

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 80M13-95

DIST. 6 REGION

W.P. No. 88-78-16

CONT. No. 92-40

W. O. No.

STR. SITE No. 37-1327

HWY. No. 407

LOCATION Hwy 407 & CPR Subway

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

WP CO-ORDINATES			
	NORTH	EAST	STATION
1	4 847 548.500	298 207.731	9+949.153
2	4 847 536.036	298 220.015	9+966.653
3	4 847 512.285	298 243.423	10+000.000
4	4 847 488.251	298 267.110	10+033.745
5	4 847 475.787	298 279.394	10+051.245

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 88-78-16

HWY. 407 - C.P.R. SUBWAY

FOUNDATION LAYOUT & DETAILS

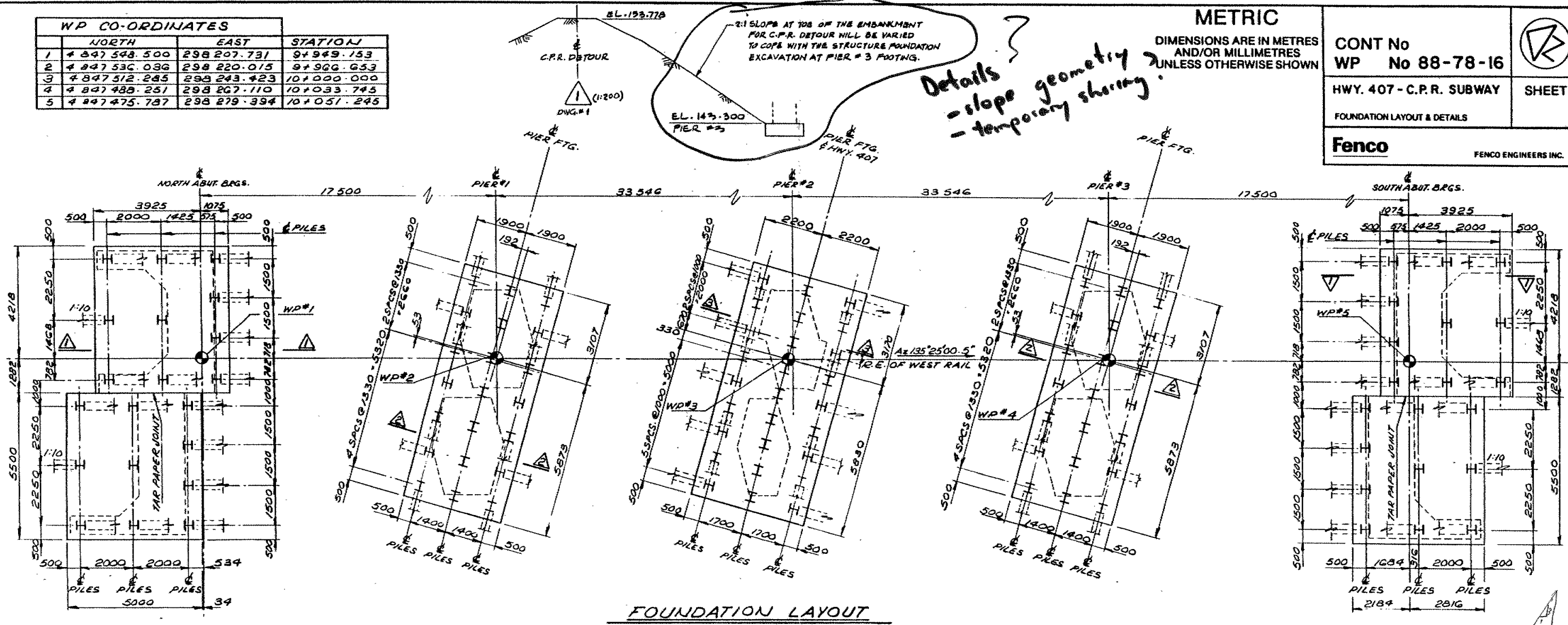
Fenco

FENCO ENGINEERS INC.



SHEET

Details
- slope geometry
- temporary shoring.



FOUNDATION LAYOUT

1:75

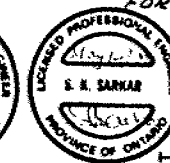
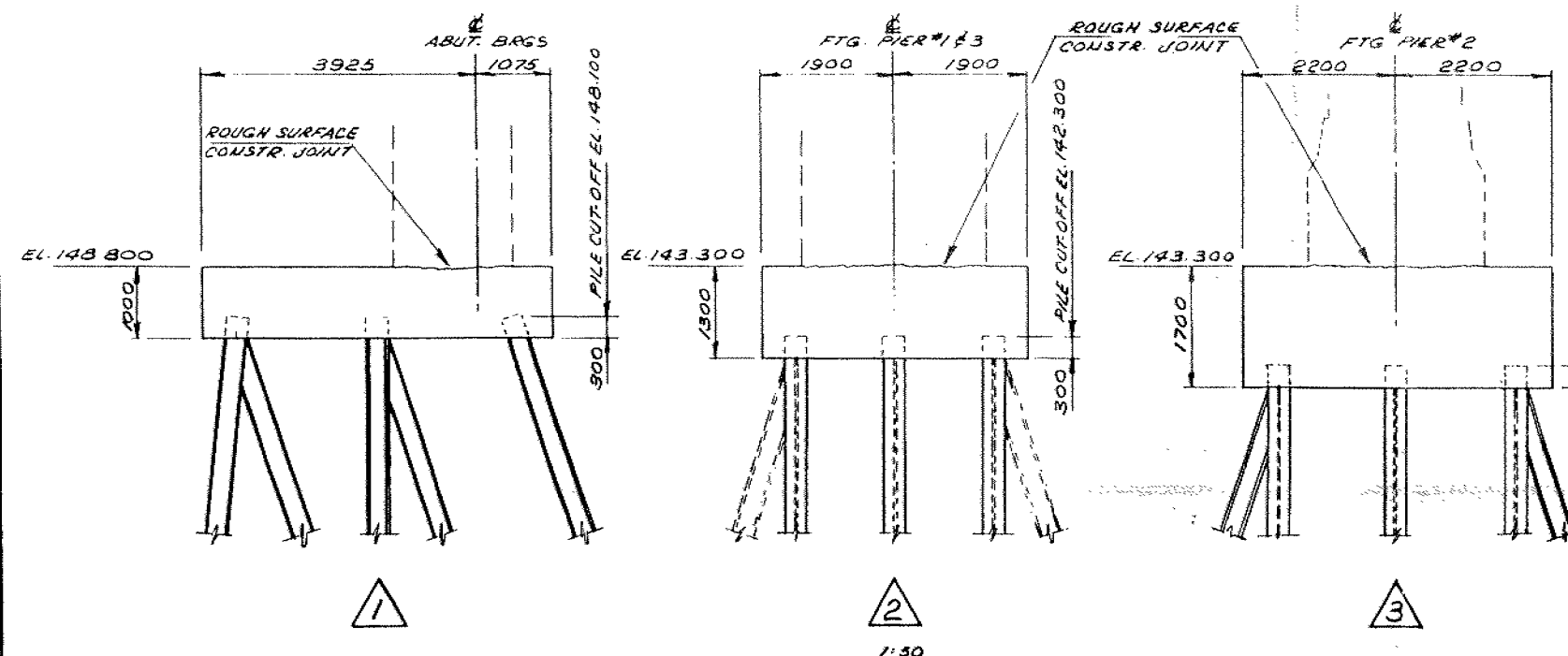
NOTES

- PILE SPACING IS MEASURED AT UNDERSIDE OF FOOTING.
- ALL PILES SHALL BE HP 310x110 STEEL 'N' PILES.
- PILE LENGTHS SHOWN ARE THEORETICAL LENGTHS BELOW PILE CUT-OFF.
- PILE DESIGN LOAD - 1150 kN PER PILE.
- ALL PILES SHALL BE FITTED WITH DRIVING SHOES.
- PILES TO BE DRIVEN WITH A DRIVING HAMMER CAPABLE OF DEVELOPING A MINIMUM ENERGY OF 50,000 JOULES PER BLOW.
- ALL PILES TO BE DRIVEN TO BEDROCK.

APPLICABLE STANDARDS

DD-3301 SPLICE AND DRIVING SHOE DETAILS FOR STEEL 'N' PILES

PILE DATA				
LOCATION	NO.	LENGTH	BATTER	
NORTH ABUT.	FRONT ROW	8	43 500	1:3
	MIDDLE ROW	4	43 500	1:3
	BACK ROW	4	43 500	1:3
PIER #1	NORTH ROW	6	37 500	1:4
	MIDDLE ROW	7	35 500	NIL
	SOUTH ROW	6	37 500	1:4
PIER #2	NORTH ROW	9	36 500	1:4
	MIDDLE ROW	9	34 500	NIL
	SOUTH ROW	9	36 500	1:4
PIER #3	NORTH ROW	6	38 500	1:4
	MIDDLE ROW	7	36 500	NIL
	SOUTH ROW	6	38 500	1:4
SOUTH ABUT.	FRONT ROW	8	45 000	1:3
	MIDDLE ROW	4	45 000	1:3
	BACK ROW	4	45 000	1:3



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN: SS CHK: MG CODE: A R E A
DRAWN: JJA CHK: MG SITE: 37.1327 STRUCT: SCHEME: DWG: 3



REVISIONS								
DATE	BY	DESCRIPTION						
DESIGN#	YSS	CHK#	S	MG	CODE AREA	LOAD	DATE	APP. 199
DRAWN	FJW	CHK#	K	AS	SITE 37-327	ISTRUCT	ISCHWF	DWG 8

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 88-78-16 DIST 6
HWY 407 STR SITE 37-1327

Hwy. 407/CPR Subway
(Between Islington Avenue and Humber River)

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FOUNDATION INVESTIGATION REPORT
For
Hwy. 407/CPR Subway
(Between Islington Avenue and Humber River)
W.P. 88-78-16, Site No. 37-1327
District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. It is proposed to construct a two span structure that will carry the existing track plus an additional track to the west over the proposed Hwy. 407. Equal span lengths of 32 metres and a bridge width of 10.47 metres is proposed for the CPR structure. The proposed Hwy. 407 grade has a proposed profile grade of approximately 145 metres at the proposed CPR subway structure. The CPR profile will remain similar to the existing with a top of rail elevation ranging from 153.2 m at the proposed north abutment location to 153.5 m at the proposed south abutment location.

This report describes the subsurface conditions encountered at the site and provides recommendations pertaining to the foundation design of the CPR structure and related earthworks to facilitate the design and construction of the structure.

SITE DESCRIPTION AND GEOLOGY

The site is located along and adjacent to the existing CPR tracks approximately 0.3 km northwest of the CPR - Islington Avenue level crossing in the Town of Vaughan, Regional Municipality of York. The site is characterized by a meandering valley that supports side slopes of approximately 2.5H:1V and trends in a general southwesterly direction. The crest of the valley is approximately 200 metres in width and the valley depth is approximately 20 metres. The valley houses the Jersey Creek that runs its course at the valley floor and is approximately 2 metres in width and normally flows at 1 metre depths. The Jersey Creek flows into the Humber River located in a floodplain immediately west of the site.

The valley slopes are densely covered with trees, brush, tall grasses and shrubs. There is no evidence of slope creep or displacement indicating that the valley slopes are stable at its present geometry.

The existing CPR track at the site is supported by an earth embankment spanning the valley crest width. The railroad embankment, supposedly constructed in the early 1900's supports side slopes approximately 1.5H:1V. Trees and low lying shrubs and grassland cover the existing constructed slopes. There appears to be no evidence of slope instability other than a localized area at the northeastern portion of the embankment. Rip-rap and armour stone was placed on the slope to retard surficial erosion at this location.

A concrete culvert is located at the base of constructed embankment, constructed to facilitate the Jersey Creek outflow beneath the embankment. Again, no visible signs of distress in the culvert were apparent.

Land use surrounding the site consists of residential lots located east of the site, a hydro corridor consisting of transmission towers just north of the site and forestland elsewhere. A CPR two span structure is located approximately 0.3 km north of the site along the same track alignment. The structure spans the Humber River at this location. In addition, a CNR rigid frame overhead exists approximately 0.2 km south of the site to facilitate CN Rail traffic in a east-west direction over the CPR track.

Physiographically, the site lies within the region known as the South Slope (Chapman and Putman, 1984). The South Slope formation at the site consists of a ground moraine, scoured at intervals by valleys tributary to the Humber River systems. The valleys accentuate the hilly moraine topography. The glacial landforms and deposits were formed by the advance and retreat of the Winsconsinan ice sheet that covered the area during the Pleistocene epoch (over 5000 years ago).

The overburden is underlain by the grey shales of the Georgian Bay Formation of the Ordovician period.

FIELD INVESTIGATION

The fieldwork for the investigation was carried out between 89 10 21 and 89 11 30 and consisted of 8 sampled boreholes advanced to depths ranging from 6.6 m to 49.1 m below ground surface. The fieldwork for the proposed realigned Jersey Creek culvert and CPR detour in conjunction with the CPR Subway was also carried out within this time period and consisted of 4 and 2 sampled boreholes respectively.

Four of the eight boreholes were advanced through the overburden using hollow stem augering techniques to the depths of the lower sand with some silt deposit (approximately 39 metres below ground surface). Beyond that depth, the boreholes were advanced using conventional diamond drilling techniques (casing and washboring) to overcome torquing restriction imposed on the hollow stem augers. The NW casing used was advanced by both driven and rotary methods. The drilling equipment used was a track mounted CME 55.

In consideration of the importance of establishing the composition of the CPR embankment fill, a total of four boreholes were advanced in the existing embankment fill. Two of the boreholes were advanced from the crest of the embankment using the track-mounted CME and conventional hollow stem augering techniques. The other two boreholes were advanced at mid-slope, on the west side of the embankment (BH's 4A and 6A). These boreholes were advanced using conventional diamond drilling techniques via a tripod apparatus.

In general, subsoil samples were retrieved at 1.5 m intervals for the upper 27-30 metres and at 3.0 m intervals thereafter. A project pilot borehole (BH D-1), however, was advanced with subsoil retrieval at increased frequency, namely 0.7 m intervals for the surficial 6.0 metres and 1.5 m intervals thereafter.

Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). Relatively undisturbed samples were also randomly retrieved in the surficial till deposit using a Shelby tube sampler in accordance with standard practice (ASTM D1587). In situ vane tests

were also conducted in the cohesive surficial deposit, generally at 1.5 m intervals, to determine the undisturbed and remoulded undrained shear strengths of the soil. The test was conducted employing the standard MTO 'N' vane in accordance with ASTM D2573.

Bedrock was cored at four of the eight boreholes advanced in conjunction with the proposed structure. The location of the four rock core boreholes coincide with the structure foundation locations (BH D-1, D-2, D-4 and D-8). Bedrock was cored using conventional rock coring methods in NQ size.

