

GEOCRES No. 30614-31DIST. 4 REGION W.P. No. CONT. No. W. O. No. 93-11006STR. SITE No. HWY. No. G.E.WLOCATION G.E.W / Townline Rd.Town of Fort ErieNo of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

MEMORANDUM



To: Dennis Billings
Acting Head,
Geotechnical Section
2nd Floor, Atrium Tower

Date: September 20, 1993

From: Foundation Design Section
Room 315, Central Bldg.

Tel: 235-3731
Fax: 235-5240

Re: Approach embankments
QEW/Townline Road Overpass
W.O. 93-11006
District 4, Burlington

Further to your request for an investigation on the failure of the approach embankments for the above structure, a joint site visit was made on 93 08 24 with representatives from both offices (R. Kohlberger, M. Devata, B. Iyer and D. Kwok).

As observed on site, a slip has occurred on the southeast embankment. A close inspection of the failed area has revealed that a geotextile has apparently been placed with granular material dumped on top. This was probably carried out as a remedial measure to a surficial slip. It is believed that the geotextile has generated a weak plane for further slips under the weight of the new fill. A similar slip scar covered with granular material was found on the southwest embankment. The failed area is of a less extent and no geotextile was noticed based on site observations.

Subsequent to the site visit, a field investigation was carried out by this office on 93 08 30 to reveal the subsurface conditions. Two (2) boreholes were advanced to depths of 9.6 m (BH 1) and 12.3 m (BH 2), at the approximate locations shown on the attached marked-up sketch.

As revealed from the field investigation, the subsurface stratigraphy typically consists of 600 mm of pavement structure (asphalt and granular fill) overlying $6\pm$ m of fill material. The fill is a clay of high plasticity and is underlain by $3\pm$ m of native clay which is also of high plasticity. In BH 2, a $3\pm$ m thick cohesive glacial till stratum was encountered below the clay layer. Shale bedrock was contacted at $12.3\pm$ m.

Groundwater level was monitored throughout the course of the investigation. No free water was encountered during drilling. Upon completion of augering at BH 2, the bottom of the borehole was wet and water rose to 9.8 m depth within 1/2 hr. It is envisaged that the stabilized water table lies within the native clay stratum at or slightly above the level of Black Creek. Seasonal fluctuations in groundwater level is expected.

Soil samples collected in the field were brought back to the laboratory for testing. The laboratory testing program consists of:

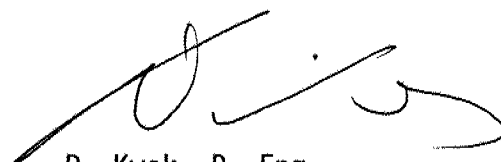
- moisture content determination
- Atterberg Limits Test
- Grain Size Distribution Test

Based on the test results, the embankment fill material is a clay of high plasticity. The natural moisture content of the material is quite high, in the order of 24-27%. This material is difficult to compact to the desired degree of compaction. The Standard Penetration Tests carried out in the field indicate that the top 2-3 m of the fill is not in a competent form. We also understand from our conversation with the patrol staff that slope failures occurred even during construction of the embankment. The gradient of the existing slope appears too steep for the type of material.

The following remedial measures are recommended.

1. Complete removal of the geotextile and overlying granular material.
2. Bench the existing slope and overbuild it to the geometry as shown on the attached sketch. The excavated granular fill material may be reused for the lower half of the rebuilt slope. The top half of the slope should be backfilled with Granular "B" material. The new fill should be well compacted.
3. Pave the new shoulder and vegetate the slope face immediately after completion of the remedial work described above.

The sketch attached is schematic and intended for illustration purpose only. A survey request has been made for actual location of boreholes and typical cross-sections at borehole locations. The sketch can be refined when the survey information is available.

