DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 52F-24

DIST. 20 REGION

W.P. No. 27-89-00

CONT. No.

W. O. No.

STR. SITE No.

HWY. No. 17

LOCATION Proposed Upgrading of Hwy 17

No of PAGES - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

FILE

Ministry
of
Transportation
Ontario

FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 27-89-00 DIST 20
HWY 17 STR SITE -

The Proposed Upgrading of Highway 17
from 35.4 km West of Junction of Hwy 17
and Hwy 105 (Vermillion Bay)

DISTRIBUTION

R. J. Krisciunas
P. Bound (3)
Head P&D
F.A. Adams (3)
M. Holowka
J. Robinson
E.A. Joseph
G. Norman (Cover Only)
F. Bacchus (Cover Only)
File ✓

GEOCRES 52F-24 DATE AUG 25 1994

FOUNDATION INVESTIGATION REPORT

For

The Proposed Upgrading of Highway 17

from 35.4 km West of Junction of Highway 17

and Highway 105 (Vermilion Bay) Easterly

W.P. 27-89-00

District 20, Kenora

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above-mentioned sites with regard to the stability and settlement of roadway embankments for the proposed upgrading of Highway 17. The following is a list of areas investigated:

1. Township of Bridges (Station 16 + 325 to Station 16 + 625) - Proposed 400 mm grade raise (maximum) over approximately 1.5 m fill over a swamp 10.0 m in depth.

2. Township of Docker (Station 13 + 560 to Station 13 + 825, Existing WBPL area) - Settlement area (auxiliary lane location - 3 lanes) approximately 1.2 m fill over swamp 12.0 + m in depth.

3. Township of Docker (Station 18 + 400 to 18 + 600) - Proposed grade raise 1.4 m maximum) over deep shot rock fill showing distortion and settlement. (Note: PCB patch area.)

4. Township of Docker (Station 20 + 650 to Station 20 + 880, Proposed EBPL) - Proposed grade raise (2.2 m maximum) over 2.4 m existing fill over 10.0 m swamp.

The fieldwork for the above-mentioned project was carried out at three (3) sites with 14 boreholes by the Foundation Design Section between July 6 and 9, 1993. These boreholes extended down to depths of 1.6 m at BH 1-3 and 15.2 m at BH 2-1 below the existing ground surface, respectively.

During the site investigation it was found that there are two patches over PCB contaminated asphalt located within Area 3. Consequently, any proposed remedial works at the site will be deferred until further direction and policy be clarified as to acceptable options for all concerned.

This report contains factual information obtained from this investigation pertaining to roadway embankments for the proposed upgrading of Highway 17 and related earthworks as shown on Dwg. No. 278900-A.

Site Description

The proposed three sites (Area 1, 2 and 4) are located along Hwy. 17 from approximately 35.4 km west of Junction of Hwy. 17 and Hwy.105 easterly. Area 1 belongs to Bridges Township, while Areas 2 and 4 are located in Docker Township in the Kenora District.

All three of the sites represent low swampy areas between rock outcrops. The topography in the immediate areas is generally flat to gently undulating. Such topography is typical of the surrounding area as well. The vicinity of the site is occupied by bushland. It should be noted that sandfill has been placed as a part of roadway embankment on the sites.

Subsurface Conditions

The subsoil conditions are generally consistent across the three sites. The subsoils encountered at the boreholes generally consist of a layer of peat and organic silty clay underneath the 1.2-7.1 m thick embankment fill, from 0.9 m to 3.6 m thick, which is in turn, underlain by an extensive deposit of silty clay to clay. The thickness of silty clay to clay ranges from 1.6 m to greater than 9.4 m. At some locations, the silty clay deposit is underlain by a layer of silty sand to sand. The bedrock was not proved at the locations investigated. The following paragraphs are intended to provide a summary of the subsurface conditions which have been simplified for the purpose of geotechnical design:

Area 1 (Bridges Township Sta. 16 + 325 to 16 + 625)

1.2 - 3.7 m	:	sand fill
0.9 - 1.7 m	:	peat and organic silty clay
1.6 - >9.4 m	:	silty clay to clay
0.7 m	:	silty sand at BH 1-2

Area 2 (Docker Township Sta. 13 + 560 to 13 + 825)

4.0 - 7.1 m	:	sand fill
1.6 - 3.6 m	:	peat and organic silty clay
>1.2 - 5.7 m	:	silty clay to clay
>1.0 ->3.9 m	:	silty sand

Area 4 (Docker Township Sta. 20 + 650 to 20 + 880)

2.4 - 4.3 m	:	sand fill
1.3 - 2.2 m	:	silty clay fill (BH's 4-1 and 4-2)
1.1 - 2.3 m	:	peat and organic silty clay
3.5 - >4.6 m	:	silty clay to clay
>0.8 ->2.3 m	:	sand

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 Sections showing stratigraphy based on borehole data, are shown on Dwg. No. 278900-A.

A detailed description of the subsurface conditions and embankment fill material is given below.

Fill Material

This material was encountered in most of the boreholes except BH 4-4. The composition of this fill material ranged from a brown sand with some gravel to a grey reworked silty clay. The thickness of sand fill ranges from 1.2 m at BH 1-2 to 7.1 m at BH 2-4. No laboratory tests were carried out on this material.

However, through visual observation, it can be classified as a sand with some gravel and boulders. In this stratum, the 'N' values vary from 3 to 44 blow/0.3 m indicating a state of compaction described as loose to dense.

A reworked silty clay fill was encountered at two borehole locations (BHs. 4-1 and 4-2) underneath the sand fill. The thickness of this layer ranges from 1.3 m at BH 4-2 to 2.2 m at BH 4-1.

An Atterberg Limit Test was performed on this sample and the result is plotted on Figure 1 and summarized as follows:

Index Properties		%
Natural Moisture Content	(W)	32.5
Liquid Limit	(W_L)	63.0
Plastic Limit	(W_p)	24.0
Plasticity Index	(I_p)	39.0

From the plasticity chart, it is evident that the layer can be classified as a silty clay to clay, trace of sand with medium to high plasticity (Cl-CH).

A Grain Size Distribution test was carried out on this material. Figure 2 in Appendix shows the result.

Peat and Organic Silty Clay

This material was encountered at most of the boreholes with the exception of three borehole locations (BH's 1-3, 2-4 and 4-3) underneath the fill material.

The thickness of this layer ranges from 0.9 m at BH 1-2 to 3.6 m at BH 2-1. This material is dark brown in colour.

Atterberg Limit test were performed on this material and the results are plotted on Figure 3 and summarized as follows:

Index Properties	Range (%)
Natural Moisture Content (W)	27.0 - 227.0
Liquid Limit (W_L)	30.0 - 264.0
Plastic Limit (W_p)	25.0 - 200.0
Plasticity Index (I_p)	4.0 - 64.0
Organic Content (OC)	16.5 - 72.5
Unit Weight γ (KN/m^3)	10.4 - 15.7

From the plasticity chart, it is evident that this layer can be classified as a peat and organic silty clay with low to high plasticity (OL to OH).

Grain Size Distribution tests were carried out on this material. Figure 4 in the Appendix shows the results in an envelope form.

Silty Clay to Clay

This is the predominant stratum found in all boring locations. The maximum proven thickness of this deposit is about 9.4 m at BH 1-4. This material is grey in colour.

Atterberg Limit tests were performed on this material and the results are plotted on Figure 1 and summarized as follows:

Index Properties	Range (%)
Natural Moisture Content (W)	27.0 - 111.0
Liquid Limit (W_L)	32.0 - 80.0
Plastic Limit (W_p)	18.0 - 31.0
Plasticity Index (I_p)	14.0 - 51.0
Unit Weight γ (KN/m^3)	12.9 - 15.9

From the plasticity chart, it is evident that this material can be classified as an inorganic silty clay to clay with intermediate to high plasticity (CL to CH).

Grain Size Distribution tests were carried out on this material. Figure 2 in the Appendix shows the results in an envelope form.

Undrained shear strength of the soil was determined by in-situ vane tests and by laboratory tests, namely unconfined compression tests. The results are plotted on the Record of Borehole log sheets in the Appendix and summarized as follows:

Undrained Shear Strength	Cu (kPa) (Average)	Sensitivity (Average)
In-Situ Vane Test	12.0 - 94.0 (31)	2.0 - 9.0 (3.6)
Unconfined Compression Tests	8.0 - 27.0 (17)	

The shear strength varied from 12 kPa to 94 kPa with an average of 31 kPa, indicated a generally soft to stiff consistency. This material has a sensitivity

varying from 2 to 9, based on the measured undisturbed and remoulded shear strengths. This would indicate that the material is generally sensitive.