All subsoil samples and rock core were identified in the field and then returned to the laboratory for further examination and applicable testing.

Water levels were obtained in the open boreholes and also in a sealed piezometer installed at BH D-8. Groundwater levels were monitored throughout the duration of the investigation. All boreholes were backfilled at the completion of the fieldwork.

Survey information related to location and elevation of boreholes was provided by Central Region Surveys and Plans.

LABORATORY ANALYSES

To identify the behaviour, gradation and pertinent properties and characteristics of the soil, various laboratory tests were performed. These tests included:

- 1) Atterberg Limit
- 2) Grain Size Analyses
- 3) Unit Weights
- 4) Natural Moisture Contents
- 5) Unconfined Compression Tests
- 6) Unconsolidated Undrained Tests
- 7) Multi-stage consolidated undrained tests with pore pressure measurements
- 8) Consolidation Test

In view of the general uniformity of soil types found in the general site area, including the proposed Jersey Creek culvert structure and the proposed detour, all laboratory results for similar soil strata have been integrated for the different structure locations. Laboratory test results have been summarized in the subsequent section of this report and are illustrated on corresponding figures and boreholes included in the attached Appendix.

SUBSURFACE CONDITIONS

The native subsoil of the original valley at the site consists of a surficial deposit composed of a clayey silt to silty clay with occasional sand seams and traces of gravel. The stratum is a till deposit of glacial origin and extends to a maximum thickness of 13.7 metres at the crest of the valley. The thickness of this deposit decreases down the valley slope and does not exist at the valley floor. The consistency of this deposit ranges from firm to hard.

Underlying the surficial deposit, exists a deposit of clayey silt that extends for a considerable thickness ranging from 18.3 m to 28 m. The consistency of this stratum also varies from firm to hard.

The clayey silt deposit is in turn underlain by a cohesionless deposit of sand with a trace to some silt. Random zones of silt also exist in this deposit. Gravel, boulders and cobbles are also components of the lower depths of the deposit. The thickness of this deposit ranges from 4.2 m to 15.8 m with an average thickness of approximately 10 metres. The denseness of this deposit varies from compact to very dense. This cohesionless deposit overlies shale bedrock of the Georgian Bay shale formation.

Two types of fill material was used to construct the CPR embankment. Surficially and within a zone above and immediately adjacent to the existing concrete culvert, a cohesionless backfill material consisting of a sand with some silt to sandy silt was used. Beneath the surficial sand material and beyond the culvert backfill wedge zone, the embankment fill material consists of a clayey silt with interbedded layers of sand. The thickness of the surficial cohesionless fill material, which also exists on the embankment slopes, ranges

from 2.0 to 4.6 metres. The maximum depth of the embankment fill explored was 13.9 metres at BH D-6, located at the proposed pier location. At BH's D-1, D-2, located in the area of the south abutment, only 1.5 to 2.4 metres of granular fill was encountered, confirming the valley crest location. At BH D-4, the location of the proposed north abutment, 12.2 metres of clayey silt fill material with interbedded layers of sand exists.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwgs. 887816-A & 887816-B.

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

Sand, some Silt (Fill)

As previously mentioned, the surficial embankment fill material and backfill material to the existing concrete culvert consists generally of a brown sand with some silt. Occasional layers of sandy silt and clayey silt are also present in the fill material and traces of fine gravel are also randomly intermixed. A grain size distribution envelope illustrating the gradation of the fill is provided in Figure 1 in the Appendix. The surficial thickness of the fill material varies from 1.5 to 2.4 metres and the maximum thickness explored was 16.2 metres at which depth the existing concrete culvert roof was encountered.

Standard Penetration tests carried out in the cohesionless fill material revealed 'N' values ranging from 2 blows/0.3 m to 21 blows/0.3 m indicating a very loose to compact state of condition.

Clayey Silt (Fill)

Beneath the surficial cohesionless fill and beyond the culvert cohesionless backfill material, the CPR embankment fill consists of a brown, cohesive clayey

silt. The maximum thickness of the clayey silt fill encountered was 12.2 metres at the proposed north abutment location. Interbedded layers of fine sand ranging in thickness from 50 mm to 150 mm are also present randomly in the cohesive matrix. A grain size distribution envelope for this material as determined by mechanical sieve and hydrometer analysis is given in Figure 2.

Atterberg Limits were obtained to evaluate the behaviour and plasticity of the soil and the results are plotted in Figure 3. A summary of the indices is provided in Table 1 below. Unit weights are also included.

Table 1 - Clayey Silt (Fill)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	15-24	8
Liquid Limit (w _L %)	21-32	8
Plastic Limit (w _p %)	13-19	8
Unit Weight (kN/m ³)	19.2-20.2	4
Undrained Shear Strength (cu) (kPa)	80->120	5

The test results reveal that the cohesive fill material is of low plasticity and hence can be categorized as clayey silt.

Undrained shear strength measurements (cu) were obtained in situ by conducting field vane tests. Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 1 above. However, in consideration of the interbedded layers of sand, consistencies ranging from stiff to very stiff which is representative of the determined shear strength values cannot be implicitly assumed.

Silty Clay to Clayey Silt (Glacial Till)

The native surficial deposit present at the site consists of a cohesive silty clay to clayey silt with traces of sand and gravel and occasional random interbedded sand seams. The thickness of the deposit explored in the

investigation ranges from 11.3 to 13.7 and the interbedded sand seams are generally 50 to 100 mm in thickness. At BH D-4, the approximate location of the proposed north abutment, this deposit does not exist indicating that the deposit decreases in thickness from the crest of the valley to the valley floor. The deposit is generally oxidized (brown) for the upper 1.5 to 3.5 metres and unoxidized (grey) for its lower thickness. The deposit is a till of glacial origin.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 4. The envelope illustrates that clay and silt percentages in the deposit range from 25-61% and 35-61% respectively, confirming the range in behaviour of the fine grained portion of the deposit.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 5. A summary of the indices is provided in Table 2. Unit weights are also included.

Table 2 - Silty Clay to Clayey Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	15-29	14
Liquid Limit (w_L %)	22-47	14
Plastic Limit (w_p %)	12-20	14
Unit Weight (kN/m^3)	18.8-20.3	9
Undrained Shear Strength (c_u) (kPa)		
- Field Vane	35->120	28
- Laboratory*	41-82	4
Sensitivity	2-3	28

*Unconfined Compression Tests

*Unconsolidated Undrained Tests

The test results reveal that the deposit varies randomly in plasticity ranging from low (clayey silt) to intermediate (silty clay).

Undrained shear strength measurements (cu) of the soil were obtained both by in situ vane tests and by laboratory tests, namely unconfined compression tests and unconsolidated undrained tests (quick triaxial). Results are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 2. A Shear Strength vs Elevation profile is also provided in Figure 6. Based on shear strength values ranging from 35-120 kPa, it is considered that the soil has a firm to very stiff consistency.

The sensitivity of the soil as defined by the ratio of the undrained strength in the undisturbed state to the undrained strength, at the same water content, in the remoulded state was also determined by the field vane test and the results are tabulated in Table 2 and identified on the Record of Borehole sheets. Sensitivity values range from 2 to 3 indicating that the soil has a low sensitivity.

Consolidated undrained multi-stage triaxial tests with pore pressure measurements were conducted in the laboratory to determine the effective strength parameters of the material. The effective shear strength parameters determined from the test are summarized in Table 3.

Table 3

Sample	BH D-1, TW5
Elevation (m)	147.0
Liquid Limit	47
Plastic Limit	20
Natural Moisture Content (w%)	26
Effective Angle of Internal Friction (ϕ°)	29.5
Effective Shear Strength Intercept (c') (kPa)	10

For design purposes, a reduced angle of internal friction (ϕ°) of 26° and a shear strength intercept of 5 kPa was selected to account for the fact that the sample tested was not saturated.

In conjunction with the proposed detour, (BH D-5, WP 141-87-00D) located immediately west of the proposed CPR Subway, a consolidation test was conducted to evaluate the compressibility characteristics of this same deposit. The results (e-log p curve) of the test are illustrated in Figure 7 in the Appendix. The results reveal that this cohesive stratum has been preconsolidated in the past to an effective pressure 200 kPa in excess of the existing overburden pressure.

The coefficient of consolidation (cv) used to determine the time rate of consolidation settlement was computed using Taylor's Method (1948). The results reveal values ranging from 0.004 m²/day to 0.005 m²/day for loadings ranging from 100 to 200 kPa.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 2 blows/0.3 m to 15 blows/0.3 m

Clayey Silt

Underlying the surficial native clayey silt to silty clay deposit at a depth ranging from 10.7 m to 13.7 m below the ground surface (Elevation 140.0 to 135.2) and extending for a maximum thickness of 18.3 metres, exists a cohesive, grey deposit of clayey silt. This stratum also contains traces of sand and random zones of silt. A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 8. The envelope reveals clay and silt percentages ranging from 12-31% and 60-88% respectively.

Atterberg Limit tests were carried out to evaluate the behaviour and plasticity of the soil and the results are plotted in Figure 9 and summarized in Table 4 below. Unit weights are also included:

Table 4

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	14-35	13
Liquid Limit (w _L %)	22-30	13
Plastic Limit (w _p %)	14-18	13
Unit Weight (kN/m ³)	20-22	6

The test results reveal that the deposit is predominantly of low plasticity.

Standard Penetration tests carried out in this stratum revealed 'N' values ranging from 5 blows/0.3 m to 76 blows/0.3 m indicating that the deposit ranges in consistency from firm to hard. In general, in the upper 10 metres or so, 'N' values ranged from 20 blows/0.3 m to 25 blows/0.3 m, indicating a very stiff consistency, but in the lower depths of the deposit, 'N' values ranged from 10 blows/0.3 m to 20 blows/0.3 m and the soil can be categorized as having a stiff consistency.

Sand, some Silt

Underlying the clayey silt deposit and extending to bedrock a cohesionless deposit of sand with some silt exists. The thickness of the deposit ranges from 4.2 m to 15.8 m, but is generally in the order of 10 metres in thickness. Random zones of silt are also present within this deposit. In addition, gravel, boulders and cobbles exist as a heterogeneous mixture in the main deposit at the lower depths immediately above the bedrock. At BH's D-4 and C-3, approximately 2.5 metres of the coarser grained gravel, boulders and cobbles were encountered. A grain size distribution envelope for this deposit is provided in Figure 10 in the Appendix.

This cohesionless deposit is water bearing and consequently, when the deposit was penetrated in the open borehole, soil cave-in resulted due to unbalanced hydrostatic head.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 10 blows/0.3 m to 120 blows/.08 m indicating that the deposit ranges in denseness from compact to very dense. In view of the fact that the lower 'N' values may be attributable to sampling disturbance induced by unbalanced hydrostatic head as mentioned above and the higher 'N' values not necessarily representing the state of denseness because of the large boulders and cobbles, the deposit can be generally categorized as dense.

Bedrock

The cohesionless sand with some silt deposit is directly underlain by shale bedrock of the Georgian Bay shale formation. The bedrock surface is generally flat with surface elevations ranging from 105.9 m to 107.7 m. The bedrock was cored by NQ size up to 2.8 metres in thickness.

The shale bedrock is grey in colour and is very fine grained and thinly laminated. The rock is generally slightly to moderately weathered and contains occasional clay seams, approximately 50 to 100 mm in thickness. Minor beds of argillaceous limestone are also present in the rock formation. Detailed descriptions of the bedrock are attached in the Appendix entitled "Description of Rock Core".

Core recoveries and Rock Quality Designations (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Rock recoveries varied between 60 and 100% while RQD's varied between 0 and 15%. The shale bedrock is weak to very weak rock.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes and monitoring the level in a piezometer installed at BH D-8 (pier location). The piezometer was installed in the clayey silt deposit with bentonite seals above and below the piezometer tip. Measurements obtained at the time of the investigation revealed levels as tabulated in Table 5 below.

Table 5 - Groundwater Levels

Depths (m)	Elevations (m)	BH's	Location
2.0-4.0 m	148.2-150.6	D-1 D-2 D-3	Valley Crest (South Abutment, 40 m north of North Abutment)
6.2	144.4	D-8	Pier
16	136.1	D-4	North Abutment (12.2 m of embankment fill).

In all cases, the groundwater level was not found in the boreholes advanced in the embankment fill.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a two span (32 m - 32 m) structure that will carry CPR train traffic along its present route over the proposed Hwy. 407 approximately 0.3 km northwest of the Islington Avenue level crossing. The proposed structure of 10.47 m width will support the replacement of the existing track presently supported on a constructed earth embankment and also support a future track located at a centreline distance of 4.27 m west of the existing track. The top of rail elevation varies from approximately 153.1 m to 153.5 m.

The proposed profile grade of the Hwy. 407 at the CPR Subway location is approximately elevation 145 m. For bridge deck elevations equivalent to the aforementioned top of the rail elevations, depths of cut of up to 8.5 m will be required in the native topography to facilitate advancement of the highway. The six lane highway will be constructed with a 17.5 m width median and the highway will decrease in elevation from elevation 150.7 m at the proposed Islington Avenue - Hwy. 407 Underpass to the proposed CPR-Hwy. 407 Subway at a 3% gradient. The profile grade of Hwy. 407 remains relatively flat west of the CPR structure.

In conjunction with the proposed CPR Subway structure, a temporary detour will be constructed immediately west of the proposed structure to facilitate construction of the structure whilst maintaining train traffic. In addition, the Jersey Creek will be realigned and will outflow to the Humber River through a proposed concrete culvert to be constructed at an elevation of approximately 135.5. The culvert is to be located approximately 35 m north of the proposed CPR north abutment.

Recommendations pertaining to the following geotechnical considerations for the design and construction of the CPR Subway structure are contained in the scope of this report.

1. Structure Foundations
2. Slope Stability
3. Lateral Earth Pressures on Structure
4. Construction Considerations

1. Structure Foundations

In view of inadequate soil bearing capacity suitable for a shallow foundation in the surficial cohesive till deposit and existing fill material, it is recommended that the structure foundations be founded on deep foundation units. The deep foundations can be supported using either end bearing or friction piles as discussed below. The design that proves to be most economical and feasible shall be selected.

End-Bearing Piles

All foundations can be founded on end-bearing steel H-piles driven to the bedrock surface. To facilitate pile penetration, particularly through the gravel, boulders and cobbles, it is recommended that the steel H-piles be equipped with reinforced tips. In view of the considerable pile length, splicing of the piles shall conform to pertinent MTO Standards (OPSS 903.07.01.03). The piles, nonetheless, can be designed as fully laterally supported columns. The following design parameters are recommended for vertical steel H-piles.

