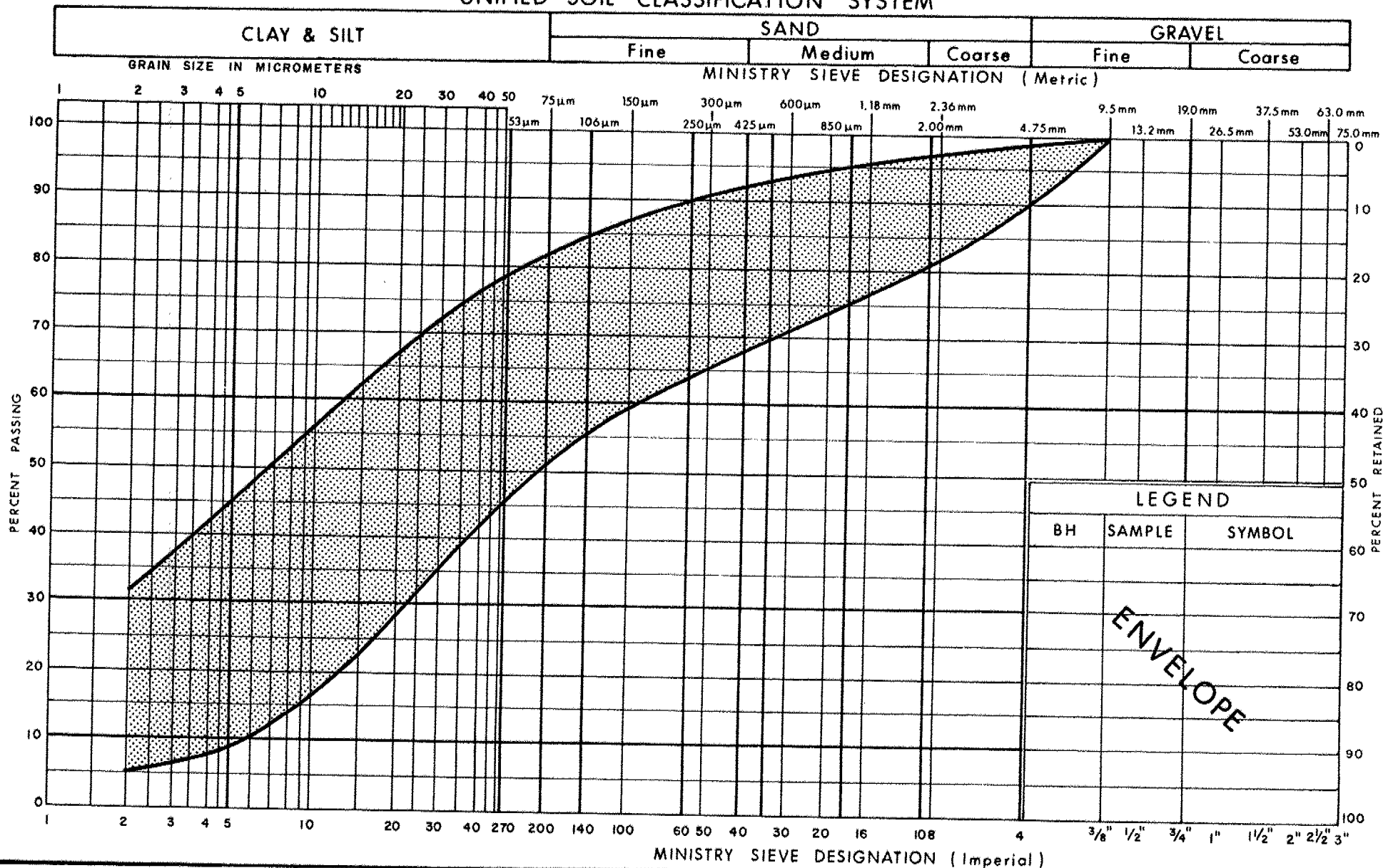
Ontario

# PLASTICITY CHART HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL (Glacial Till)

FIG No 3

W P 409-85-04

## UNIFIED SOIL CLASSIFICATION SYSTEM



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

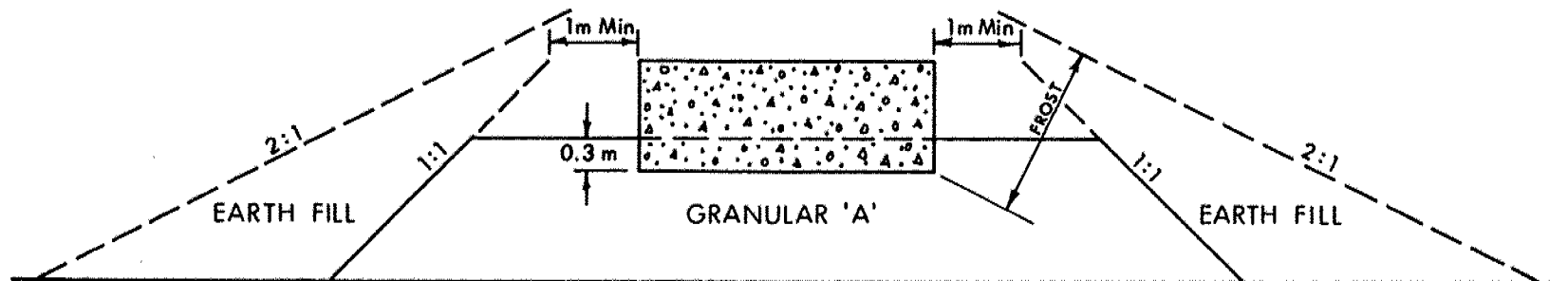