Two odometer tests were carried out to investigate the consolidation characteristics of silty clay to clay layer. The samples tested are considered representative of the clay deposit which was selected from Shelby tube samples obtained from the depth of 3.8 m and 7.9 m below the ground surface. The results of the consolidation tests are shown on Figure 5. These tests indicate that this stratum has been preconsolidated in the past to an effective stress ranging from 30 kPa to 82 kPa which is about the same to the existing effective overburden pressure, indicating a normally consolidated state. The compression index Cc was determined to be between 0.546 and 1.306.

Silty Sand to Sand

This stratum was encountered underneath the upper clay material at five (5) borehole locations (BH's 1-2, 2-1, 2-2, 4-3 and 4-5). The proven thickness of this layer ranges from 0.7 m at BH 1-2 to greater than 3.9 m at BH 2-2. This layer is basically non-plastic. Based on a Grain Size Distribution test and visual observation, it can be classified as silty sand to sand with trace to some gravel as shown on Figure 6. In this stratum, the 'N' values vary from 2 to over 100 blow/0.3 m indicating the state of compaction described as loose to very dense.

GROUNDWATER CONDITIONS

Groundwater conditions were observed through the measurement of water level in the open borehole and toe of the slope. The groundwater level was at or above the existing swamp surface as shown on the following table.

Area	Groundwater Level	Elevation (m)
1	0.5 - 1.8	378.1 - 379.0
2	0.9 - 1.8	392.8 - 393.3
4	0.9 - 3.0	362.1 - 363.4

However, it is likely that the groundwater level is subject to season fluctuation with the precipitation.

Discussion and Recommendations

It is proposed to raise the Hwy. 17 grade as much as 2.2 m at Area 4 as follows:

Area 1 - proposed 0.4 m grade raise
(Township of Bridges, Sta. 16 + 325 to 16 + 625)

Area 2 - proposed 0.8 m grade raise to original grade
(Township of Docker Sta. 13 + 560 to 13 + 825)

Area 4 - proposed 2.2 m grade raise
(Township of Docker Sta. 20 + 650 to 20 + 880)

The recommendations in this memo apply to the highway embankment and related earthworks. In view of the presence of the compressible layer of peat and organic silty clay, and silty clay to clay, which are of relatively low shear strength, slope stability and settlement of the roadway embankment will be discussed in detail.

Stability Consideration

Stability analyses were carried out to evaluate the overall stability of the embankment fills and the internal stability of fills.

A total stress analysis was applied for calculations of slope stability of the embankment fills using the limit equilibrium method of stability developed by Sarma (1973 and 1979). A minimum factor of Safety 1.3 was incorporated for the analysis. It should be noted that all stability calculations were made for the static condition only.

The design parameters, subsurface geometry and groundwater level used in the analysis will be discussed as follows:

Area 1 (Typical Section, Station 16 + 425)

At this location, a maximum height of embankment fills will be in the order of 1.7 m above the swamp. The subsurface conditions and their design parameters based on our site investigation are as follows:

Thickness (m)	Soil Type	Cu (KPa)	ϕ(degree)	γ(KN/m^3)
1.7	sand fill above swamp	0	30	20
0.5 - 2.3	sand fill below embankment	0	30	20
1.2 - 4.2	peat and organic silty clay	30	0	13.2
2.0 - 5.6	silty clay to clay	35	0	16.5

Water level is at the swamp surface.

Based on the analyses, embankment fill raised to 0.4 m will be stable provided they are constructed with MTO current standards of 2H:1V slope.

Area 2 (Typical Section, Station 13 + 650)

At this location roadway embankment has been settled at about 0.8 m and will be raised to the original grade. Maximum height of the embankment fill will be in the order of 2.2 m above the swamp. The subsurface conditions and their design parameters are as follows:

Thickness (m)	Soil Type	Cu(KPa)	ϕ(degree)	γ(KN/m^3)
2.2	sand fill above swamp	0	30	20
3.3	sand fill below embankment	0	30	20
4.0 - 6.0	peat & organic silty clay	30	0	13.2
3.4 - 5.4	silty clay to clay	35	0	16.5

Water level is at the swamp surface.

Based on the analyses, no stability problems are anticipated for the permanent road embankment constructed to a 2H:1V geometry, if all of the existing organic material (peat and organic silty clay) be stripped or excavated throughout the full-width and full-depth of the proposed fill areas in swamp as shown on Figure 7.

Area 4 (Typical Section, Station 20 + 750)

At this location, a maximum height of embankment fill will be in the order of 4.2 m above the swamp. The subsurface conditions and their design parameters based on our site investigation are as follows:

Thickness (m)	Soil Type	Cu (KPa)	ϕ(degree)	(KN/m^3)
4.2	sand fill above swamp	0	30	20
2.5	sand fill below embankment	0	30	20
2.0 - 5.0	peat and organic silty clay	30	0	13.2
4.0 - 8.0	silty clay	35	0	16.5

Water level is at the swamp surface.

Based on the analyses, if all of the existing organic material (peat and organic silty clay) be stripped or excavated throughout the full-width and full-depth of the proposed fill areas in swamp as shown on Figure 7, embankment fill raised up to 2.2 m will be stable provided they are constructed with MTO current standard of 2H:1V slope.

Settlement of Road Embankments

Based on currently available information, it is our understanding that the proposed raise of the roadway embankment at these locations will be required to place to 0.4 m at Area 1, 0.8 m at Area 2 and 2.2 m at Area 4 over the existing roadway surface. Consequently, the additional fill will act as a surcharge and induce settlement within the underlying organic material and silty clay to clay strata.

To minimize settlement, total embankment loading should not exceed the preconsolidation pressure, σ pc, of the organic material and silty clay to clay layers. Based on the results of the consolidation test, it was found that both materials are normally consolidated with a preconsolidation pressure of 30 kPa for the organic material and that of 80 kPa for the silty clay to clay. As such, the proposed additional embankment loading will result in stresses higher than the preconsolidation pressures.

For the settlement calculations, it was assumed that the peat and organic silty clay would remain in place and that the rate of construction would be sufficiently slow to permit compression of the compressible organic material and that a significant "mud wave" would not occur.

The total settlements anticipated as a result of primary consolidation settlement of the peat and organic silty clay, and silty clay to clay layers under the weight of sand fill (Unit Weight: 20 kN/m^3) are summarized below:

Area	Total Settlement	Duration
1	50 - 60 mm	15 years
2	100 - 150 mm	20 years
4	300 - 350 mm	15 years

As shown above, the magnitude of settlements of the road embankment will be modest. Consideration should be given to placing and compacting the additional fill well in advance of road construction to allow some settlement to take place prior to final road grading or delay paving as long as possible.

Construction Considerations

Prior to embankment construction, all of the existing organic material (peat and organic silty clay) and other unsuitable soils must be stripped or excavated throughout the full-width and full-depth of the proposed fill areas in swamp as shown on Figure 7 (for Areas 2 and 4). To do this, the organic material below the groundwater level is excavated and could then be replaced with end-dumped granular material to approximately 0.3 m above the groundwater level. Above this level, any acceptable borrow material may be used to construct the remainder of the embankments.

During excavation of organic material along the existing toe of the slope, the area should be excavated with small strips in the order of about 3 m base width longitudinally in order to achieve the safety standard for the existing highway embankment.

During construction, it may require closing of one lane in order to obtain the safe temporary geometry. Alternatively, a shoring scheme should also be considered. The details for a shoring scheme will be provided later if it is required.

The fill should be placed in thin layers and compacted as per MTO Standards. The fill should be keyed into the pre-existing slope in accordance with MTO Standards and practice.

Consideration should be given to placing and compacting the additional fill well in advance of road construction to allow some settlement to take place prior to final road grading or delay paving.

For erosion protection purposes, the embankment side slopes should be covered with a layer of topsoil and properly seeded in order to enhance adequate vegetation cover in accordance with OPSD 218.01, to protect the earth fill from gulling.

It should be also noted that due to the expected long term settlement of organic material and soft silty clay to clay layers underneath the highway embankment, a periodic maintenance of roadway embankment will be required at these locations.