<u>Structure</u>	<u>Pile Type</u>	Factored Capacity at U.L.S. (kN)	Bearing Capacity at S.L.S. Type II (kN)	Bedrock Surface El. (m)
North Abutment	HP310x79	890	1150	107.1±
	HP310x110	1150	1600	
Pier	HP310x79	890	1150	107.7±
	HP310x110	1150	1600	
South Abutment	HP310x79	890	1150	105.5±
	HP310x110	1150	1600	

Driving of piles shall be carefully monitored and controlled employing the Hiley Dynamic Pile Driving Formula driven in accordance with MTO Standards SS103-10 or SS103-11 assuming an ultimate capacity as follows:

<u>Pile Type</u>	<u>Ultimate Capacity (kN)</u>
HP 310x79	2670
HP 310x110	3450

Although attempts should be made in all cases to drive the piles to the bedrock surface, some piles may terminate on or in the gravel, cobbles and boulders that directly overly the bedrock. To ensure adequate seating of the pile, it is important that pile driving be accurately controlled.

Friction Piles

Alternatively, all structure foundations can be founded on friction files that derive their supporting strength primarily as a result of shaft resistance produced in the clayey silt stratum. It is recommended that the piles be driven to an elevation of 115 metres and the piles be equipped with driving shoes to facilitate the installation process. For purposes of the O.H.B.D.C., the design capacities for various pile types are summarized below.

<u>Pile Type</u>	<u>Factored Capacity at U.L.S. (kN)</u>	<u>Bearing Capacity at S.L.S. Type II (kN)</u>
HP310x110	990	660
324 mm Ø x 9.5 thick steel tube pile A252 (concrete filled)	990	660
Reinforced Precast Concrete (305 mm x 305 mm)	1600	1150

The tabulated values have been determined apply static Formula. However, in our opinion, actual capacities exceeding these values are expected. It is recommended that the design capacities and load/deformation behaviour of the piles be verified by a full scale load test conducted at the site.

Driving of piles shall be carefully monitored and controlled employing the Hiley Dynamic Pile Driving Formula in accordance with MTO Standards SS103-10 or SS103-11 assuming an ultimate capacity as follows:

<u>Pile Type</u>	<u>Ultimate Capacity (kN)</u>
HP310x110	1980
steel pipe	1980
reinforced concrete	3450

Design/Construction Criteria for Deep Foundation Units

Regardless of the type of deep foundation unit selected, the following criteria and comments are applicable.

- 1) Reduction of axial capacities for inclined loadings shall conform to factors provided in Section 6.8.3.4.3 of the O.H.B.D.C.
- 2) The lateral resistance for both vertical and battered piles shall be computed in accordance with Section 6.8.3.8 of the O.H.B.D.C.
- 3) Pile spacing shall conform to Section 6.8.3.10 of the O.H.B.D.C. Adjacent pile should be checked for heaving during pile installation.
- 4) All pile caps shall be protected against frost protection by providing a minimum 1.2 m of earth over. No dewatering problems are anticipated for the construction of pile caps within the surficial native silty clay to clayey silt or underlaying clayey silt deposits in view of the impervious nature of the material. Pile cap construction within the embankment fill can also be conducted without major dewatering difficulty. Any localized seepage can be readily discharged using conventional sump pumping techniques.

2. Slope Stability

General

The complex topography at the site presents a scenario that necessitates a combination of cuts and fills to facilitate advancement of the Hwy. 407 beneath the proposed CPR overpass. Basically, forward slopes at the proposed south abutment will require excavation cuts up to 8.5 metres in depth in the native surficial deposit whilst at the proposed north abutment forward slopes of up to

8.5 m will require excavation in the existing embankment fill. Immediately west of the proposed structure, the proposed highway will be advanced in the low lying floodplain and hence fills in the order of magnitude of 9.5 metres will be required. East of the proposed CPR structure, excavation cuts up to 8.5 metres will be required for the majority of the distance between the CPR-Hwy. 407 structure and the Islington Ave.-Hwy. 407 structure. However, the Hwy. 407 westbound lanes will require fills up to 5 metres between approximately stations 15+305 and 15+335 where the highway intersects the existing valley floor.

Recommendations for the stability of the fills on the floodplain west of the proposed CPR structure and east of the proposed Hwy. 407 overpass structure at the Humber River will be included in the report for the Humber River structure (WP 88-78-15) subsequent to collection of additional data. Recommendations for the analysis for the approach cuts and fills between the proposed CPR structure and Islington Avenue is also beyond the scope of this report.

Longitudinal Slopes

The critical condition examined in the evaluation of excavation cuts such as those proposed at the site location is the long term (drained) condition. Consequently, an effective stress analysis was implemented using Bishop's method on an in-house mainframe program incorporating a factor of safety of 1.3. The properties of the subsoil and the geometry used in the analysis is summarized in Figure 11 in the Appendix. The analysis was carried out employing static loading conditions and circular slip surfaces.

The results of the analyses is summarized in Table 6 below. Based on the results, all excavation cut slopes exceeding 5 m in depth will require stabilizing benches and/or flatter slopes, whilst slopes cut less than 5 metres can be constructed at 2H:1V. The recommended slope geometry requirements for various depths of cut are tabulated in Table 6 below. An 8.5 m cut required at the site will require a 4 metre bench and 2H:1V slopes. The requirement of flatter slopes and/or benches must be incorporated in the design of the superstructure.

Table 6 - Slope Geometries

<u>Depth of Cut (m)</u>	<u>Recommended Geometry</u>
0-5 inclusive	2H:1V
>5-8 inclusive	2 m bench, 2H:1V slopes*
>8-9 inclusive	4 m bench, 2H:1V slopes
>9-10 inclusive	5 m bench, 2H:1V slopes

For practical construction considerations, a 3 m bench may be desirable.

Drained stability analyses of slopes are very sensitive to groundwater levels and pore pressures that can develop in the slope. Therefore slope protection and drainage measures will be required to ensure their long-term surficial stability. By employing a 1.2 m thick granular blanket consisting of free draining material such as Granular 'A' material, softening of material due to freeze-thaw cycles and development of excess pore water pressures can be prevented. Inabilities to control these parameters usually result in surficial slope failures.

The granular blankets should be designed in conjunction with a permanent drainage system that will discharge drained water from the slope. It is recommended that toe drains be constructed consisting of a perforated pipe encased with a suitable geotextile filter fabric and in turn surrounded by a suitable granular soil filter material. The toe drains should then be connected to an appropriate integrated drainage system. At the site, the toe drains can be constructed in conjunction with the highway perimeter drainage system.

Normal slope vegetation should be established as soon as possible after completion of the cut in order to control surficial erosion.

3. Lateral Earth Pressure on Structure

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)	22.8	21.2
Coefficient of Active Earth Pressure (K_a)	0.27	0.33
Coefficient of Earth Pressure at Rest (K_0)	0.43	0.5

The earth pressure coefficient at rest (K_0) is to be used in design if the abutment walls are rigid and unyielding. The coefficient of active earth pressure (K_a) is to be applied to flexible, yielding abutment walls. The tabulated earth pressure coefficient apply to horizontal surfaces only. Adjustment for any sloping surfaces shall be incorporated in lateral earth pressure computation. Weep holes in the abutment walls should be designed to drain any accumulation of water in the backfill.

4. Construction Considerations

Construction of the CPR Subway structure shall be planned and coordinated with consideration to the other proposed structures alluded to earlier in this report, namely the proposed concrete culvert and the temporary detour. Recommendations for the design and construction of the CPR detour are provided in a separate report. The feasibility of the construction of the CPR structure is contingent on the type of detour structure selected. Hence the interdependencies of the CPR detour and CPR Subway structure need to be addressed in the preliminary design stage. This office will provide any information required to assist in the selection and design.

Temporary Shoring

Should the CPR detour be constructed of an earth embankment, one method of facilitating the construction of the CPR Subway is by installing a temporary shoring system. A shoring system that can be considered is an anchored timber lagging-soldier pile wall. Cantilevered walls can be considered provided that earth pressure equilibrium is ascertained and the design is practically feasible. The design that proves to be most economical and technically feasible shall be selected. Liaison with this office should be coordinated in the temporary shoring selection process.

The design of the shoring system shall include the appropriate earth pressures computed in accordance with Section 6.6.1.2. of the O.H.B.D.C. The loadings induced by the surcharge train traffic and adjustment for any sloping surfaces shall be incorporated in the design. Preliminary design parameters of the soil to be supported are summarized in Table 7 below.

Table 7 - Shoring Design Soil Parameters

<u>Soil Type</u>	<u>Saturated Unit Weight (kN/m³)</u>	<u>Effective Shear Strength Parameters (ϕ°)</u>
Fill	20	30
Silty Clay to Clayey Silt	19.6	26
Clayey Silt	20	30

Soil anchors can be installed in the native clayey silt material present at the site to resist the induced loadings. A bond stress of 50 kPa can be used for design. Further information pertaining to the design of soil anchors and test loading procedures to verify anchor capacity can be obtained from this office.

The shoring wall can be installed employing conventional augering or driving techniques. The removal of the shoring system upon completion of the CPR Subway is an important factor in the selection of the system.

Alternatively, the shoring wall can be supported on rakers installed in front of the wall. Rakers must be installed while an earth berm remains in front of the pile. Slots should be cut into this berm to install rakers before the supporting berm is removed. Raker footing can be founded in the clayey silt deposit underlying the surficial silty clay to clayey silt deposit at an elevation ranging approximately from 137 to 140 metres. An allowable bearing value of 200 kPa at S.L.S. Type II and 300 kPa at U.L.S. can be used for the raker footing design.

The overall stability of the shoring wall must be checked to ensure that no deep seated failures undermine the wall. To this regard, it is recommended that the wall be advanced to the competent clayey silt stratum underlying the clayey silt to silty clay deposit.

Temporary Excavation Cuts

Temporary excavation cuts required to advance the construction shall be no steeper than 1.5H:1V.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer, utilizing equipment owned and operated by Marathon Drilling. The description of bedrock core samples was carried out by S. Senior, Geological Engineer.

The project was carried out by T. Sangiuliano under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief Foundation Engineer.



A handwritten signature in cursive script, appearing to read "T. Sangiuliano".

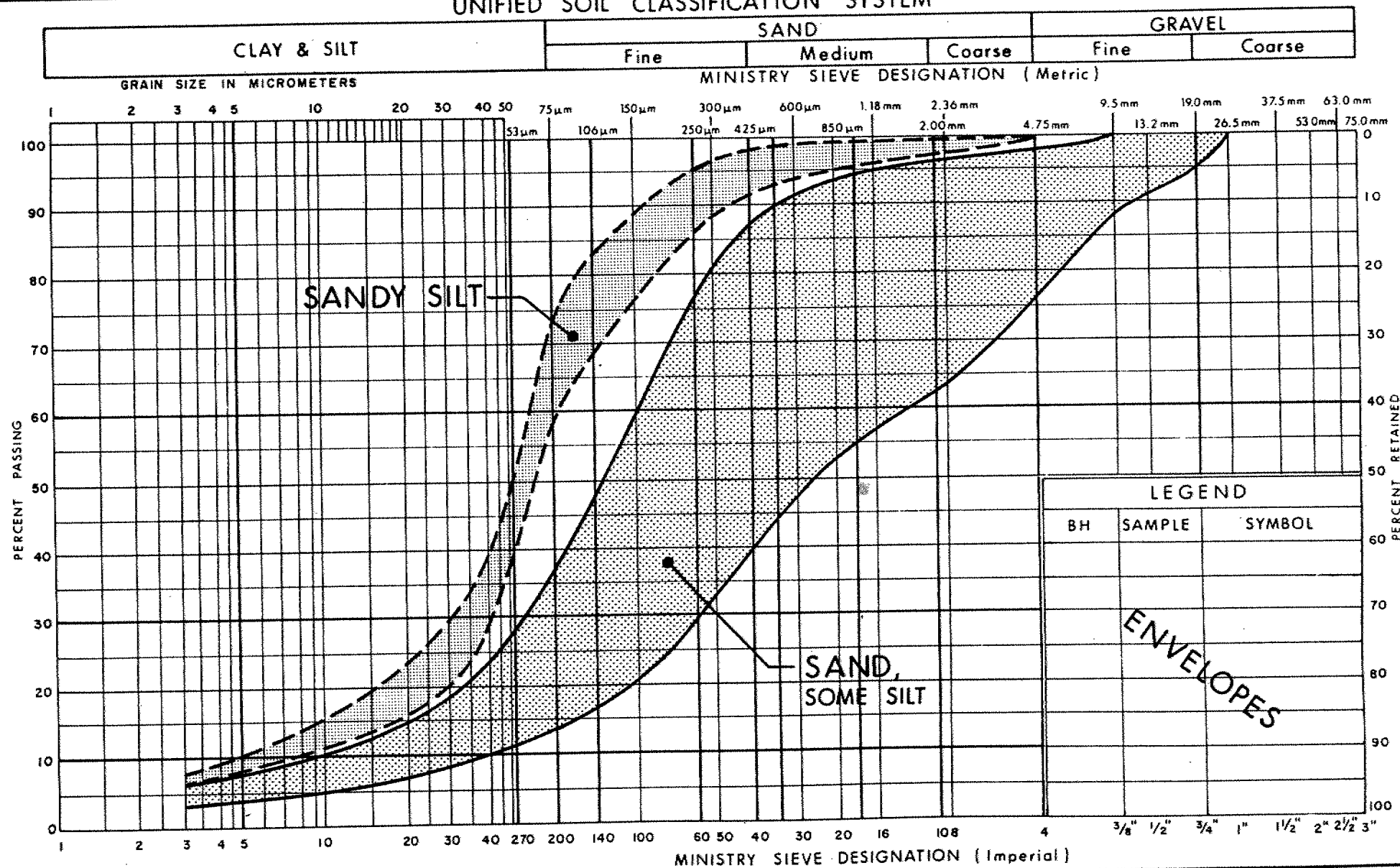
T. Sangiuliano, P.Eng.
Foundation Engineer

A handwritten signature in cursive script, appearing to read "M.S. Devata".