FIG No 4

W P 409-85-04

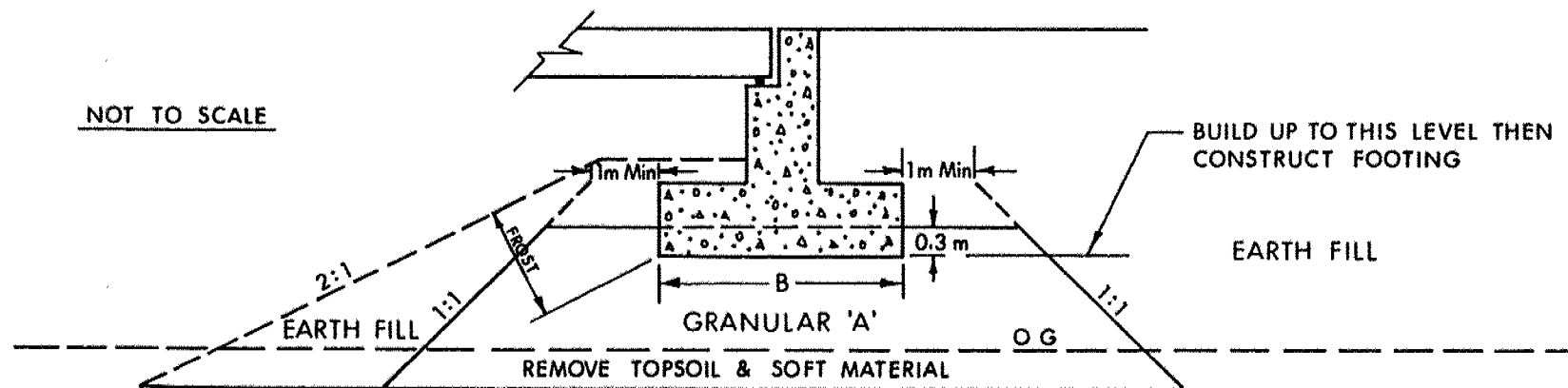


GRAIN SIZE DISTRIBUTION  
SANDY SILT

W P 409-85-04



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 O STANDARDS.
- 3- CONSTRUCT CONCRETE FOOTING.
- 4- PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.