Miscellaneous

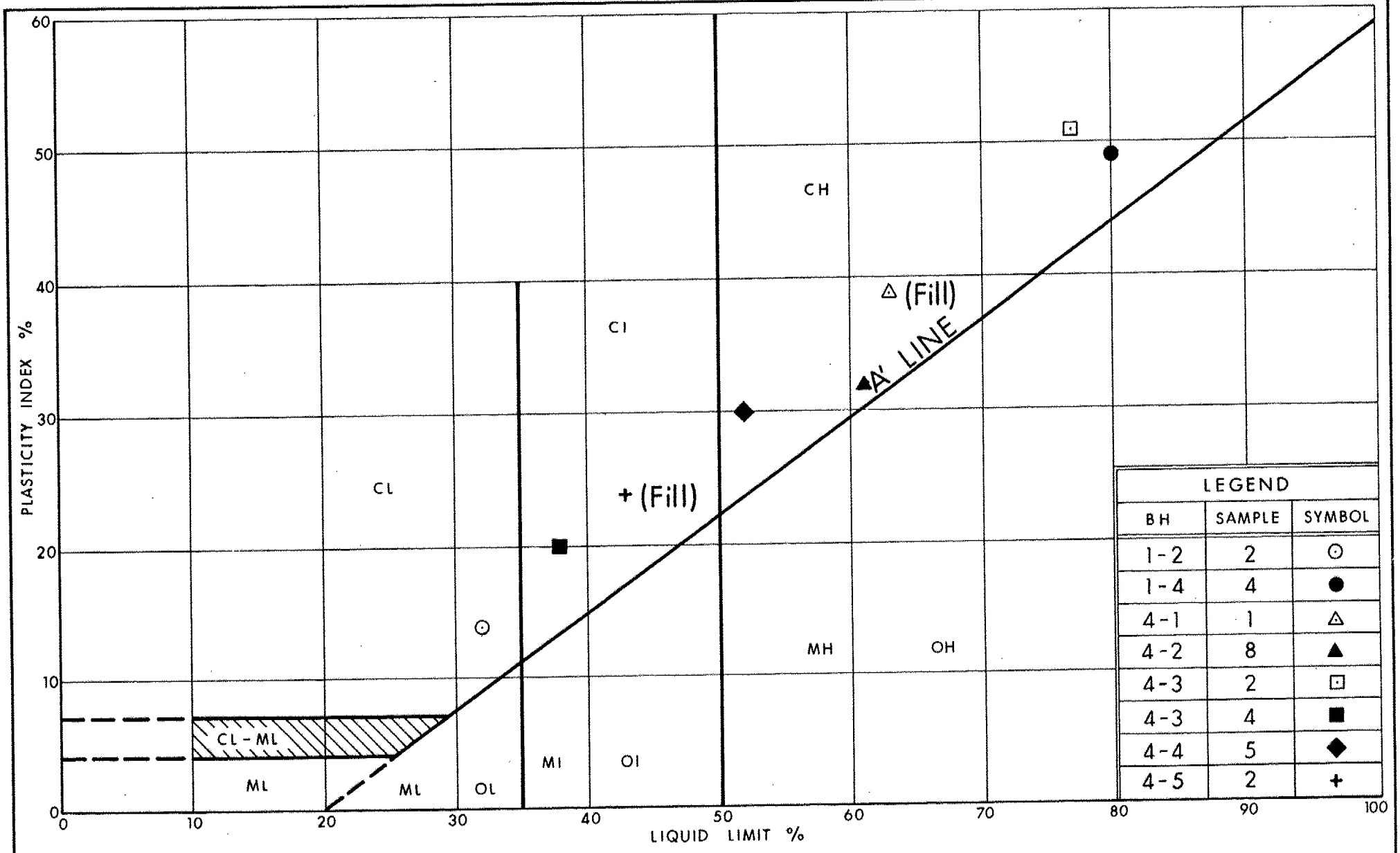
The fieldwork for this investigation was carried out during the period of 93 07 06 to 93 07 09 under the supervision of J. Curtis, Student Engineer and D. Dundas, Sr. Foundation Engineer. The equipment was owned and operated by Dominion Soil Thunder Bay Ltd. and Longyear Canada Inc.

This report was written by Tae C. Kim, Sr. Foundation Engineer and reviewed by D. Dundas, Chief Foundation Engineer (Acting).