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

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

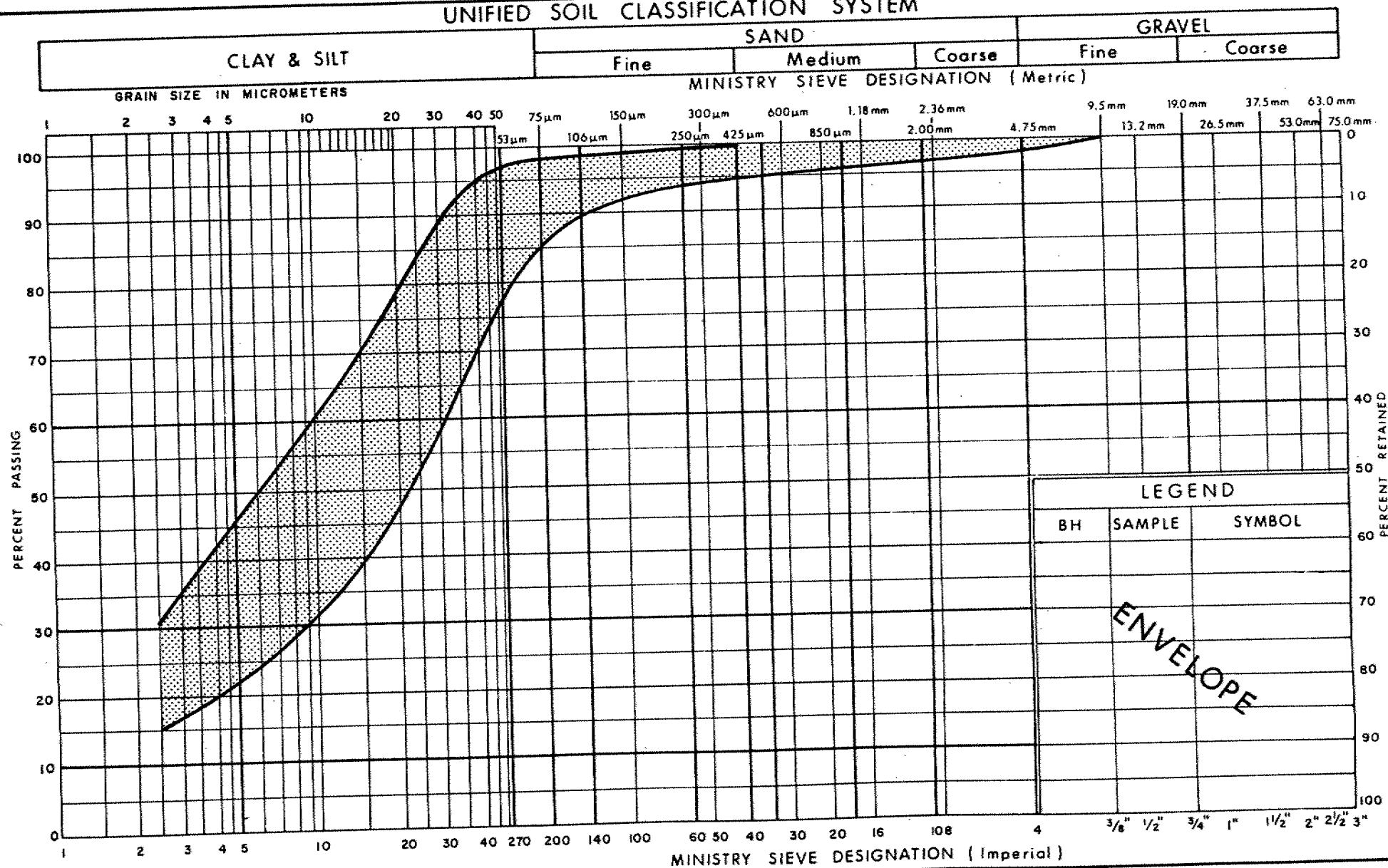
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
(FILL MATERIAL)

FIG No 1

W P 88-78-16

UNIFIED SOIL CLASSIFICATION SYSTEM

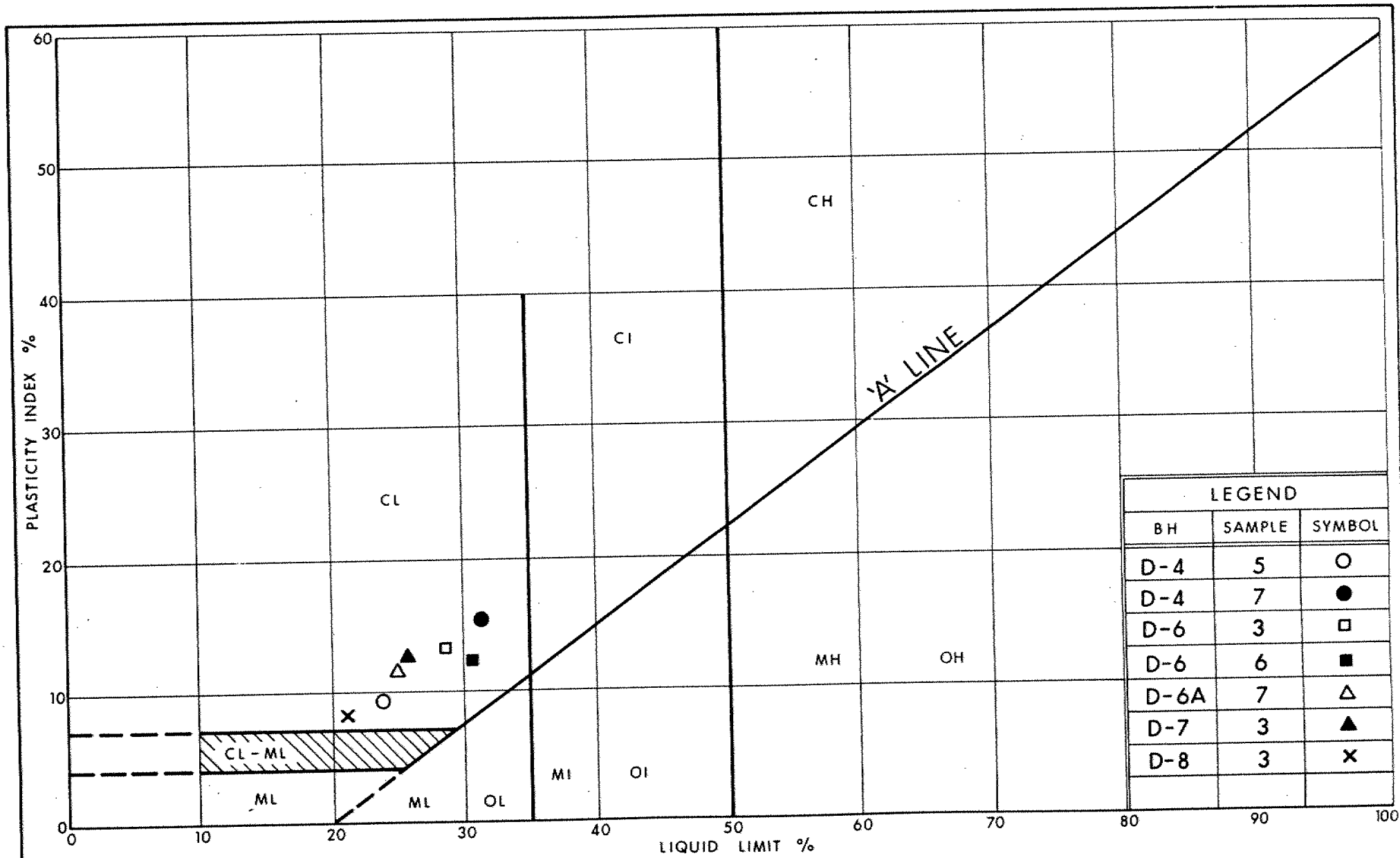


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT (FILL)

FIG No 2

W P 88-78-16



Ministry of
Transportation

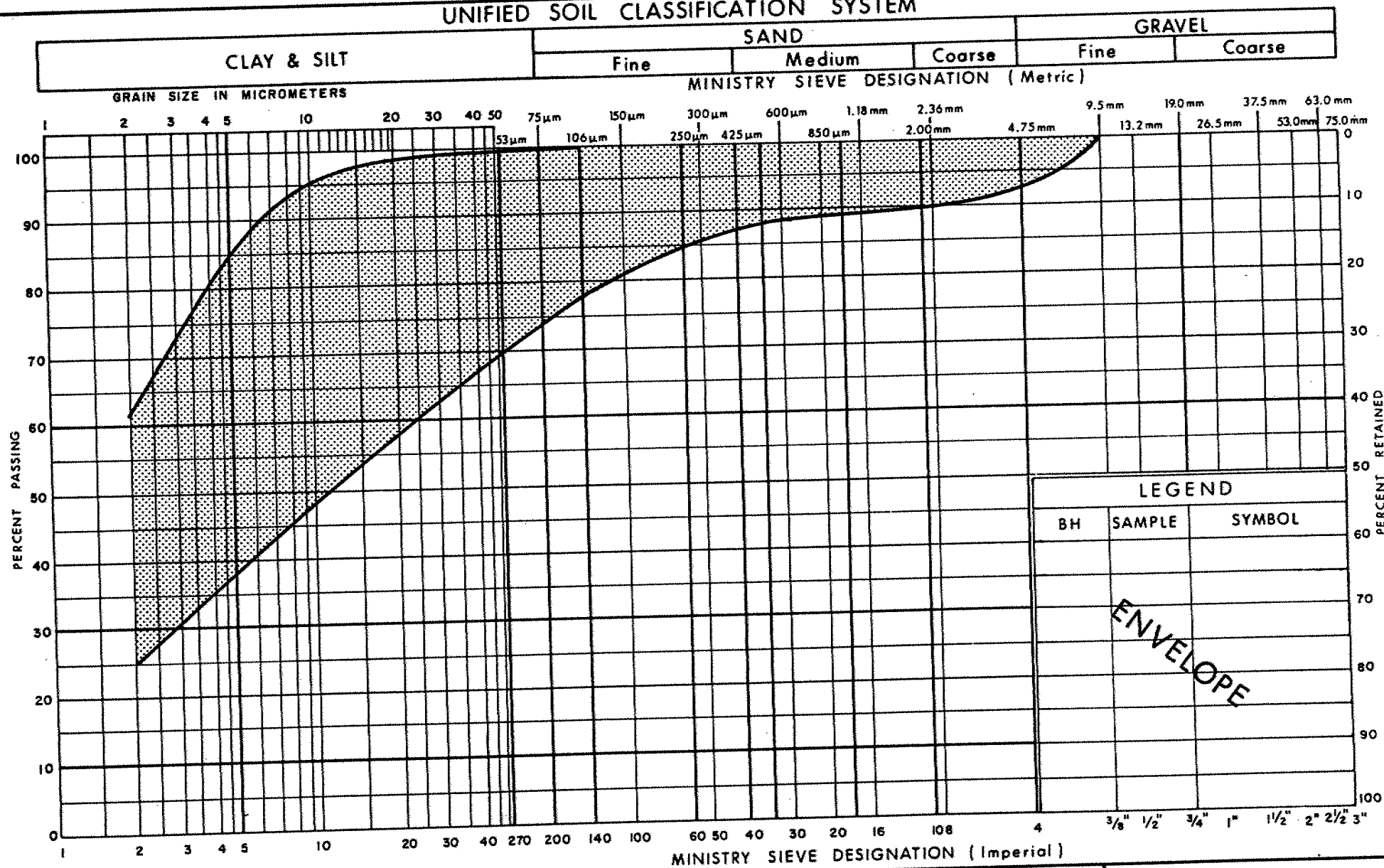
Ontario

PLASTICITY CHART CLAYEY SILT (FILL)

FIG No 3

W P 88-78-16

UNIFIED SOIL CLASSIFICATION SYSTEM

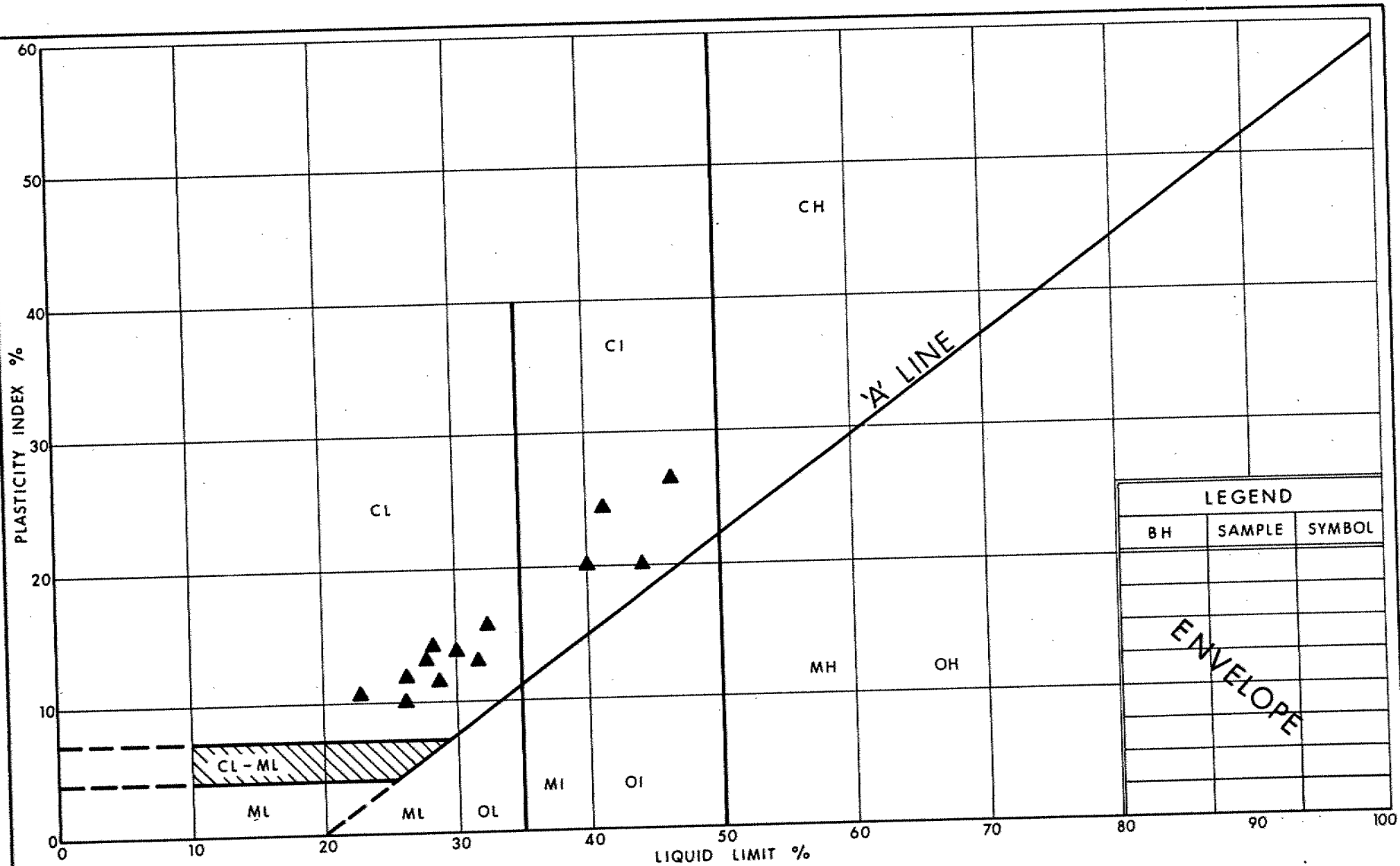


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILTY CLAY TO CLAYEY SILT
(Glacial Till)