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ABUTMENT ON COMPACTED FILL  
SHOWING GRANULAR 'A' CORE

FIG No 6

W P 409-85-04

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

### MECHANICAL PROPERTIES OF SOIL

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

### PHYSICAL PROPERTIES OF SOIL

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

1 OF 1

METRIC

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 $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100					
157.7	GROUND SURFACE						SHEAR STRENGTH kPa • UNCONFINED + FIELD VANE • QUICK TRIAXIAL * LAB VANE 20 40 60 80 100						

[illegible]



# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 409-85-04 LOCATION Co-ord: N 4 809 817.7 E 280 147.8 ORIGINATED BY F.L.R.  
 DIST 4 HWY 403 BOREHOLE TYPE Cone Test, H.S. Auger, and NQ Core COMPILED BY J.L.  
 DATUM Geodetic DATE April 4, 1990 CHECKED BY T.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
157.6	GROUND SURFACE													
0.0	Sand and Gravel ( Fill )													
156.8														
0.8	Clayey Silt ( Topsoil )		1	SS	6									
156.2														
1.4	Heterogeneous Mixture of Clayey Silt, Sand and Gravel Very Stiff to Hard ( Glacial Till )		2	SS	17									
			3	SS	39									
	Sandy Silt Layer		4	SS	55									
	----- Brown													
	----- Reddish Brown		5	SS	120	/15cm								
	Reddish Brown		6	SS	124	/18cm								
152.5	Red													
5.1			7	SS	130	/25cm								
	----- Weathered Sound		8	SS	120	/13cm								
	Bedrock		9	RC	REC	100%								RQD 42%
	Queenston Shale													
			10	RC	REC	79%								RQD 18%
148.5														
9.1	End of Borehole													
	* Borehole dry on completion, charged with water later													

# RECORD OF BOREHOLE No 3

1 OF 1 METRIC

W.P. 409-85-04 LOCATION Co-ord: N 4 809 797.5 E 280 181.0 ORIGINATED BY G.P.  
 DIST 4 HWY 403 BOREHOLE TYPE Cone Test, H.S. Auger, and NO Core COMPILED BY J.L.  
 DATUM Ceodetic DATE April 3 and 4, 1990 CHECKED BY T.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
157.7	GROUND SURFACE														
0.0															
157.2	Sand and Gravel ( Fill )														
0.5															
156.3	Clayey Silt ( Fill )		1	SS	10		157								0 22 51 27
1.4			2	SS	44		156								
			3	SS	50		155								1 20 46 33
	Brown Reddish Brown Heterogeneous Mixture of Clayey Silt, Sand and Gravel Hard ( Glacial Till )		4	SS	60	/3cm	154								
			5	SS	110		153								
			6	SS	100	/8cm	152								
152.4	Reddish Brown		7	SS	100	/10cm	151								
5.3	Red		8	SS	100	/5cm	150								22 27 43 8
			9	SS	100	/8cm	149								
	Weathered Sound		10	RC	REC		148								RQD 0%
	Bedrock Queenston Shale		11	RC	REC	100%									RQD 37%
147.2															
10.5	End of Borehole • Borehole dry on completion, charged with water later														

# RECORD OF BOREHOLE No 4

1 OF 1 METRIC

W.P. 409-85-04 LOCATION Co-ord: N 4 809 771.3 E 280 207.8 ORIGINATED BY F.L.R.  
 DIST 4 HWY 403 BOREHOLE TYPE Cone Test, H.S. Auger, and NQ Core COMPILED BY J.L.  
 DATUM Geodetic DATE April 3, 1990 CHECKED BY T.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
158.0	GROUND SURFACE							20 40 60 80 100							
157.8	Sand and Gravel ( Fill )							20 40 60 80 100							
0.4	Heterogeneous Mixture of Clayey Silt, Sand and Gravel Very Stiff to Hard ( Glacial Till ) Brown --- Reddish Brown		1	SS	19		157							1 27 50 22	
			2	SS	25		156								
			3	SS	28		155								
			4	SS	36		154								
			5	SS	39		153								
			6	SS	92		152								
152.5	Reddish Brown Red		7	SS	120	/23cm	151								
5.5	Bedrock  Queenston Shale  Weathered Sound		8	SS	105		150							17 2 68 13	
			9	SS	170	/22cm	149								
			10	SS	120	/5cm	148								RQD 33%
			11	RC	REC 100%		147								RQD 45%
146.3			12	RC	REC 100%										
11.7	End of Borehole														