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

D. Dundas, P. Eng.
Chief Foundation Engineer
(acting)

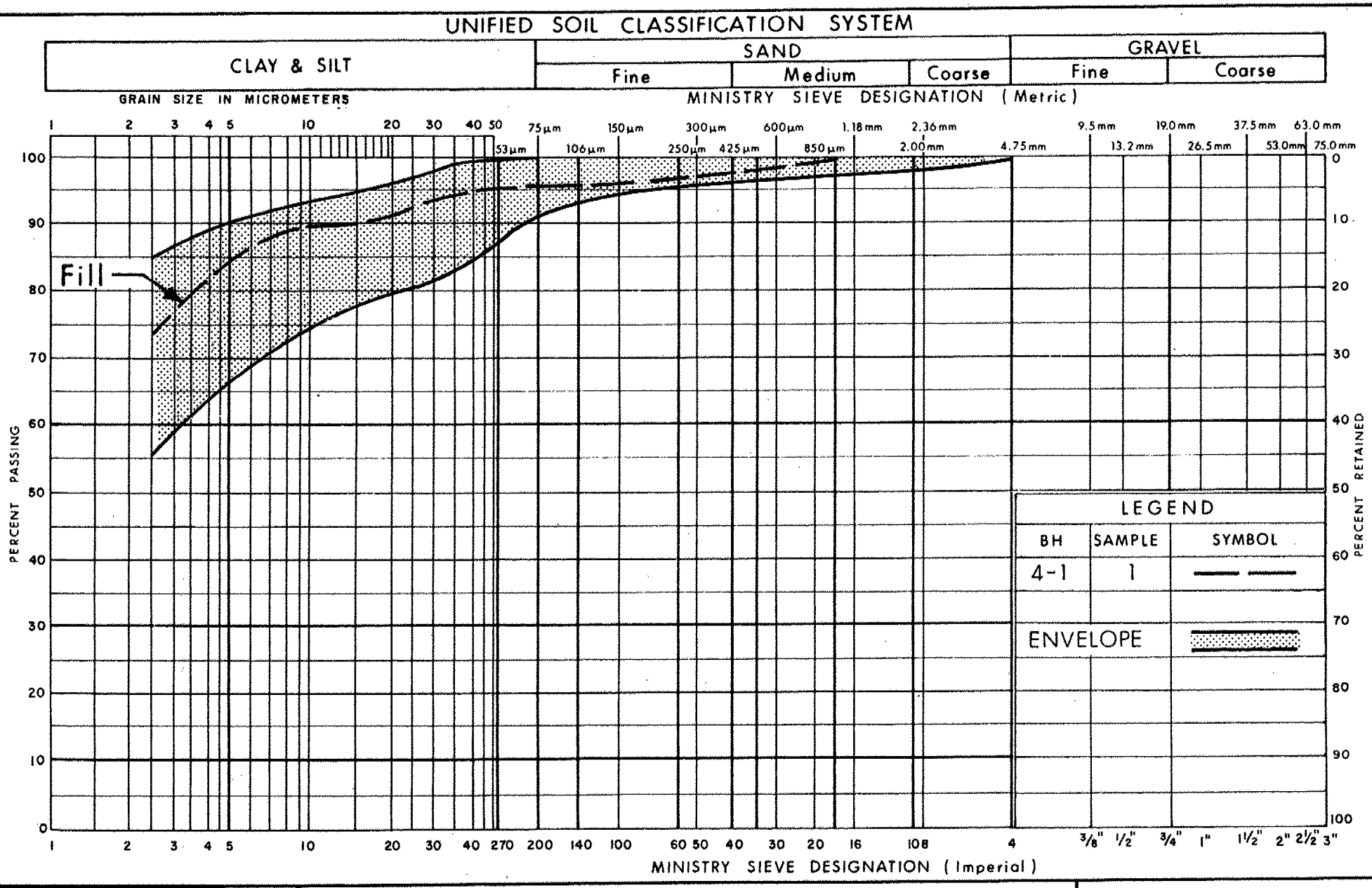
APPENDIX



Ministry of Transportation
Ontario

PLASTICITY CHART
SILTY CLAY to CLAY

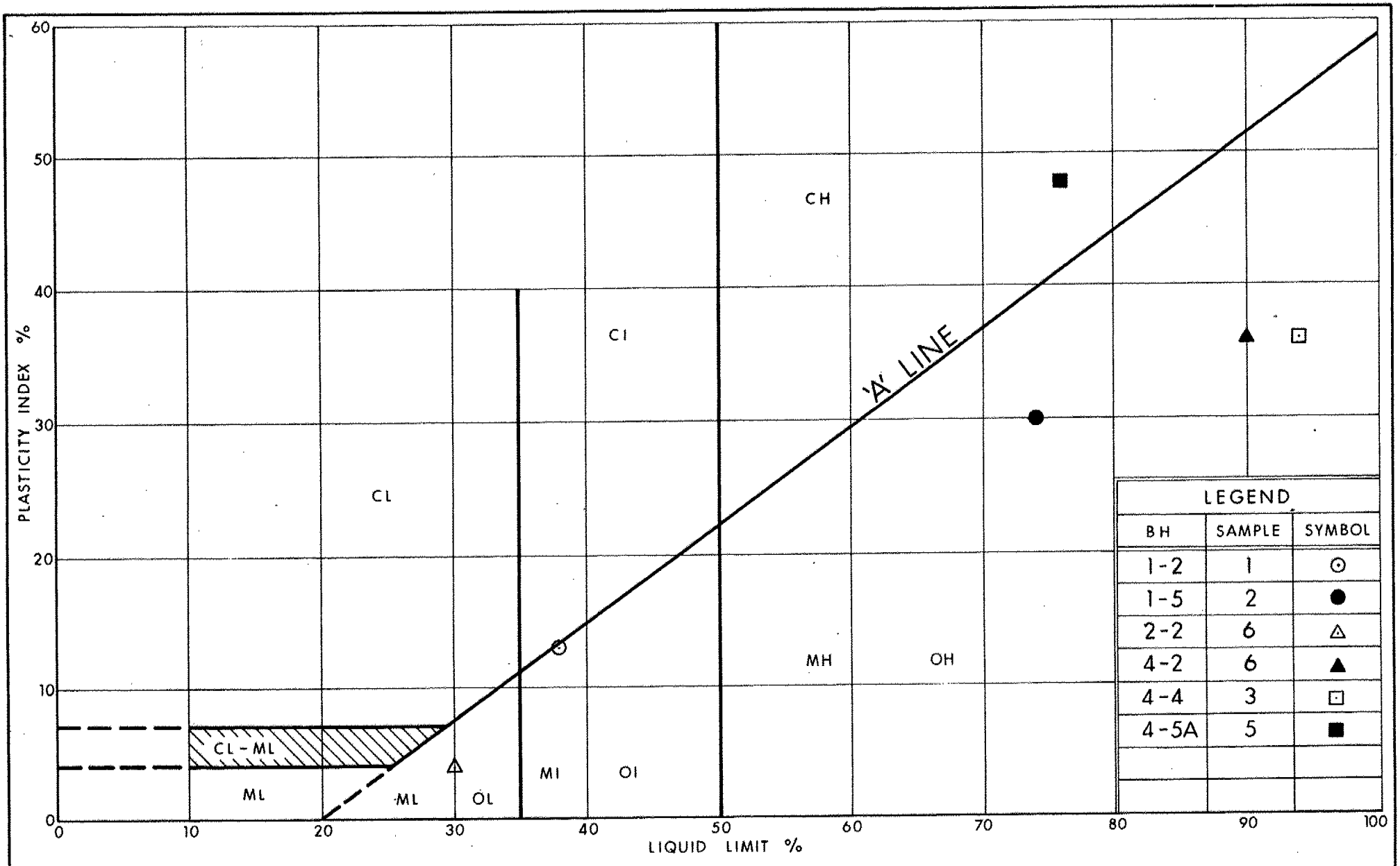
FIG No 1
W P 27-89-00



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
SILTY CLAY to CLAY

FIG No 2
W P 27-89-00

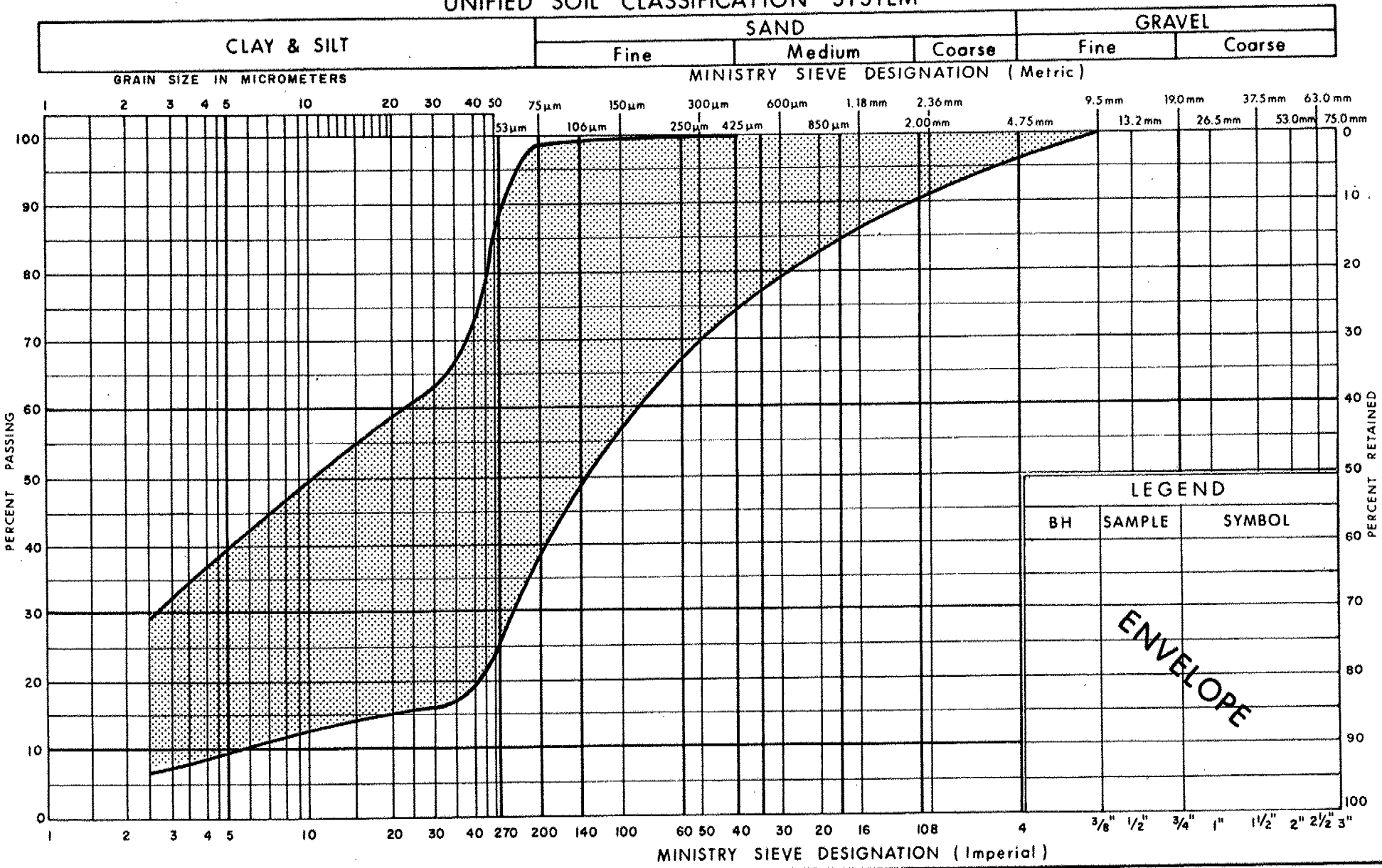