FIG No 4

W P 88-78-16



PLASTICITY CHART
SILTY CLAY TO CLAYEY SILT
(Glacial Till)

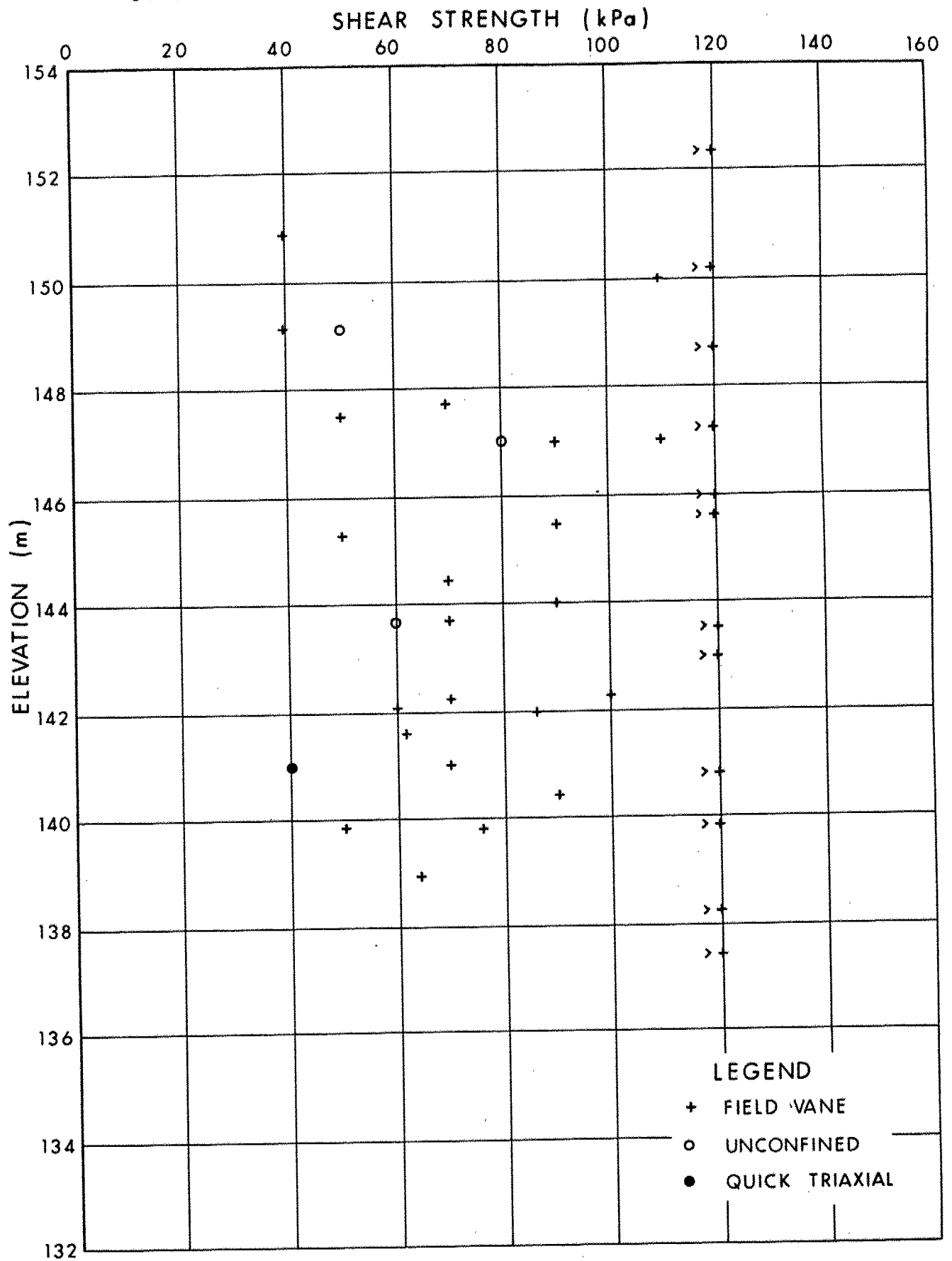
FIG No 5

W P 88-78-16

Ministry of
Transportation

Ontario

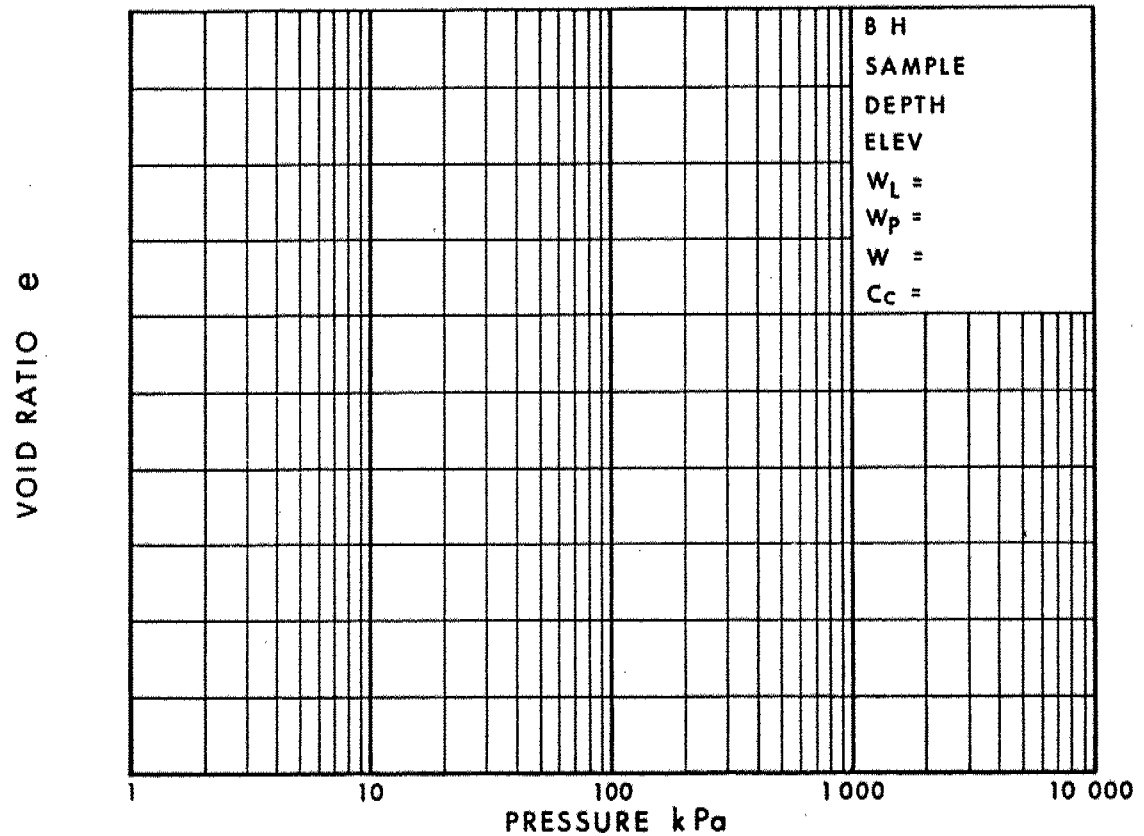
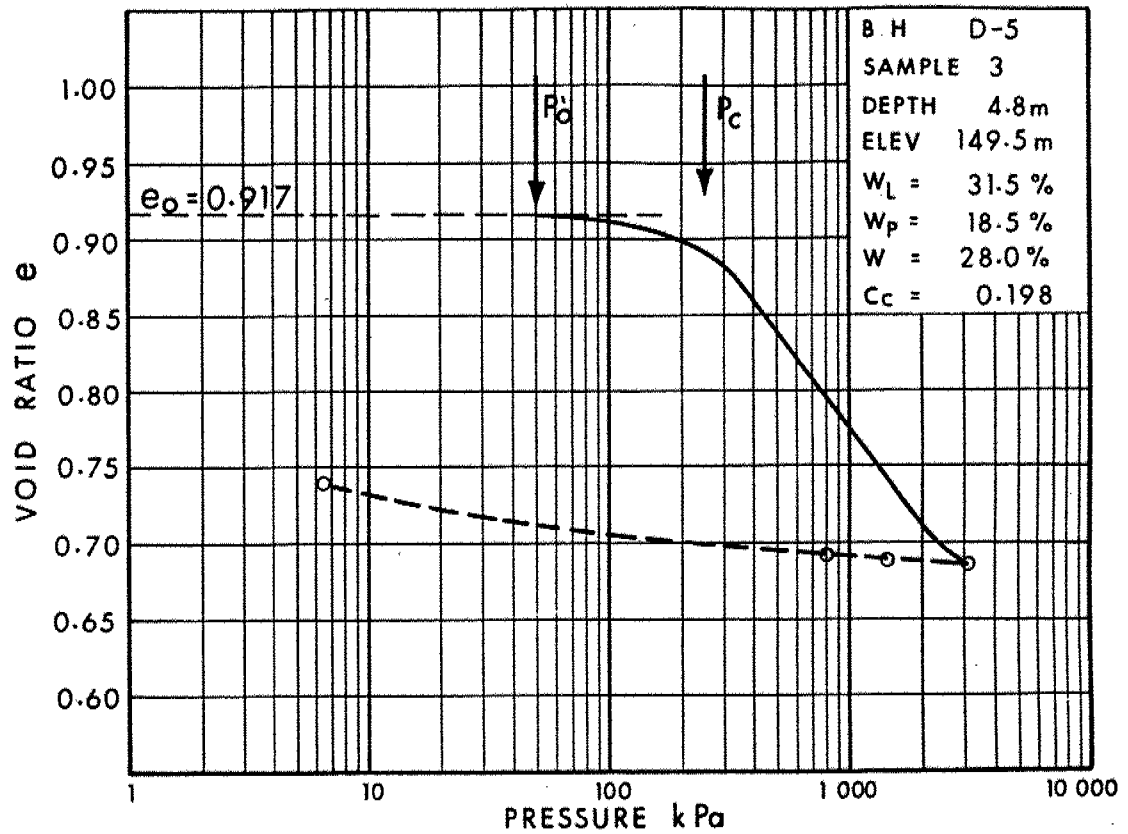
UNDRAINED SHEAR STRENGTH V_s ELEVATION