## METRIC

[illegible]

# RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 409-85-04 LOCATION Co-ord: N 4 809 841.5 E 280 124.0 ORIGINATED BY G.P.  
 DIST 4 HWY 403 BOREHOLE TYPE Cone Test, and H.S. Auger COMPILED BY J.L.  
 DATUM Geodetic DATE April 4, 1990 CHECKED BY T.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
157.7	GROUND SURFACE														
0.0	Sand and Gravel ( Fill )														
156.6			1	SS	11										
1.1	Clayey Silt ( Topsoil )														
155.8			2	SS	11										
1.9			3	SS	42										
			4	SS	61										
	Brown Reddish Brown		5	SS	100										
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		6	SS	80	/15cm									
	Hard ( Glacial Till )														
152.3	Reddish Brown														
5.4	Red		7	SS	100	/8cm									
	Bedrock Queenston Shale														
150.0	Weathered		8	SS	100	/10cm									
7.7	End of Borehole	Sound													

# RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 409-85-04 LOCATION Co-ord: N 4 809 750.4 E 280 229.2 ORIGINATED BY F.L.R.  
 DIST 4 HWY 403 BOREHOLE TYPE Cone Test, and H.S. Auger COMPILED BY J.L.  
 DATUM Geodetic DATE April 4, 1990 CHECKED BY T.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
157.9	GROUND SURFACE													
0.0	Sand and Gravel ( Fill )													
157.4														
0.5	Clayey Silt, trace of Organics  ( Topsoil )		1	SS	6									
155.8			2	SS	5									3 21 54 22
2.1	Heterogeneous Mixture of Clayey Silt, Sand and Gravel Stiff to Hard ( Glacial Till )		3	SS	13									
			4	SS	26									3 22 52 23
			5	SS	50									
			6	SS	120	/13cm								
152.7			7	SS	120	/10cm								26 27 39 8
5.2			8	SS	109									

# ROCK CORE DESCRIPTION

## WP 409-85-04

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1						SHALE, expected as below (no core recovered).
2	9	6.22-7.62	100	42	6.22-9.14	SHALE, dark reddish brown, interbedded with greyish green SILTSTONE (22%); very fine grained; weak to very weak rock; unweathered to slightly weathered; close to very close spaced fractures.
	10	7.62-9.14	77	18		
3	10	7.72-8.94	100	0	7.72-10.46	SHALE, dark reddish brown, interbedded with greyish green SILTSTONE (28%); very fine grained; weak to very weak rock; unweathered to slightly weathered; close to very close spaced fractures.
	11	8.94-10.46	100	37		
4	11	8.89-10.42	100	33	8.89-11.68	SHALE, dark reddish brown, interbedded with greyish green SILTSTONE (18%); very fine grained; weak to very weak rock; unweathered to slightly weathered; close to very close spaced fractures.
	12	10.42-11.68	100	45		
5						SHALE, expected as above (no core recovered).
6						SHALE, expected as above (no core recovered).
7						SHALE, expected as above (no core recovered).