Ministry of Transportation
Ontario

PLASTICITY CHART
PEAT & ORGANIC SILTY CLAY

FIG No 3
WP 27-89-00

UNIFIED SOIL CLASSIFICATION SYSTEM

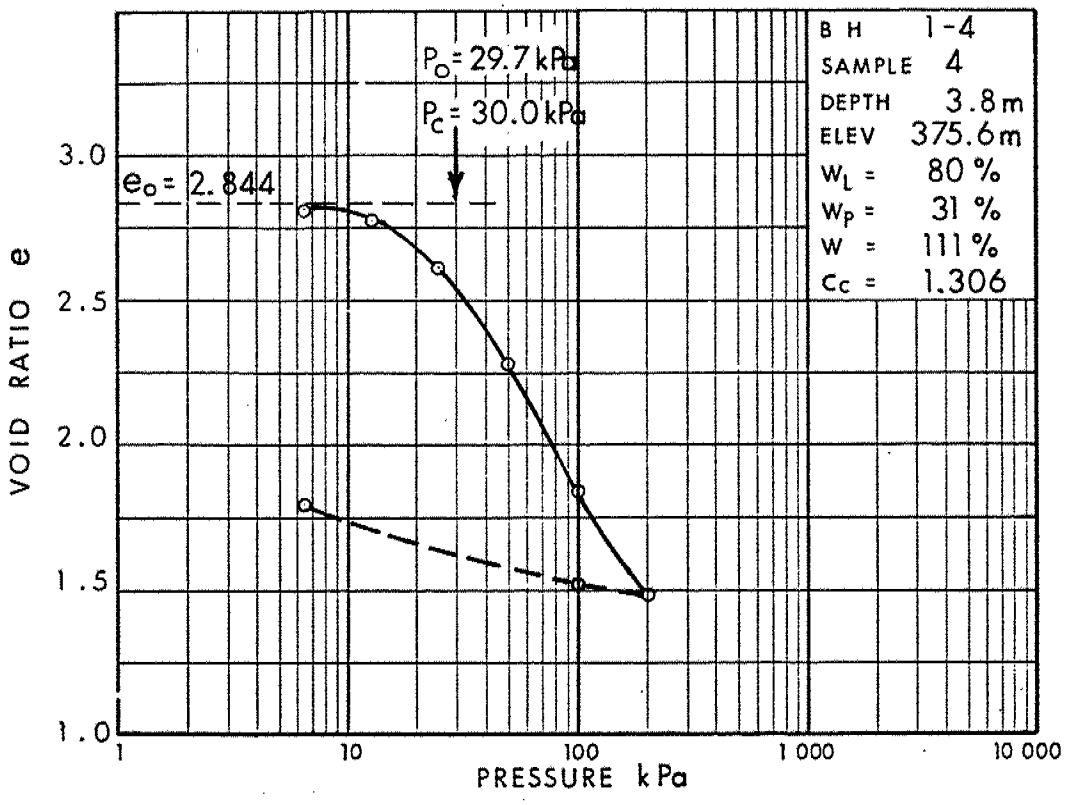


Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
PEAT & ORGANIC SILTY CLAY

FIG No 4
W P 27-89-00

VOID RATIO - PRESSURE CURVES



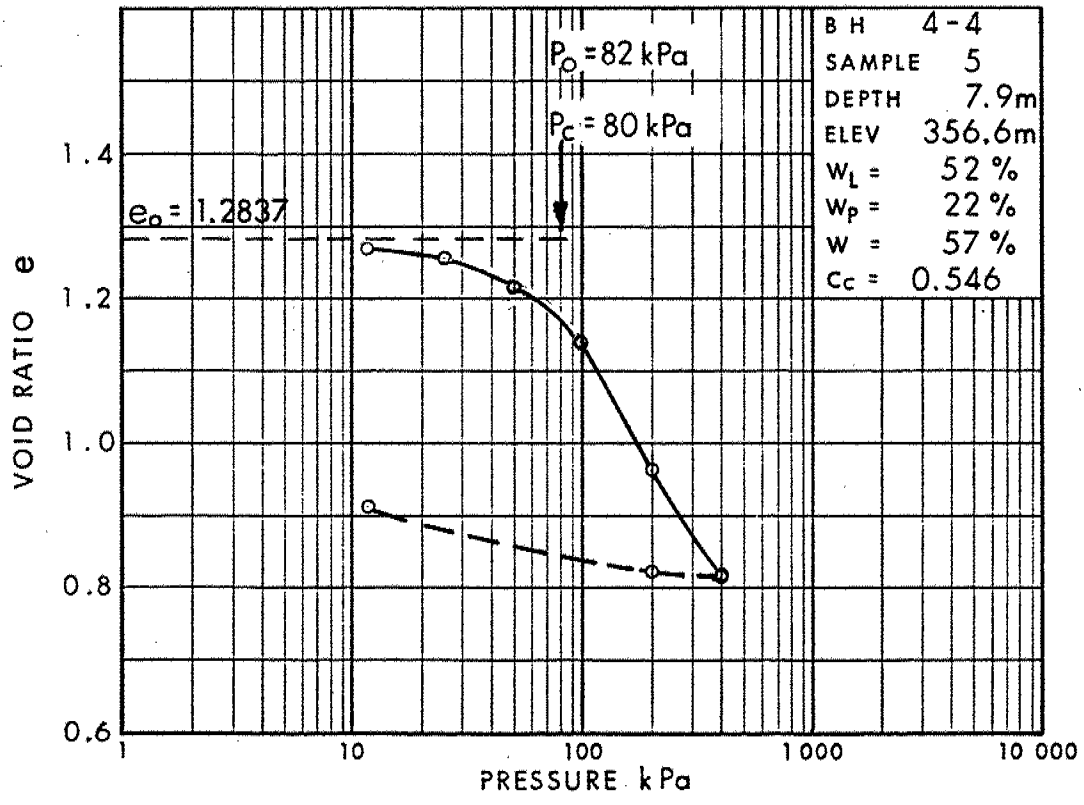
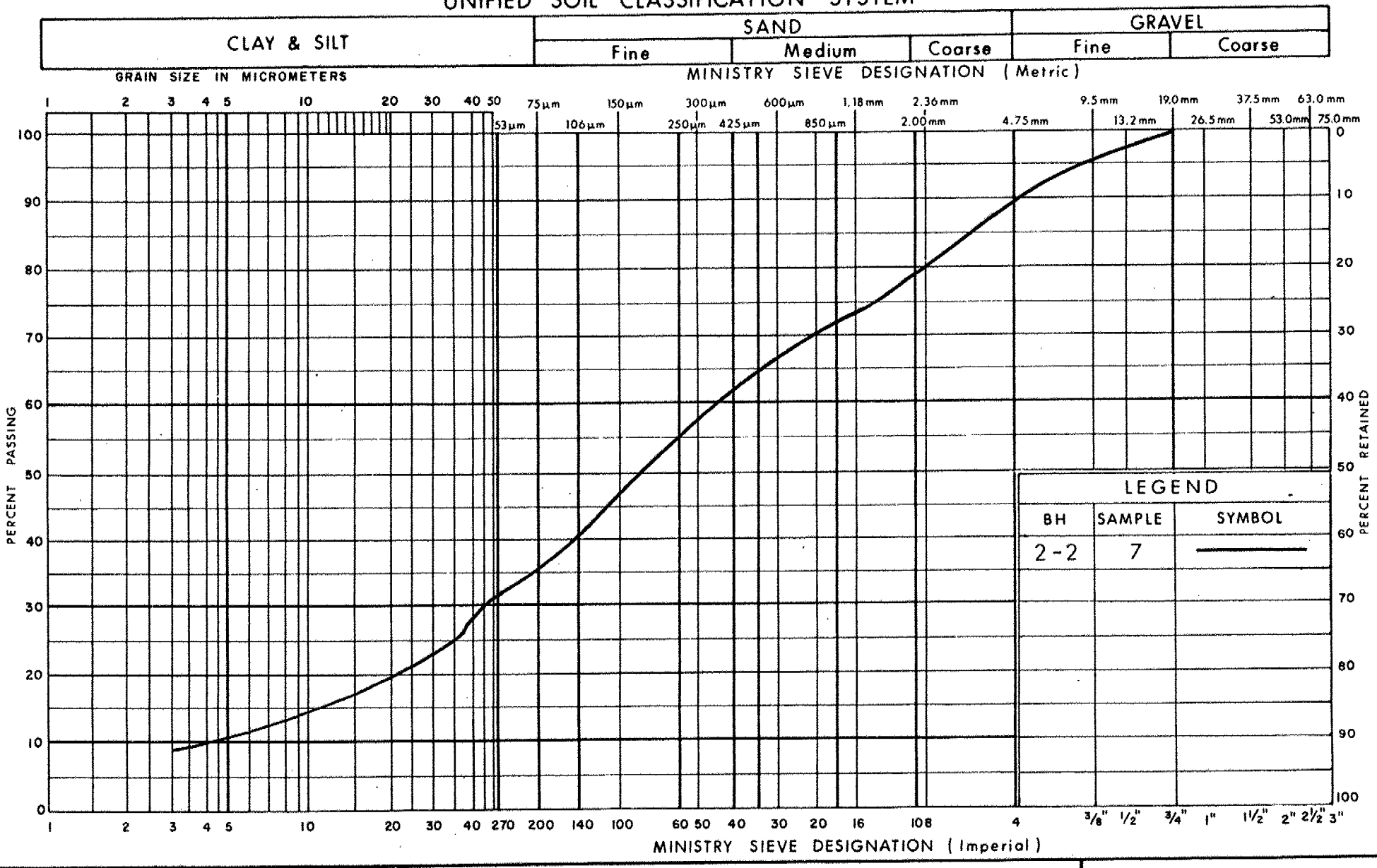