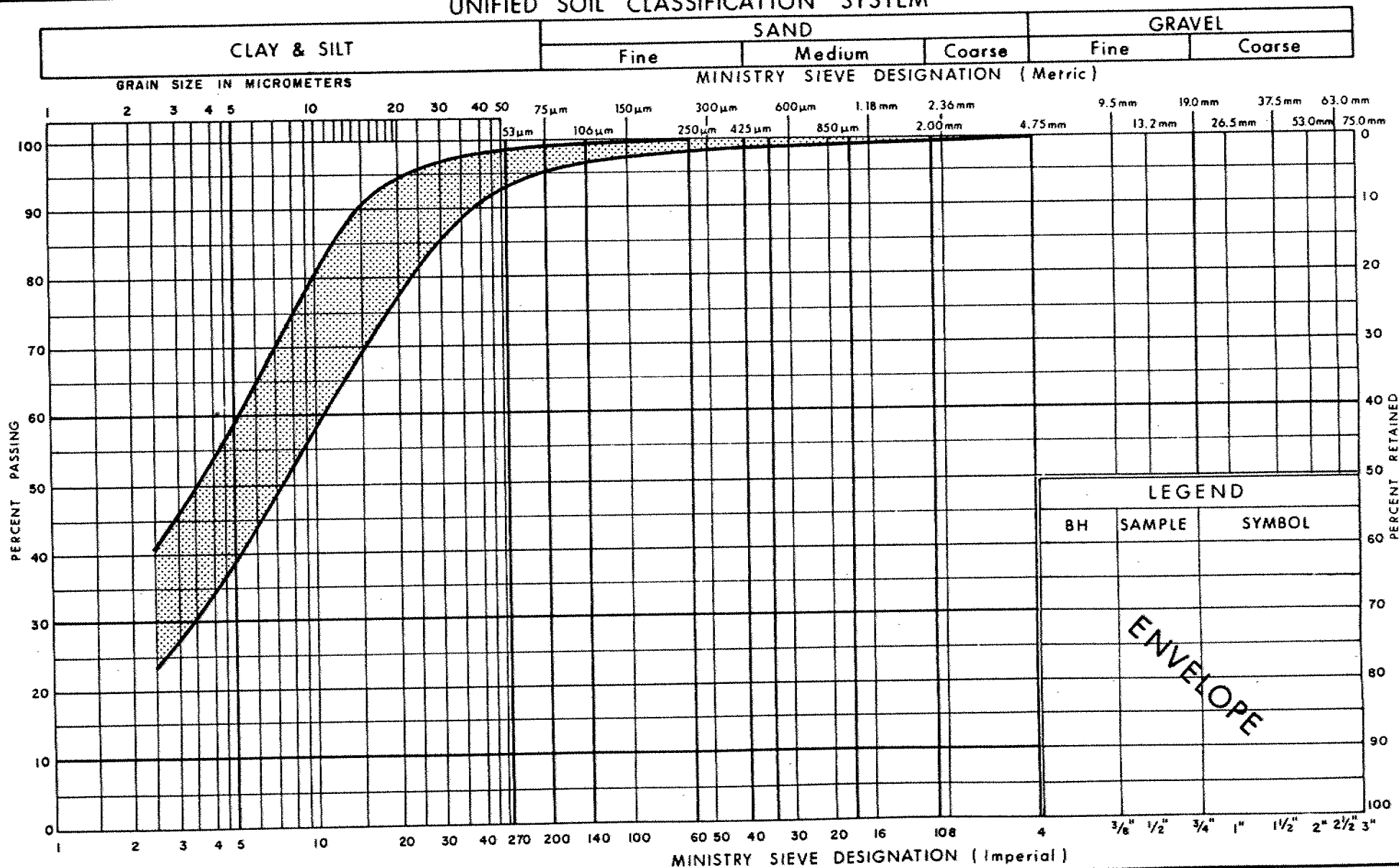
W P 88-78-16

Fig 6

VOID RATIO - PRESSURE CURVES



UNIFIED SOIL CLASSIFICATION SYSTEM

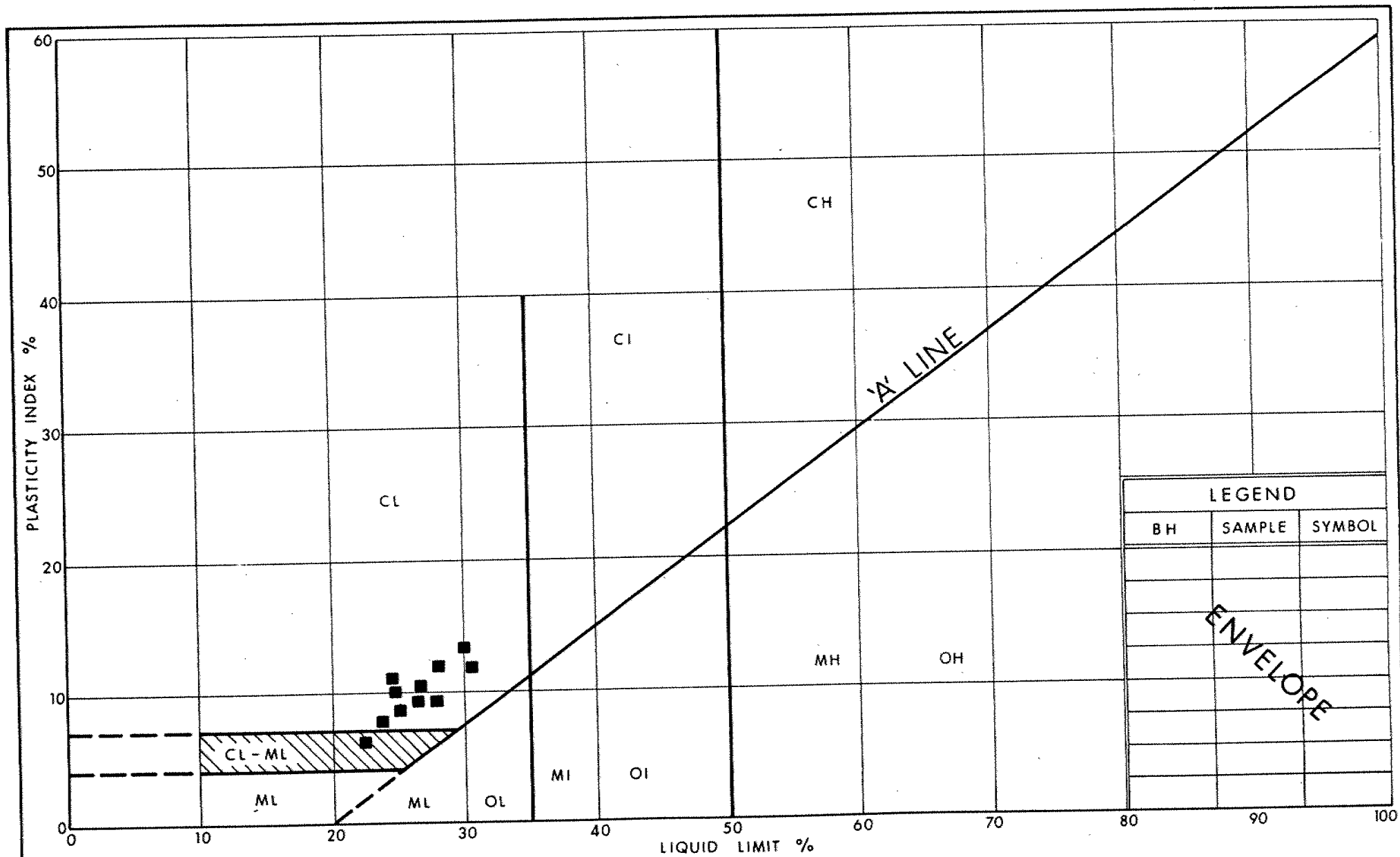


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT

FIG No 8

W P 88-78-16



Ministry of
Transportation

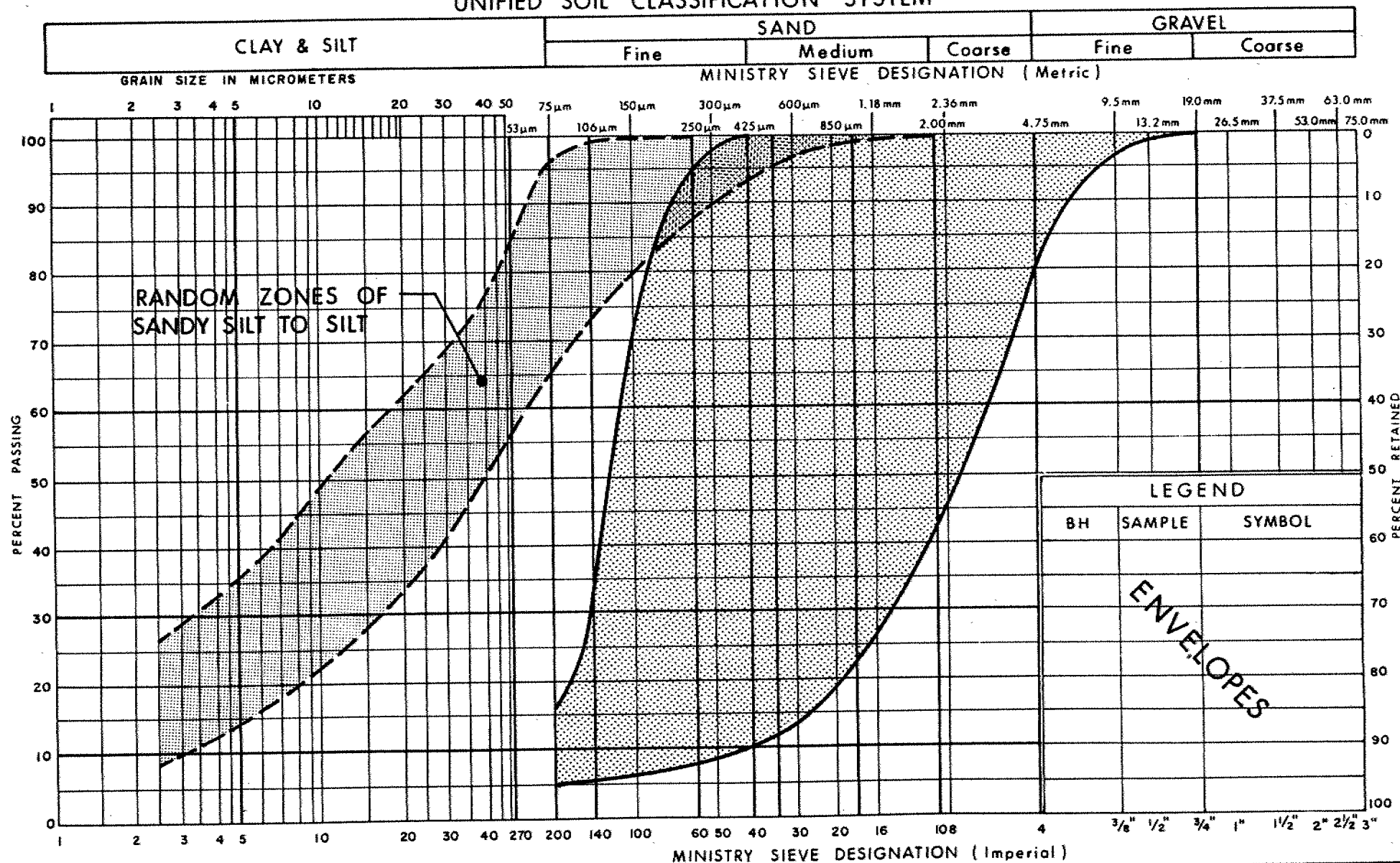
Ontario

PLASTICITY CHART CLAYEY SILT

FIG No 9

W P 88-78-16

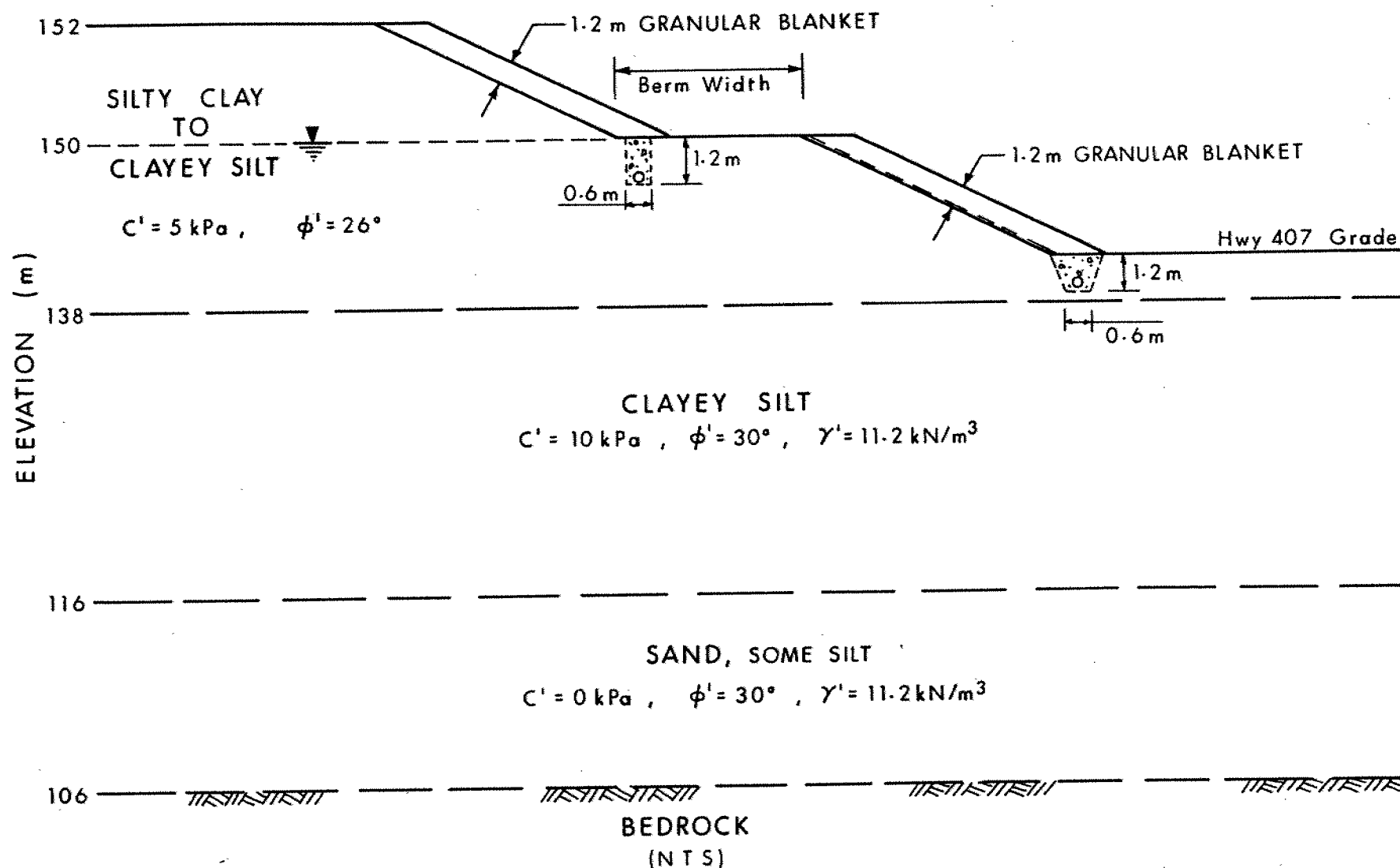
UNIFIED SOIL CLASSIFICATION SYSTEM

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SAND, SOME SILT

FIG No 10

W P 88-78-16



HWY 407 EXCAVATION CUT AT CPR SUBWAY
STABILITY ANALYSES AND SLOPE TREATMENT

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS:

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

ROCK CORE DESCRIPTION

WP 88-78-16

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
D-1	34	46.10-47.22	73	0	46.10-48.90	SHALE, medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; slightly weathered to moderately weathered; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (5%).
	35	47.22-48.90	100	0		
D-2	22	47.55-49.07	92	7	47.55-49.07	SHALE, medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; slightly weathered to moderately weathered, intensely weathered sections at 47.60m and 48.18m; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (8%).
D-4	22	44.81-46.33	60	8	44.81-44.98	OVERBURDEN, cobbles, weathered, bedrock.
					44.98-46.33	SHALE, medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; moderately weathered to highly weathered; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (20%).
D-8	25	42.98-44.65	100	15	42.98-44.65	SHALE, medium grey to medium dark grey; very fine grained; very thinly laminated; weak to very weak rock; slightly weathered to moderately weathered; very close to extremely close spaced fractures. Minor interbeds of fine grained argillaceous limestone (11%).

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated in zones of poor core recovery)

Logged by: SAS, Soils and Aggregates Section.

ROCK CORE DESCRIPTION **WP 141-87-00**

Page 1 of 1.

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
C-3	27	45.67-47.19	60	10	45.67-46.28	OVERBURDEN , gravel, cobbles, weathered bedrock.
					46.28-47.19	SHALE , medium grey to medium dark grey; very fine grained, very thinly laminated; weak to medium strong rock; slightly to medium weathered; extremely close spaced fractures.

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated in zones of poor core recovery)

Logged by: SAS, Soils and Aggregates Section.