\*CR = CORE RECOVERY

\*RQD = ROCK QUALITY DESIGNATION

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

Logged by: DAW, Soils and Aggregates Section

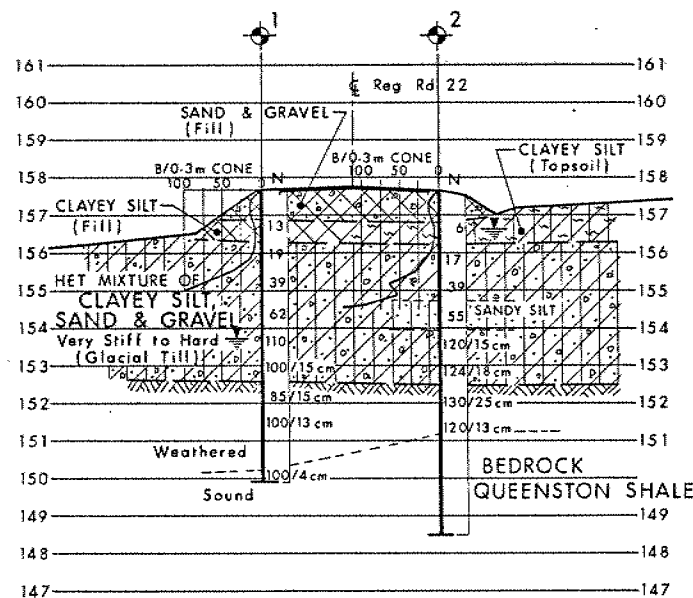
CONT No  
WP No 409-85-04

REGIONAL ROAD 22  
(TREMAINE ROAD)  
BORE HOLE LOCATIONS & SOIL STRATA

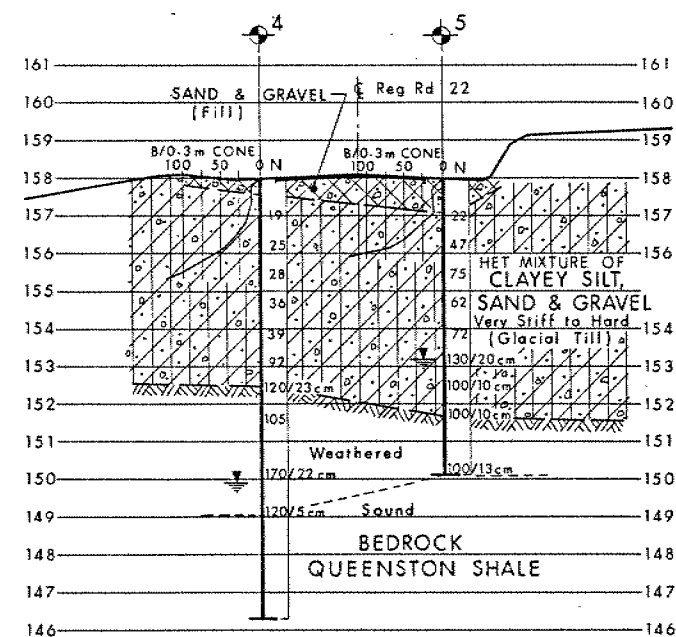


SHEET

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

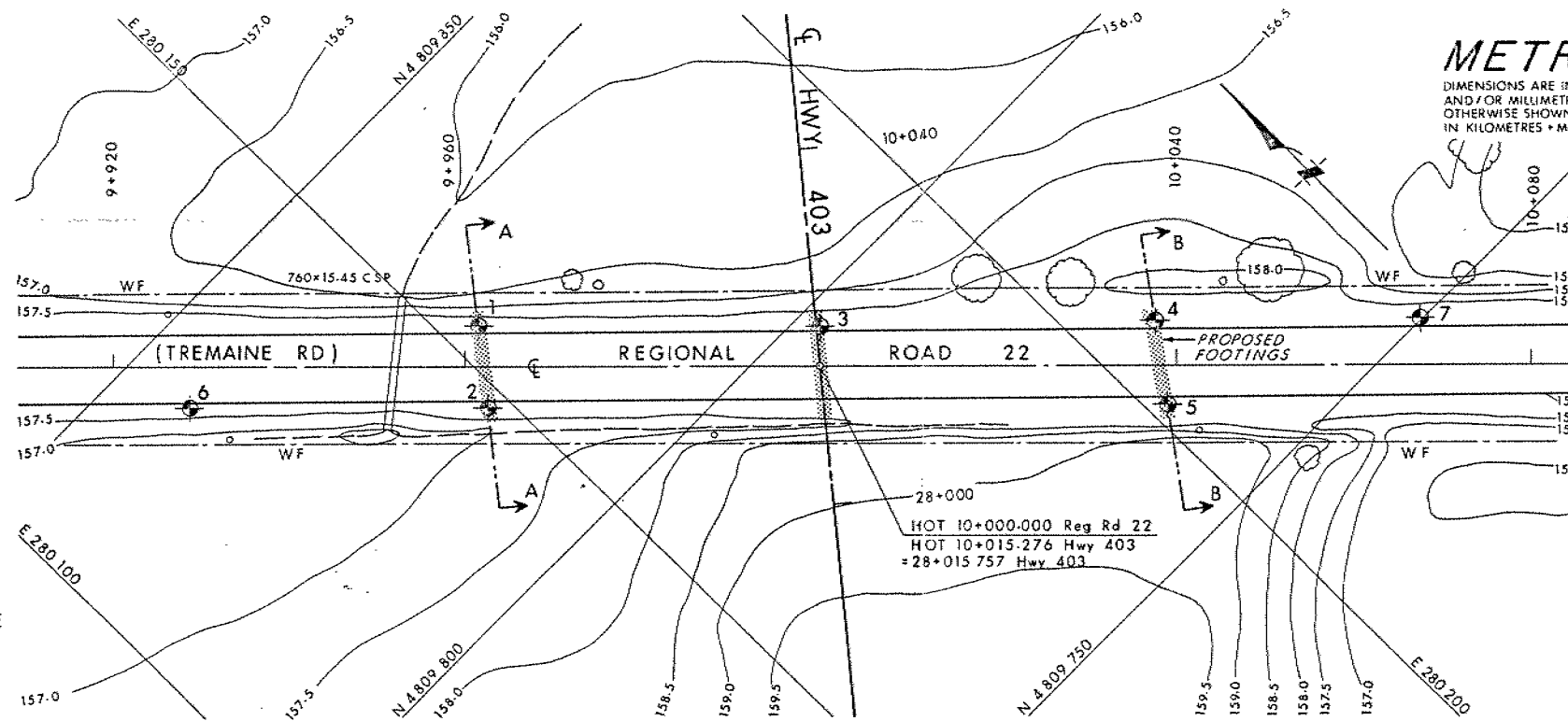


SECTION A-A