Fig 5 WP 27-89-00

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
SANDY SILT to SILTY SAND

FIG No 6
W P 27-89-00

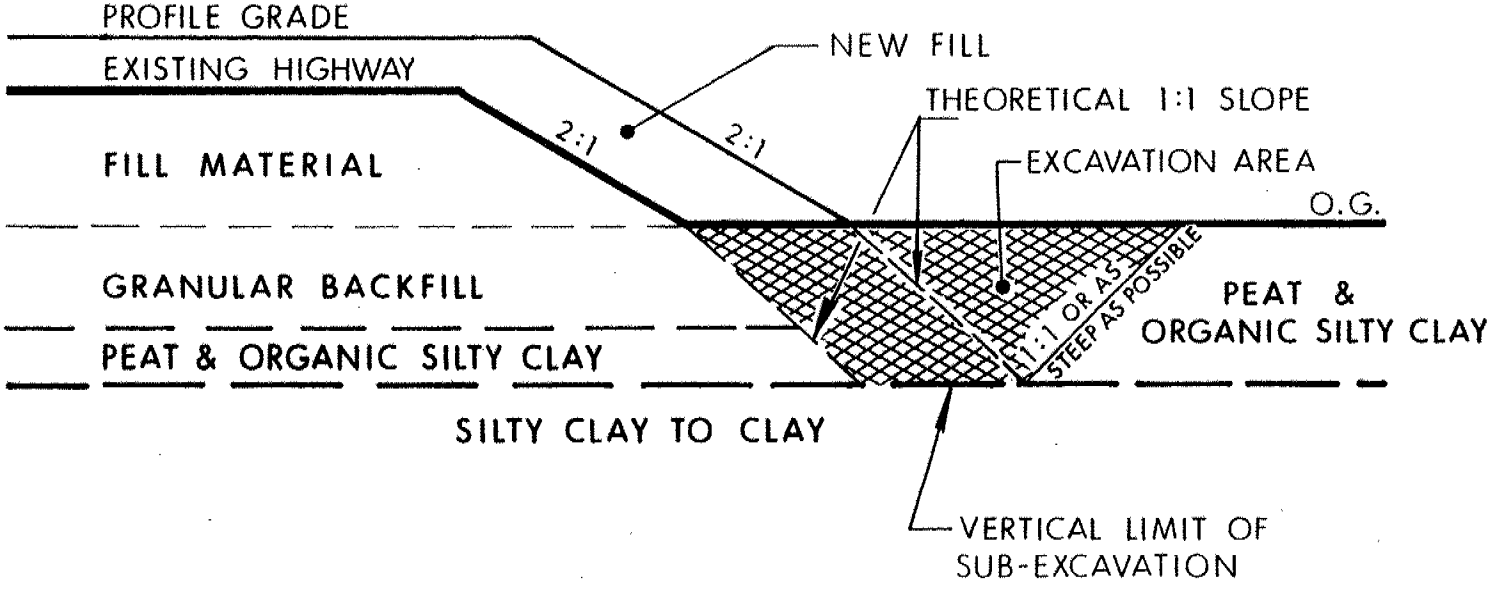


Figure 7 - SKETCH FOR SUB-EXCAVATION AND EMBANKMENT CONSTRUCTION

NOT TO SCALE

WP 27-89-00

RECORD OF BOREHOLE No 1-1 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Bridges, Sta. 16+400, o/s 5m RT ℄ HWY 17 ORIGINATED BY DD

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY JC

DATUM Geodetic DATE 93 07 08 CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
379.9	Ground Surface										
0.0	Sand, Some Gravel and Boulders (Fill) Loose to Compact brown		1	SS	19	▼	378				
			2	SS	6						
376.2											
3.7	Peat and Organic Silty Clay soft dark brown		3	SS	3		376				
374.9			4	SS	3				w_P = 78, w_L = 97, w = 141.5	13.2	0 22 69 9 OC=23.5%
5.0	grey		5	SS	2		374	+3			
	Silty Clay to Clay Soft to Firm		6	SS	0		372	+2			
			7	SS	0			+4			
369.4							370				
10.5	End of Borehole Auger Refusal due to probable Boulders										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 1-2 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Bridges, Sta. 16+480, o/s 5m LT ℄ HWY 17 ORIGINATED BY JC

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY JC

DATUM Geodetic DATE 93 07 08 CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
379.5	Ground Surface							20 40 60 80 100	20 40 60		
0.0	Sand, some Gravel and Boulders (Fill) brown										
378.3											
1.2	Peat and Organic Silty Clay stiff dark brown		1	SS	10		378				0 60 30 10
377.4											
2.1	Clayey Silt, some Gravel trace of Sand Soft to Firm grey		2	SS	1			+3			23 6 45 26
375.8							376				
3.7	Silty Sand Some Gravel very dense		3	SS	149	/16cm					
375.1											
4.4	End of Borehole at Probable Bedrock										

+3, ×5 : Numbers refer to Sensitivity

20
15◇5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 1-3 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Bridges, Sta. 16+600, o/s 5m LT ℄ HWY 17 ORIGINATED BY JC

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY JC

DATUM Geodetic DATE 93 07 08 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
380.5	Ground Surface										
0.0	Sand and Gravel Boulders (Fill)					▼					
378.9											
1.6	End of Borehole at Probable Boulders							120/5cm			

+³, ×⁵ : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 1-4 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Bridges, Sta. 16+530, o/s 5m RT ℄ HWY 17 ORIGINATED BY JC

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY JC

DATUM Geodetic DATE 93 07 08 CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
379.4	Ground Surface									
0.0	Sand, Some Gravel and Boulders (Fill)					▼				
377.9	brown									
1.5	dark brown Peat and Organic Silty Clay soft to firm		1	SS	6		378			6 11 72 11 OC=72.5%
			2	SS	3				13.2	4 32 63 1 OC=45.6%
376.2	dark brown									
3.2	grey		3	SS	2		376			
			4	TW	PH				12.9	0 0 30 70
			5	SS	0		374			
			6	SS	0					
	Silty Clay to Clay soft		7	SS	0		372			
			8	SS	2		370			
							368			
366.8			9	SS	0					
12.6	End of Borehole									

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

w_P=200 w_L=264 w=227

w_P=148 w_L=189 w=144

w=111

+3, ×5 : Numbers refer to Sensitivity

15 20 5 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 1-5 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Bridges, Sta. 16+442, o/s 5m LT ℄ HWY 17 ORIGINATED BY JC

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY JC

DATUM Geodetic DATE 93 07 08 CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
379.5	Ground Surface									
0.0	Sand, Some Gravel and Boulders (Fill)									
378.0	brown						378			
1.5	dark brown Peat and Organic Silty Clay firm		1	SS	7				11.8	0 2 87 11 OC=66%
			2	SS	4				15.7	0 21 63 16 OC=20%
376.3	dark brown									
3.2	grey Silty Clay to Clay soft		3	SS	0		376			
			4	SS	0					
373.9							374			
5.6	End of Borehole at Probable Boulders									

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

WATER CONTENT (%): PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L; 20 40 60

128

w_P=181

w_L=227

w=203.5

+4

+2

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2-1 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Docker, Sta. 13+640, o/s 5m RT ℄ HWY 17 ORIGINATED BY JC

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY JC

DATUM Geodetic DATE 93 07 07 CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
394.8	Ground Surface						
0.0							394
	Sand, some Gravel (Fill) loose to compact		1	SS	12		
			2	SS	13		392
			3	SS	7		
			4	SS	24		
389.9	brown		5	SS	5		390
4.9	dark brown						
	Peat and Organic Silty Clay soft to firm		6	SS	6		
			7	SS	5		388
			8	SS	6		
			9	SS	3		
386.3	dark brown						
8.5	grey						386
	Silty Clay to Clay firm		10	SS	2		
			11	SS	1		384
			12	SS	1		
381.1							382
13.7							
380.6	Clayey Silt, some Sand, stiff grey		13	SS	7		
14.2	brown						
	Sand, loose		14	SS	9		380
379.6							

15.2 End of Borehole

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa 20 40 60 80 100

○ UNCONFINED + FIELD VANE

● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 20 40 60

w_P = 143

w_L = 181

w = 171

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

0 33 61 6

OC=35%

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

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2-2 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Docker, STA 13+750, o/s 5m RT ℄ HWY 17 ORIGINATED BY JC

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY JC

DATUM Geodetic DATE 93 07 07 CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
394.3	Ground Surface							
0.0	Sand, Some Gravel (Fill) loose to compact		1	SS	13	▼		
			2	SS	6			
390.3	brown		3	SS	3			
4.0	dark brown Peat and Organic Silty Clay soft		4	SS	2			
388.7	dark brown		5	SS	3		10.4	1 9 73 17 OC=16.5%
5.6	grey Clayey Silt, some Peat layers firm — Peat		6	SS	4		23.4	0 8 80 12 OC=2.5%
387.1			7	SS	12			11 65 18 6
7.2	Sandy Silt to Silty Sand loose to compact		8	SS	2			
383.2			9	SS	6			
11.1	End of Borehole							