RECORD OF BOREHOLE No C-1

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 519.6; E 298 137.8 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 24 CHECKED BY

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
136.5	Ground Surface													
0.0	Trace Organics		1	SS	7		136							
			2	SS	9									
	Firm to Stiff		3	SS	11		134							
	Stiff to Hard	Brown Grey	4	SS	22								21.6	0 2 73 25
			5	SS	30		132							
			6	SS	32									
	Clayey Silt		7	SS	28		130							
	Trace of Sand		8	SS	10		128						21.3	0 5 65 30
			9	SS	12									
125.8			10	SS	12		126							0 1 84 15
10.7	Sandy Silt		11	SS	18		124							0 36 60 4
			12	SS	120		122							28 32 34 6
	Compact V. Dense		13	SS	120/15cm		120							
	Occ. Gravel Seams		14	SS	90		118							
			15	SS	94		116							
			16	AS	-		114							
111.8	Gravel, Boulders and Cobbles						112							
24.7	End of Borehole													
	*Artesian Head 3.0m Above Ground Surface													



RECORD OF BOREHOLE No C-2

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 540.1; E 298 173.9 ORIGINATED BY BC
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
DATUM Geodetic DATE 1989 11 28 CHECKED BY

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	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
							SHEAR STRENGTH kPa					WATER CONTENT (%)				
							○ UNCONFINED + FIELD VANE									
							● QUICK TRIAXIAL × LAB VANE									
							20 40 60 80 100					10 20 30				
147.4	Ground Surface															
0.0																
	Sand, Trace Silt															
	Trace Gravel		1	SS	5		146									
	(Fill)															
	Brown, V. Loose		2	SS	4		144									10 81 (9)
	to Loose															
142.4			3	SS	7		142									
5.0																
	Silty Clay		4	SS	5		140									
	to															
	Clayey Silt		5	SS	10		138									
	Trace Gravel															
	Occ. Sand Seams		6	TW	PH		136									
	Firm to V. Stiff															
	(Glacial Till)		7	TW	PH		134									
135.2																
12.2			8	SS	9		132									
	Clayey Silt		9	SS	15		130									
			10	SS	14		128									
	Trace Sand		11	SS	15		126									
			12	SS	13		124									
	Grey		13	SS	11											
			14	SS	12											
			15	SS	13											
			16	SS	10											
	Stiff															
	Firm		17	SS	7											
124.5			18	SS	5											
22.9	Sand															
	Some Silt															
122.6	Grey, Loose		19	SS	8											
24.8	End of Borehole															

+3, x5 : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No C-3

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 561.0; E 298 190.8 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NQ Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 22 - 25 CHECKED BY

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			20 40 60 80 100	20 40 60 80 100					
152.2	Ground Surface					152							
0.0													
	Clayey Silt, Trace Sand, Trace Gravel		1	SS	8								
			2	SS	9								
	Brown Grey		3	SS	2								
	Firm to V. Stiff		4	TW	PH								
	Occ. Sand Seams (Glacial Till)		5	SS	12								0 4 61 35
			6	SS	5							20.2	
	Silt, Tr. Sand		7	SS	12								0 10 85 5
140.0			8	SS	16								
12.2			9	SS	23								
	Clayey Silt		10	SS	24								
	Trace Sand		11	SS	26								
	Grey, Stiff to		12	SS	26								
	V. Stiff		13	SS	27								
			14	SS	29								
			15	SS	24								
			16	SS	21								
			17	SS	15								
			18	SS	36								
			19	SS	14								
			20	SS	14								
			21	SS	11								
			22	SS	14								
122.0						124							

OFFICE REPORT ON SOIL EXPLORATION

Continued

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued



Ministry
of
Transportation
Ontario

RECORD OF BOREHOLE No C-3 Cont'd

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 561.0; E 298 190.8 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NQ Core COMPILED BY TS
DATUM Geodetic DATE 89 11 22 - 25 CHECKED BY

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					
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
122.0	Continued												
121.7	Clayey Silt												
30.5			23	SS	10								
	Sand												
	Some Silt												
	Grey, Compact		24	SS	39								
	to Dense												
			25	SS	28								
			26	SS	46								
	Occ. Cobbles												
	Boulders and												
	Gravel												
105.9													
46.3	Bedrock		27	RC	REC								
105.0	Shale				60%								RQD = 10%
47.2	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No C-4

METRIC

W P 141-87-00C LOCATION Co-ords: N 4 847 580.0; E 298 204.5 ORIGINATED BY BC
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
 DATUM Geodetic DATE 1989 11 27 CHECKED BY

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			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100								10 20 30		
147.0	Ground Surface																	
0.0							146											
	Brown Grey		1	SS	12		144											
	Clayey Silt		2	SS	6		142		2									
	Some Sand, Tr. Gravel		3	SS	7		140		2					8 17 47 28				
	Stiff to V. Stiff		4	SS	5		138		2									
	Occ. Sand Seams (Glacial Till)		5	SS	5		136											
136.3			6	SS	13		134											
10.7			7	SS	22		132											
	Clayey Silt		8	SS	13		130							0 1 73 26				
	Grey, Stiff to Hard		9	SS	34		128											
	Random Zones of Silt		10	SS	39		126							0 3 67 30				
			11	SS	25		124											
			12	SS	23													
			13	SS	19													
			14	SS	18													
			15	SS	15													
			16	SS	14													
			17	SS	10													
122.2			18	SS	11													
24.8	End of Borehole																	

+3, x5: Numbers refer to
Sensitivity

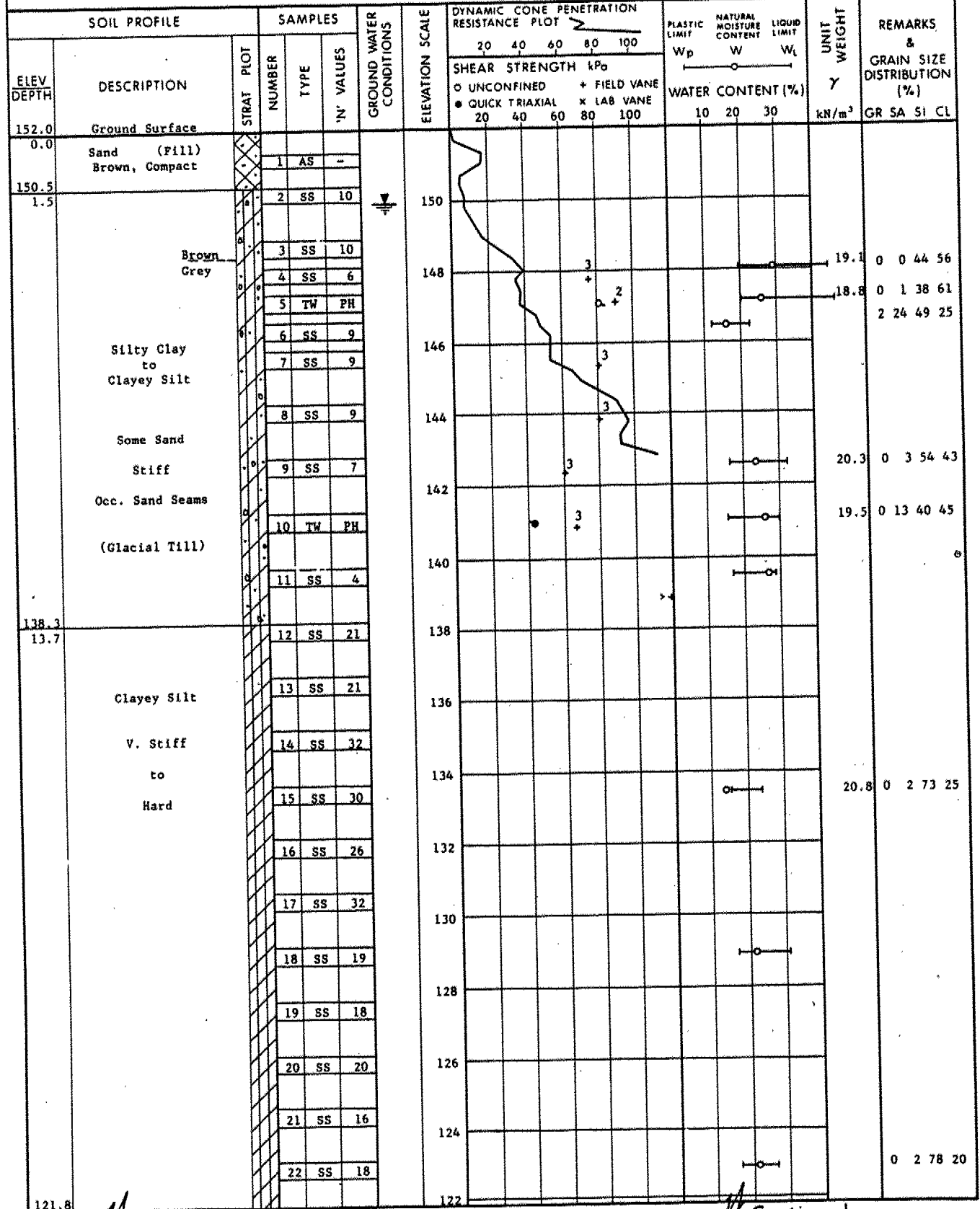
20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No D-1

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 491.9; E 298 279.3 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, BXL Rock Core & COMPILED BY TS
 DATUM Geodetic DATE 89 10 21-30 Cone Test CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION



Continued

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued

RECORD OF BOREHOLE No D-1 Cont'd

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 491.9; E 298 279.3 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, BXL Rock Core & Cone Test COMPILED BY TS
 DATUM Geodetic DATE 89 10 21-30 CHECKED BY _____

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
121.8 30.2	Continued	23	SS	16									
	Clayey Silt Very Stiff to Hard	24	SS	16									
		25	SS	76									
		26	SS	45									
115.4 36.6		27	SS	15									0 86 (14)
	Sand Tr. Silt Compact to V. Dense	28	SS	59									
		29	SS	58									
		30	SS	65									1 89 (10)
		31	SS	33									
		32	SS	44									8 85 (7)
105.9 46.1	Bedrock Shale Weak to Very Weak	33	SS	129/23cm									RQD = 34%
		34	BXL RC	REC 73%									RQD = 0%
103.1 48.9	End of Borehole	35	BXL RC	REC 100%									

RECORD OF BOREHOLE No D-2

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 472.6; E 298 274.6 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Core COMPILED BY TS
 DATUM Geodetic DATE 1989 11 08-11 CHECKED BY _____

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	20 40 60 80 100					
153.0	Ground Surface													
0.0	Irregular Mixture of Silt, Sand, Slag Ballast (Fill)		1	SS	11		152							
150.6	Brown-Black, Compact		2	SS	7		150		2					
2.4			3	SS	7		148		2					
	Brown Grey		4	SS	8		146	2						
	Silty Clay to Clayey Silt		5	TW	PH		144	2					21.0	1 13 58 28
	Some Sand, Trace Gravel Firm to V. Stiff		6	TW	PH		142	2						
	Occ. Sand Seams		7	SS	4		140							4 13 35 48
	(Glacial Till)		8	SS	4		138							
139.3			9	SS	22		136							0 4 79 17
13.7	Clayey Silt		10	SS	20		134							
	Firm to		11	SS	23		132							
	V. Stiff		12	SS	12		130							
			13	SS	20		128							
			14	SS	18		126							
			15	SS	13		124							

122.8
30.2

Continued

+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

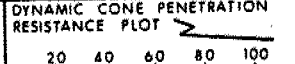
Continued

RECORD OF BOREHOLE No D-2 Cont'd

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 472.6; E 298 274.6 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Core COMPILED BY TS
 DATUM Geodetic DATE 1989 11 08-11 CHECKED BY _____

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 Wp W WL			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%) 10 20 30				
122.8 30.2	Continued		16	SS	9		122										
	Clayey Silt Firm to Very Stiff		17	SS	5		120										
			18	SS	50		118										
116.1 36.9	Sand Tr. Silt Compact to V. Dense Occ. Gravelly Seams		19	SS	20		116									17 78 (5)	
			20	SS	56		114										
			21	SS	50		112										
			22	RC	REC 92%		110										
105.5 47.5	Bedrock Shale Weak to Very Weak						108										
103.9 49.1	End of Borehole						106									RQD = 20%	
							104										



RECORD OF BOREHOLE No D-3

METRIC

W P 141-87-00D LOCATION Co-ords: N 4 847 504.0; E 298 204.0 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
DATUM Geodetic DATE 1989 11 27 CHECKED BY _____

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					
136.0	Ground Surface																
0.0																	
	Interbedded Layers of Sand and Gravel Brown Grey		1	SS	4		134	2									0 5 61 34
			2	SS	2												
			3	SS	14												
			4	SS	12												
			5	SS	22		132										
			6	SS	19												
			7	SS	27		130										
	Clayey Silt																
	Tr. Sand, Tr. Gravel		8	SS	20		128										0 0 77 23
			9	SS	20												
	Stiff to Hard						126										
124.9			10	SS	15												
11.1																	
	Silt		11	SS	7		124										
	Tr. Clay, Tr. Sand																
	Loose V. Dense		12	SS	85		122										
			13	SS	100/	15cm											0 5 85 10
			14	SS	120/	10cm	120										
119.1																	
16.9	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-4

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 539.6; E 298 210.1 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NO Rock Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 13-21 CHECKED BY

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	20 40 60 80 100	W _p	W	W _L		
152.1	Ground Surface					152							
0.0													
	Clayey Silt With Interbedded Layers of Sand (Fill) Brown to Grey V. Soft to Stiff		1	SS	2	150							
			2	SS	3	148							0 32 64 4
			3	SS	3	146							
			4	SS	6	144						20.0	0 2 78 20
			5	SS	6	142							
			6	SS	8	140						20.2	4 22 49 25
			7	SS	15	138							
139.9			8	SS	20	136							
12.2	Clayey Silt Grey, Stiff to Hard		9	SS	25	134							0 1 79 20
			10	SS	30	132						22.0	
	Sandy Silt		11	SS	53	130							
			12	SS	32	128							
			13	SS	17	126						21.2	
			14	SS	11	124							
			15	SS	13	122							0 0 88 12

OFFICE REPORT ON SOIL EXPLORATION

121.9
30.2

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No D-4 Cont'd

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 539.4; E 298 210.1 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, NQ Rock Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 13 CHECKED BY _____

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					NATURAL MOISTURE CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _p	W	W _L		
121.9 30.2	Continued															
	Clayey Silt Grey Stiff to Hard		16	SS	10											
118.6 33.5			17	SS	45											
	Sand Some Silt Grey, Compact to V. Dense		18	SS	20											
			19	SS	72											
			20	SS	120/8 cm											
	Occ. Cobbles Boulders and Gravel		21	SS	65											
107.1 45.0	Bedrock Shale		22	NQ RC	REC 60%											
105.8 46.3	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-4A

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 520.0; E 298 212.0 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE R-Casing, Washbore COMPILED BY TS
 DATUM Geodetic DATE 1989 11 30 CHECKED BY _____

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								
143.5	Ground Surface					*							
0.0	Sand, Tr. Gravel (Fill)		1	SS	6		142						
	Brown, Loose to Compact		2	SS	21		140						
138.9	Clayey Silt With Interbedded Layers of Sand		3	SS	37		138						
4.6	(Fill)		4	SS	22								
136.9	Brown, Stiff to Hard												
6.6	End of Borehole *Borehole Dry												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-5

METRIC

W P 141-87-00D LOCATION Co-ords: N 4 847 605.0; E 298 115.0 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
 DATUM Geodetic DATE 1989 11 16-17 CHECKED BY

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
154.3 0.0	Ground Surface												
	Silty Clay		1	SS	7							19.5	0 4 61 35
	to		2	SS	3								
	Clayey Silt		3	TW	PH								
	Trace Gravel		4	TW	PH								
	Grey, Firm		5	SS	11								
	to V. Stiff		6	SS	8								
	Occ. Sand Seams		7	SS	10								
	(Glacial Till)		8	SS	5								
			9	SS	10								
139.1 15.2	Clayey Silt Grey, Stiff to V. Stiff		10	SS	12							20.1	6 7 60 27
			11	SS	22								
			12	SS	32								
134.0 20.3	End of Borehole *Borehole Dry		13	SS	22							20.0	0 2 74 24

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-6

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 511.1; E 298 240.4 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
 DATUM Geodetic DATE 89 11 20 CHECKED BY

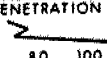

OFFICE REPORT ON SOIL EXPLORATION

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			
								20 40 60 80 100									10 20 30			
152.5	Ground Surface					*	152													
0.0	Sand, Tr. Silt (Fill)																			
150.5	Brown, V. Loose		1	SS	4															
2.0	Clayey Silt With Interbedded Layers of Sand (Fill) Brown, Firm		2	SS	6		150													
			3	SS	6		148									0 5 73 22				
			4	SS	5		146													
			5	SS	7		144									19.4 0 2 84 14				
			6	SS	6											19.2 0 14 64 22				
			7	SS	4		142									1 79 15 5				
141.8	Sand, Some Silt (Fill)		8	SS	6		140													
10.7	Brown, Very Loose to Loose		9	SS	7											6 72 18 4				
138.6	Clayey Silt, Tr. Gravel Tr. Organics Grey, Firm to Stiff						138													
13.9			10	SS	14															
136.8	End of Borehole																			
15.7	*Borehole Dry																			