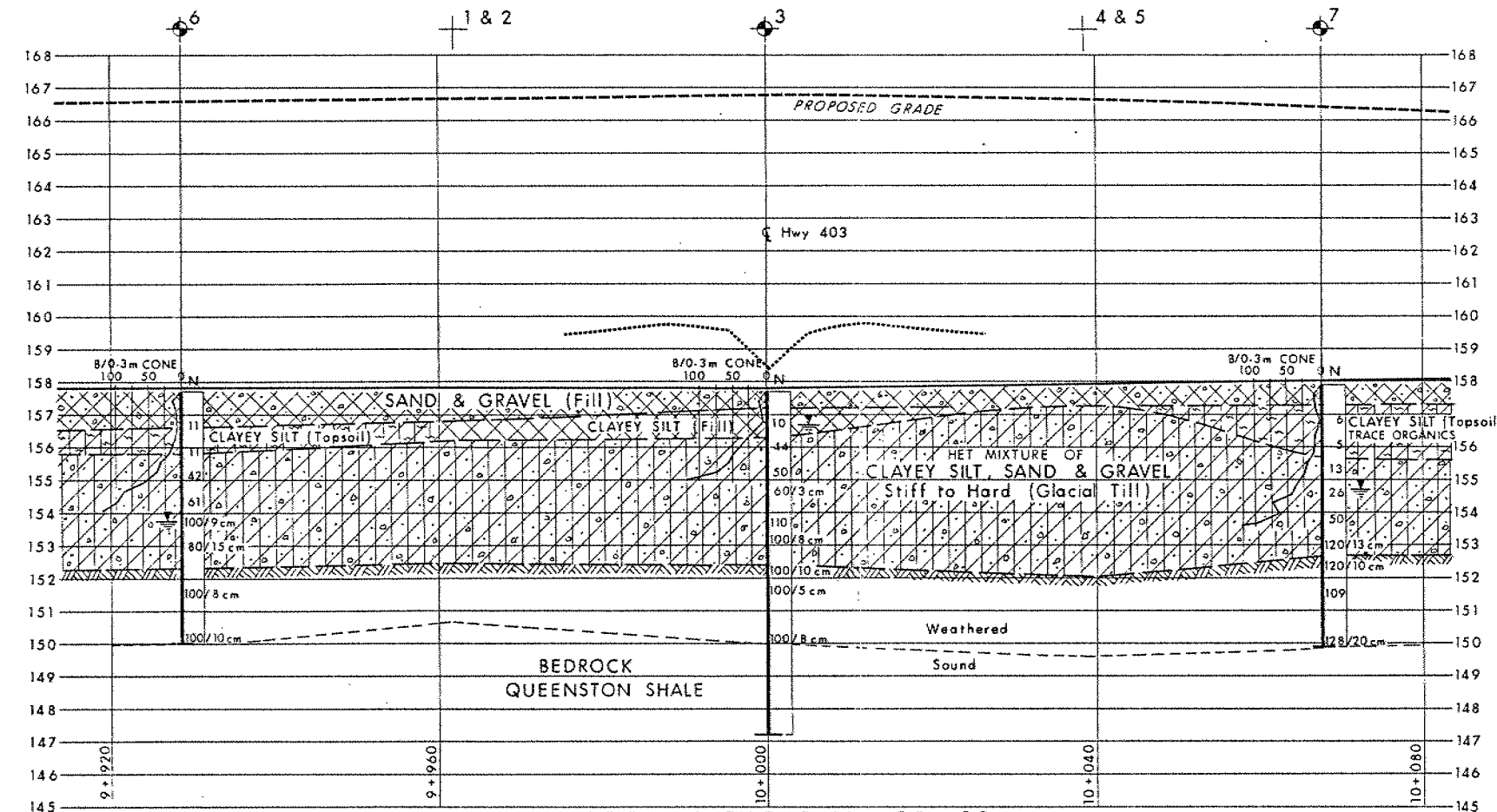
SECTION B-B

SCALE  
4m 2 0 4m Hor  
2m 1 0 2m Vert



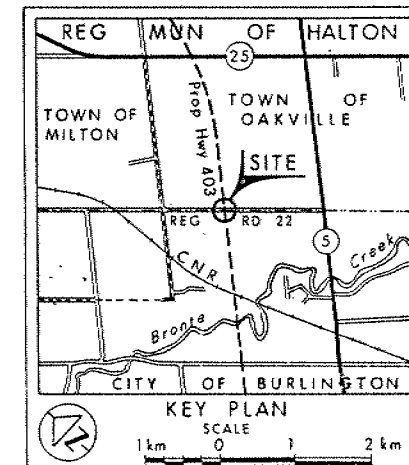
PLAN

SCALE  
8m 4 0 8m



PROFILE REGIONAL RD 22

SCALE  
8m 4 0 8m Hor  
2m 1 0 2m Vert



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 1990 04

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	157.7	4 809 824.9	280 153.7
2	157.6	4 809 817.7	280 147.8
3	157.7	4 809 797.5	280 181.0
4	158.0	4 809 771.3	280 207.8
5	158.0	4 809 763.7	280 201.9
6	157.7	4 809 841.5	280 124.0
7	157.9	4 809 750.4	280 229.2

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.

DATE	BY	DESCRIPTION

Geocres No 30 M5-164

HWY No 403	DIST 4
SUBMD T K (CHECKED) DATE 1990 11 01	SITE 10-230
DRAWN (CHECKED) APPROVED	DWG 4098504-A



PROPOSED CROSSING OF REGIONAL ROAD NO. 22  
AND HIGHWAY 403



LOOKING NORTH



LOOKING SOUTH

PROPOSED CROSSING OF REGIONAL ROAD NO. 22  
AND HIGHWAY 403



LOOKING EAST



LOOKING WEST