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%) 20 40 60

ELEVATION SCALE 394 392 390 388 386 384

w_P=99 w_L=122 w=190

120/5cm

H o

+³, ×⁵ : Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2-3 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Docker, Sta. 13+720, o/s 7m Lt ℄ HWY 17 ORIGINATED BY JC

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY JC

DATUM Geodetic DATE 93 07 07 CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS
394.0	Ground Surface					
0.0	Sand, Some Gravel (Fill) loose to compact		1	SS	4	
390.0	brown					
4.0	dark brown		2	SS	2	
	Peat and Organic Silty Clay soft		3	SS	2	
386.7	dark brown					
7.3	grey					
	Silty Clay to Clay soft		4	SS	0	
385.5						
8.5	End of Borehole					

ELEVATION SCALE: 392, 390, 388, 386

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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

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

RECORD OF BOREHOLE No 2-4 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Docker, Sta. 13+820, o/s 5m RT ℄ HWY 17 ORIGINATED BY JC

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY JC

DATUM Geodetic DATE 93 07 07 CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
394.8	Ground Surface										
0.0	brown Sand, Some Gravel and Boulders (Fill) compact to dense		1	SS	22	▼	394				
			2	SS	22		392				
			3	SS	44		390				
387.7							388				
7.1	End of Borehole										

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4-1 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Docker, Sta. 20+700, o/s 5m RT ℄ HWY 17 ORIGINATED BY JC

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY JC

DATUM Geodetic DATE 93 07 06 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	WATER CONTENT (%)		GR SA SI CL
386.4	Ground Surface							20 40 60 80 100	20 40 60		
0.0	Sand, Some Gravel and Boulders (Fill) compact brown						366				
364.0											
2.4	grey Silty Clay, trace of Sand (Fill) stiff		1	SS	12	▼	364				0 5 25 70
361.8	grey										
4.6	Fibrous Peat dark brown Pieces of Undecayed Wood firm		2	SS	7						
360.7	dark brown		3	SS	9		362				
5.7	reddish brown Silty Clay to Clay firm to stiff		4	SS	2		360				
	reddish brown / grey		5	SS	2		358				
357.1											
9.3	End of Borehole										
355.7											
10.7	End of Cone Test										

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

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

RECORD OF BOREHOLE No 4-2

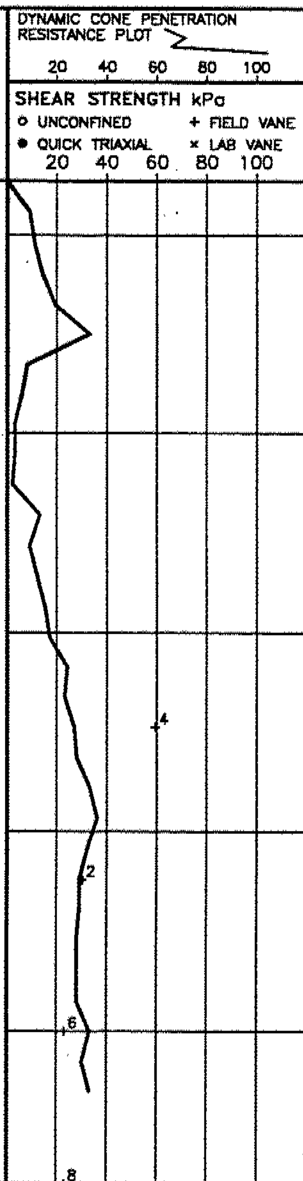
1 OF 1 METRIC

W.P. 27-89-00 | LOCATION TWP of Docker, Sta. 20+780, o/s 5m RT ℄ HWY 17 | ORIGINATED BY JC

DIST 20 HWY 17 | BOREHOLE TYPE Hollow Stem Auger AND Cone Test | COMPILED BY JC

DATUM Geodetic | DATE 93 07 06 | CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
364.5	Ground Surface									
0.0	Sand, Some Gravel and Boulders (Fill) compact, brown	1	SS	23		364				
		2	SS	120 /0cm	▼					
361.8		3	SS	13		362				
2.7	Silty Clay (Fill) stiff, grey	4	SS	13						
360.5 / 4.0	Peat and Organic Silty Clay, trace of Sand stiff, dark brown	5	SS	11		360				
		6	SS	7				w_L = 90, w = 76	11.7	0 4 80 16 OC=23%
359.0 / 5.5	Silty Clay to Clay, occ. organic layers firm, grey						+ (4)			
		7	SS	2		358	+ (2)			
		8	SS	2						
						356	+ (6)			
		9	SS	0						
354.4							+ (8)			
10.1	End of Borehole									



PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

+³, ×⁵ : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4-3 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Docker, Sta. 20+880, o/s 20m RT ℄ HWY 17 ORIGINATED BY JC

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JC

DATUM Geodetic DATE 93 07 08 CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	WATER CONTENT (%) (w_P PLASTIC LIMIT, w NATURAL MOISTURE CONTENT, w_L LIQUID LIMIT)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
363.2	Ground Surface										
0.0	grey					▼	382				
			1	SS	11						
							360				0 2 21 77
	trace of organics, occasional silt pockets		2	SS	6						
			3	SS	1		358	+9			
	Silty Clay to Clay, Stiff to Firm										
355.9			4	SS	0			+3	o		0 1 58 41
7.3							356				
	Sand, Some Gravel, loose to compact		5	SS	1						
353.6			6	SS	30		354				
9.6	End of Borehole										

+³, ×⁵: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4-4 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Docker, Sta. 20 +750, o/s 5m LT ℄ HWY 17 ORIGINATED BY JC

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JC

DATUM Geodetic DATE 93 07 06 CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
364.5	Ground Surface										
0.0	Sand, some Gravel (Fill) loose		1	SS	9	▼	364				
360.2	brown		2	SS	4		362				
4.3	dark brown Peat and Organic Silty Clay firm		3	SS	4		360		94 w=95	12.7	0 12 65 23 OC=28.5%
357.9	dark brown		4	SS	5		358				
6.6	grey Silty Clay to Clay soft to stiff		5	TW	PH		356	+2; o-5; o; +1		15.9	0 0 36 64
354.4			6	SS	1			+3			
10.1	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity

20 / 15 ◇-5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4-5 1 OF 1 METRIC

W.P. 27-89-00 LOCATION TWP of Docker, Sta. 20+818, o/s 5m LT ℄ HWY 17 ORIGINATED BY JC

DIST 20 HWY 17 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY JC

DATUM Geodetic DATE 93 07 09 CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
365.3	Ground Surface						
0.0	Sand, some Gravel, occ. Clayey Silt layers (Fill) Loose to Compact		1	SS	13		
			2	SS	3	▼	0 6 51 43
361.9	brown		3	SS	9		
3.4	Peat and organic Silty Clay, some pieces of undecayed wood dark brown		4	SS	5		
360.6	Firm to Stiff dark brown		5	SS	6		
4.7	reddish brown						
	reddish brown / grey		6	SS	2		
	Silty Clay to Clay Soft to Stiff		7	SS	7		
356.5							
8.8	Sand, some Silt dense		8	SS	41		
355.7							
9.6	End of Borehole						
353.1							
12.2	End of Cone Test						

ELEVATION SCALE: 364, 362, 360, 358, 356, 354

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m³

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

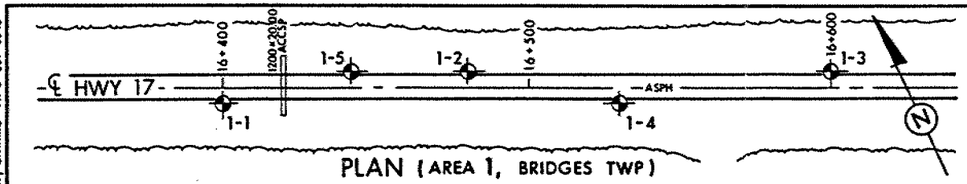
PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