RECORD OF BOREHOLE No D-6A

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 504.0; E 298 229.0 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE B-Casing, Washbore COMPILED BY TS
 DATUM Geodetic DATE 1989 11 29 CHECKED BY _____

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			SHEAR STRENGTH kPa					WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					10 20 30					
143.5	Ground Surface																	
0.0	Sand, Some Gravel, Trace Silt (Fill) Brown, V. Loose to Compact		1	SS	2	*	142									20 77 (3)		
			2	SS	6													
			3	SS	8													
			4	SS	9													
			5	SS	12													
138.9			6	SS	19			140										26 59 (15)
4.6	Clayey Silt (Fill) Brown, V. Stiff																	
137.3	Clayey Silt					138										4 6 65 25		
136.6	Grey, Tr. Organics		7	SS	29													
6.6	End of Borehole																	
	* Borehole Dry																	

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-7

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 530.8; E 298 232.1 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY TS
 DATUM Geodetic DATE 89 11 20 CHECKED BY _____

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					
152.5	Ground Surface															
0.0																
			1	SS	2											11 62 23 4
			2	SS	3											
	Clayey Silt Brown, Firm		3	SS	8											0 12 66 22
			4	SS	4											
	Silty Sand to Sandy Silt (Fill)		5	SS	5											2 41 54 3
	V. Loose to Loose		6	SS	5											
			7	SS	8											
			8	SS	9											0 30 66 4
			9	SS	9											1 63 31 5
			10	SS	8											4 73 19 4
136.3																
16.2	End of Borehole Auger Refusal Probable Culvert Roof *Borehole Dry															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D-8

METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 516.1; E 298 252.3 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Rock Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 02-08 CHECKED BY _____

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					
150.6	Ground Surface																
0.0																	
	Sand, Some Silt With Interbedded Layers of Clayey Silt Brown, Loose		1	SS	9		150										14 56 29 1
	(Fill)		2	SS	6		148										
			3	SS	4		146										0 13 75 12
144.5			4	SS	4		144										0 7 52 41
6.1	Clayey Silt Grey, Firm to Stiff Occ. Sand Seams (Glacial Till)		5	SS	8		142									20.2	
			6	SS	12		140										
			7	SS	4		138										
139.9			8	SS	17		136										
10.7	Clayey Silt Grey, Firm to Hard		9	SS	22		134										
			10	SS	19		132										
			11	SS	22		130										
			12	SS	28		128										
			13	SS	25		126										
			14	SS	23		124										
			15	SS	19		122										
			16	SS	16												
			17	SS	14												
			18	SS	18												
			19	SS	10												
120.4																	
30.2																	

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+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

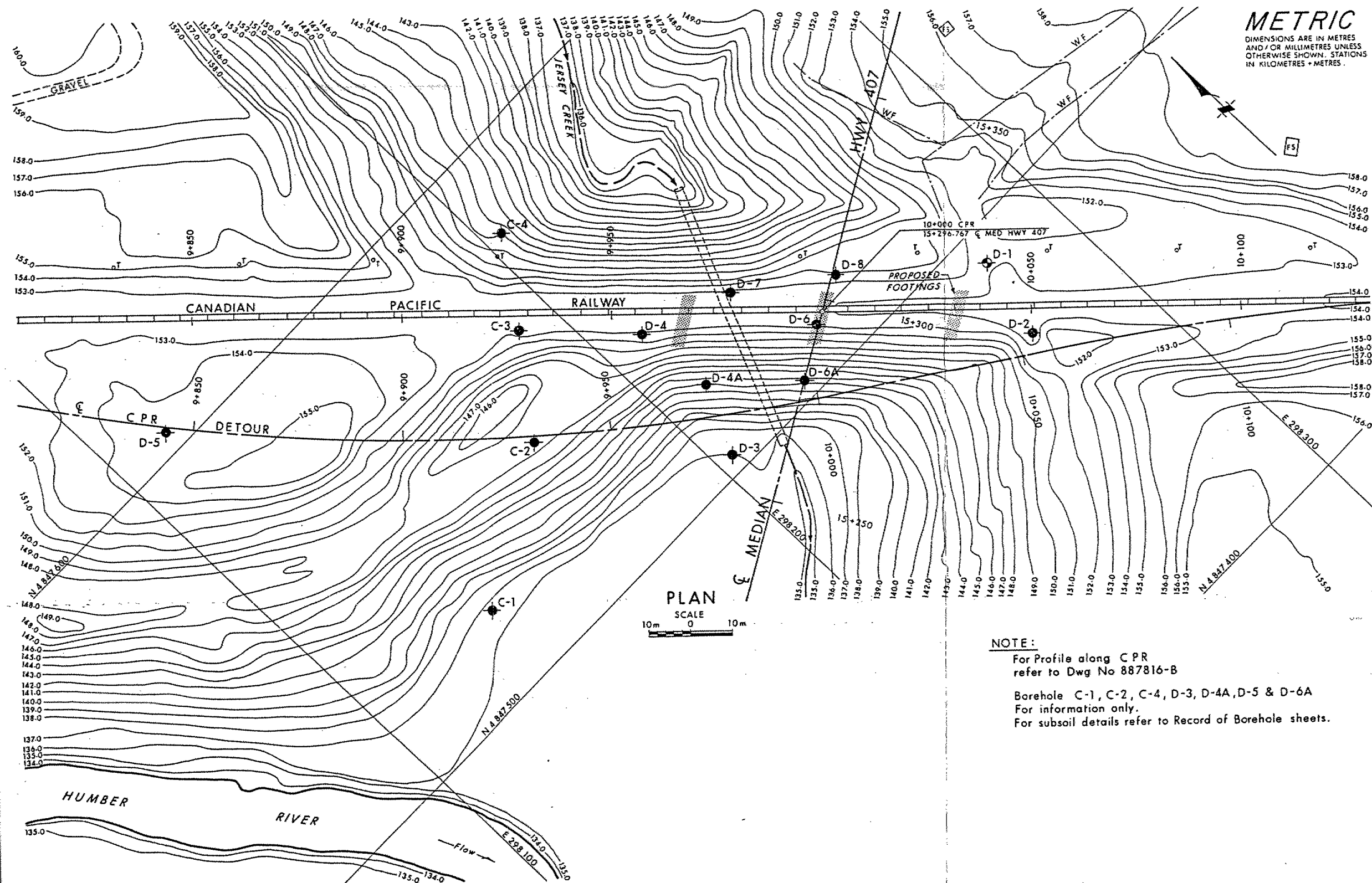
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RECORD OF BOREHOLE No D-8 Cont'd METRIC

W P 88-78-16 LOCATION Co-ords: N 4 847 516.1; E 298 252.3 ORIGINATED BY TS
 DIST. 6 HWY 407 BOREHOLE TYPE H.S. Auger, BW Casing, Washbore, NQ Rock Core COMPILED BY TS
 DATUM Geodetic DATE 89 11 02-08 CHECKED BY

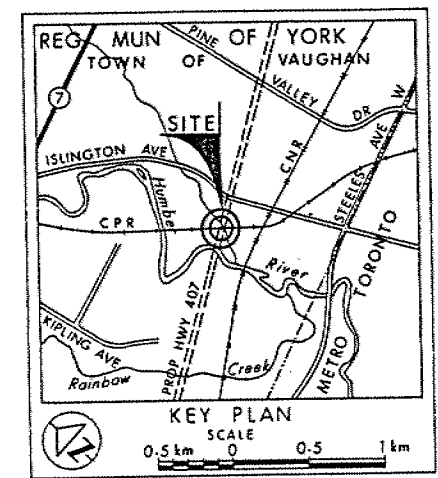
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
120.4	Continued															
30.2			20	SS	9											
	Silt, Tr. Sand V. Dense		21	SS	107								OH			0 7 79 14
	Clayey Silt Grey Firm to Hard		22	SS	36											
111.9																
38.7	Sand With Silt Grey, Compact		23	SS	12											
107.7	Some Gravel		24	SS	120	15 cm										17 38 31 14
42.9	Bedrock Shale Weak to Very Weak		25	NQ RC	REC 100%											RQD = 15%
105.9																
44.7	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION



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

CONT No
WP No 88-78-16
HWY 407 & CPR SUBWAY
BORE HOLE LOCATIONS & SOIL STRATA



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

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
C-1	136.5	4847 519.6	298 137.8
C-2	147.4	4847 540.1	298 173.9
C-3	152.2	4847 561.0	298 190.8
C-4	147.0	4847 580.0	298 204.5
D-1	152.0	4847 491.9	298 279.3
D-2	153.0	4847 472.6	298 274.6
D-3	136.0	4847 504.0	298 204.0
D-4	152.1	4847 539.4	298 210.1
D-4A	143.5	4847 520.0	298 212.0
D-5	154.3	4847 605.0	298 115.0
D-6	152.5	4847 511.2	298 240.4
D-6A	143.5	4847 504.0	298 229.0
D-7	152.5	4847 530.8	298 232.1
D-8	150.6	4847 516.1	298 252.3

NOTE:
For Profile along CPR
refer to Dwg No 887816-B

Borehole C-1, C-2, C-4, D-3, D-4A, D-5 & D-6A
For information only.
For subsoil details refer to Record of Borehole sheets.

=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 Farm 100.

REV	DATE	BY	DESCRIPTION
1			

Geocres No 30M13-95

HWY No 407	DIST 6
SUBMITTAL CHECKED	DATE 90 03 14
DRAWN	DWG 887816-A

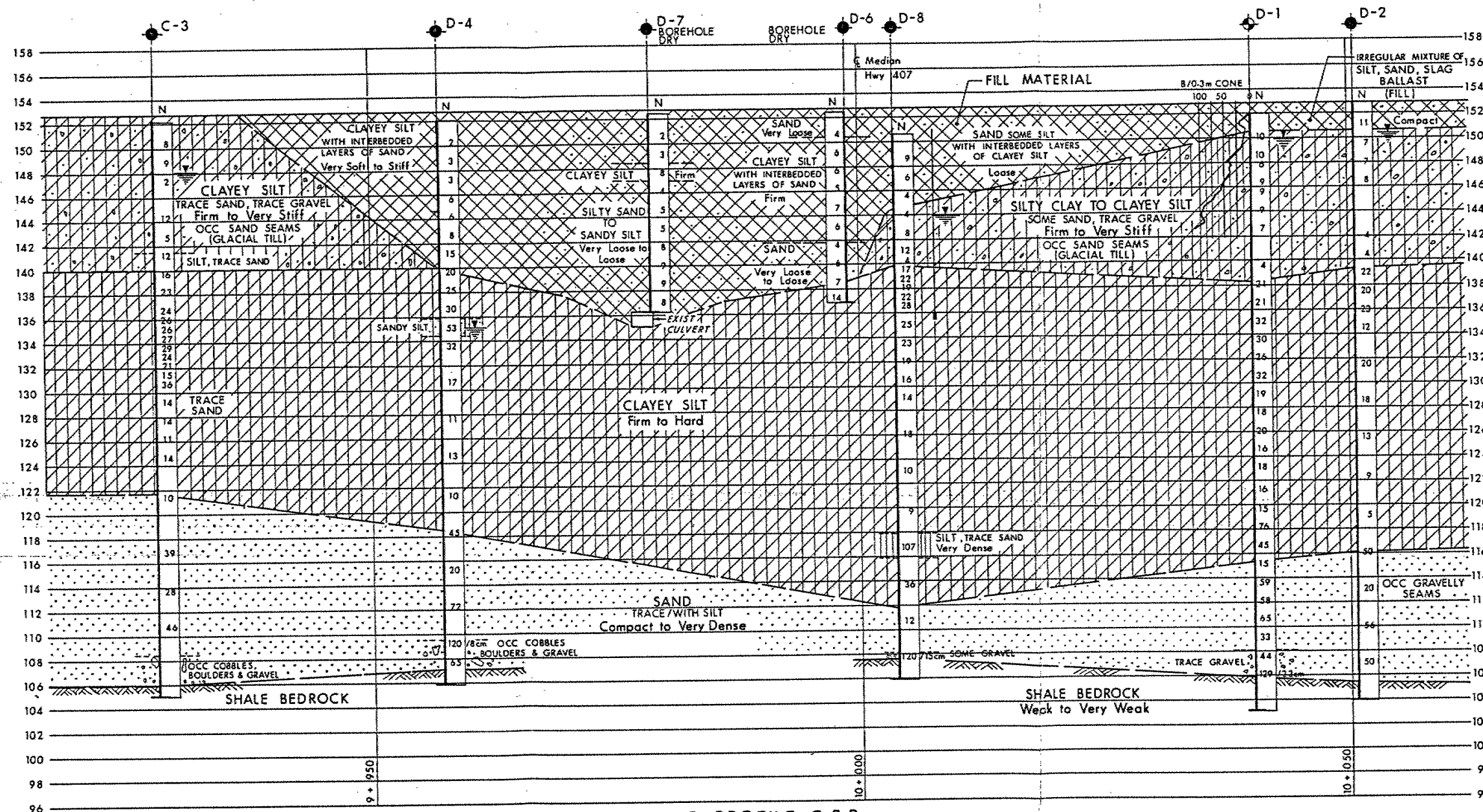
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 88-78-16

HWY 407 & CPR SUBWAY

BORE HOLE LOCATIONS & SOIL STRATA

SHEET



PROFILE C P R
SCALE
5m 0 5m Hor
4m 0 4m Vert

NOTE:
For Plan refer to
Dwg No 887816-A

SEE DWG No 887816-A

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)
- WL at time of investigation 89 10 and 89 11
- WL in Piezometer
- Piezometer

No	ELEVATION	CO-ORDINATES NORTH	EAST
C-3	152.2	4 847 561.0	298 190.8
D-1	152.0	4 847 491.9	298 279.3
D-2	153.0	4 847 472.6	298 274.6
D-4	152.1	4 847 539.4	298 210.1
D-6	152.5	4 847 511.2	298 240.4
D-7	152.5	4 847 530.8	298 232.1
D-8	150.6	4 847 516.1	298 252.3

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
1	90 03 07		
2	90 03 07		
3	90 03 07		
4	90 03 07		
5	90 03 07		
6	90 03 07		
7	90 03 07		
8	90 03 07		
9	90 03 07		
10	90 03 07		

Geocres No 30M13-95

HWY No 407	DIST 6
SUBWD T5 CHECKED	DATE 90 03 07 SITE 37-1327
DRAWN DT CHECKED	APPROVED DWG 887816-B