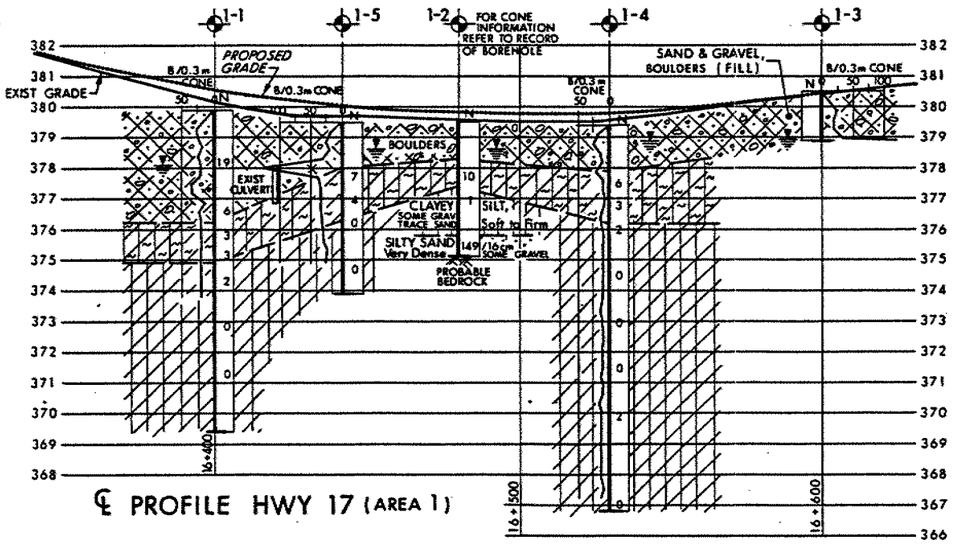
e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

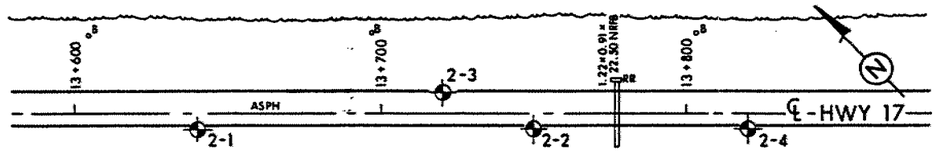
MINISTRY OF TRANSPORTATION, ONTARIO PH-0-207 88 10



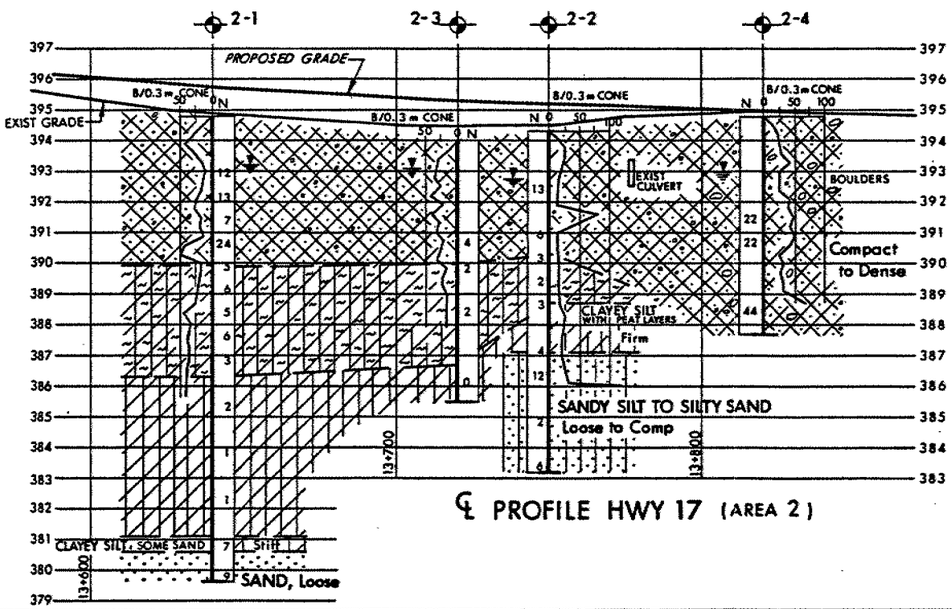
PLAN (AREA 1, BRIDGES TWP)



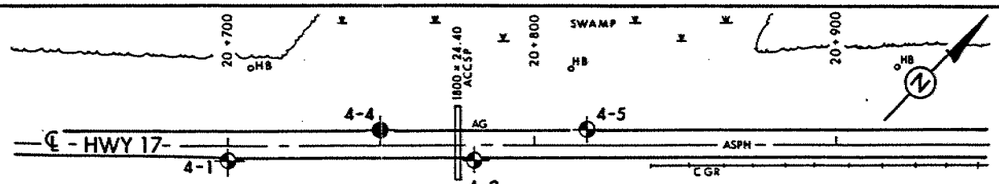
℄ PROFILE HWY 17 (AREA 1)



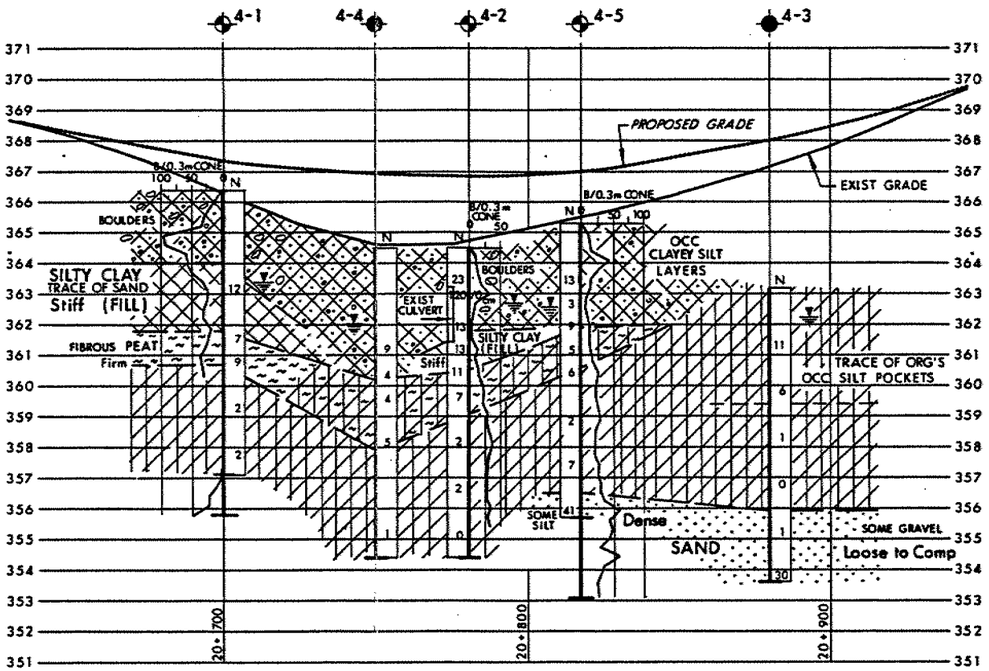
PLAN (AREA 2, DOCKER TWP)



℄ PROFILE HWY 17 (AREA 2)



PLAN (AREA 4, DOCKER TWP)



℄ PROFILE HWY 17 (AREA 4)

SCALE FOR PLANS
20m 10 0 20m

SCALES FOR PROFILES
20m 10 0 20m HOR
2m 1 0 2m VERT

SOIL STRATIGRAPHY LEGEND

- SAND, SOME GRAVEL (FILL) Loose to Compact
- PEAT AND ORGANIC SILTY CLAY Soft to Stiff
- SILTY CLAY TO CLAY Soft to Stiff

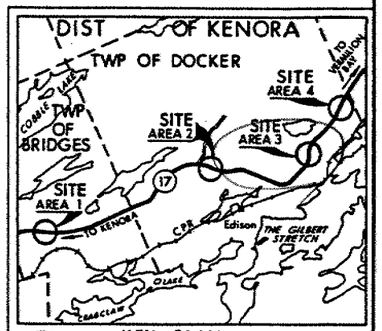
CONT No
WP No 27-89-00

HWY 17 UPGRADING - (3 SITES)
35.4 km W of Jct Hwy 17/105 (Vermilion Bay) Easterly

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

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



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 1993 07

No	ELEVATION	STATION	OFFSET
1-1	379.9	16+400	5 m RT
1-2	379.5	16+480	5 m LT
1-3	380.5	16+600	5 m LT
1-4	379.4	16+530	5m RT
1-5	379.5	16+442	5 m LT
2-1	394.8	13+640	5 m RT
2-2	394.3	13+750	5 m RT
2-3	394.0	13+720	7 m LT
2-4	394.8	13+820	5 m RT
4-1	366.4	20+700	5 m RT
4-2	364.5	20+780	5 m RT
4-3	363.2	20+880	20 m RT
4-4	364.5	20+750	5 m LT
4-5	365.3	20+818	5 m LT

=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 GC 2.01 of OPS Gen. Cond.

REV	DATE	BY	DESCRIPTION

LICENSED PROFESSIONAL ENGINEER T.-C. KIM PROVINCE OF ONTARIO

Geocres No 52F-24

HWY No 17			DIST 20
SUBM'D TCK	CHECKED TCK	DATE 1994 02 25	SITE
DRAWN RS	CHECKED APPROVED		DWG 278900-A