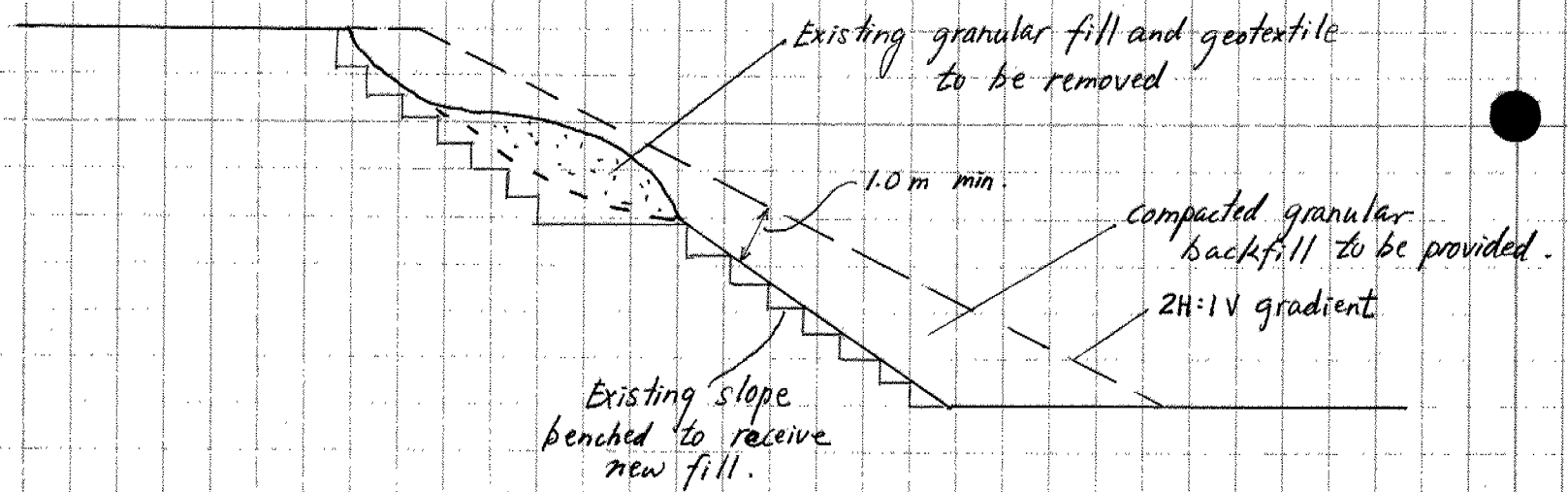


D. Kwok, P. Eng.
Project Foundation Engineer

for

B. Iyer, P. Eng.
Senior Foundation Engineer

MD/BI/jb



Schematic Diagram showing Proposed Remedial Measures.

(N.T.S.)

HOT 30+00.00 TOWNLIN RD REV'N
HOT 2+04.35 QEW

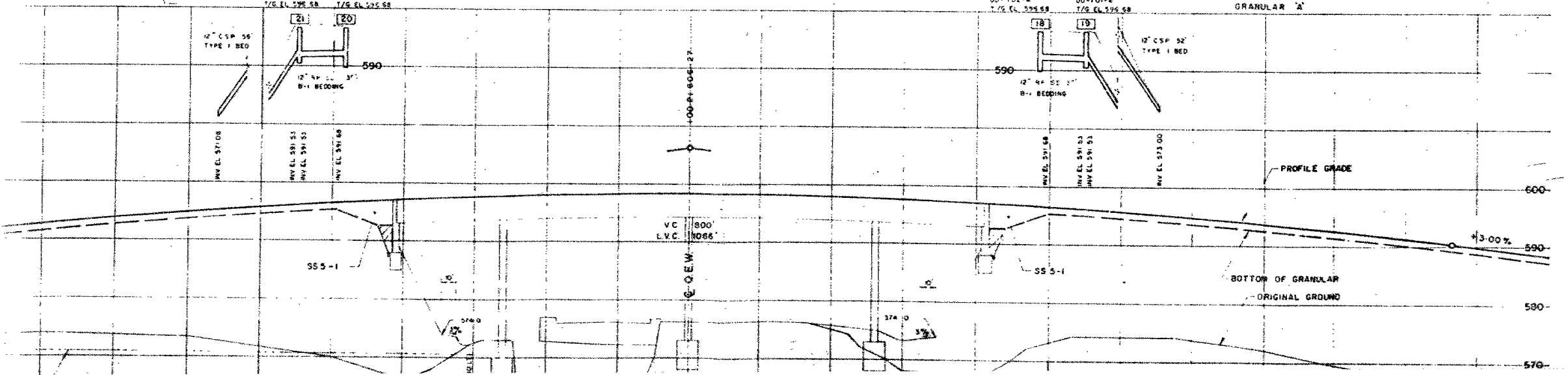
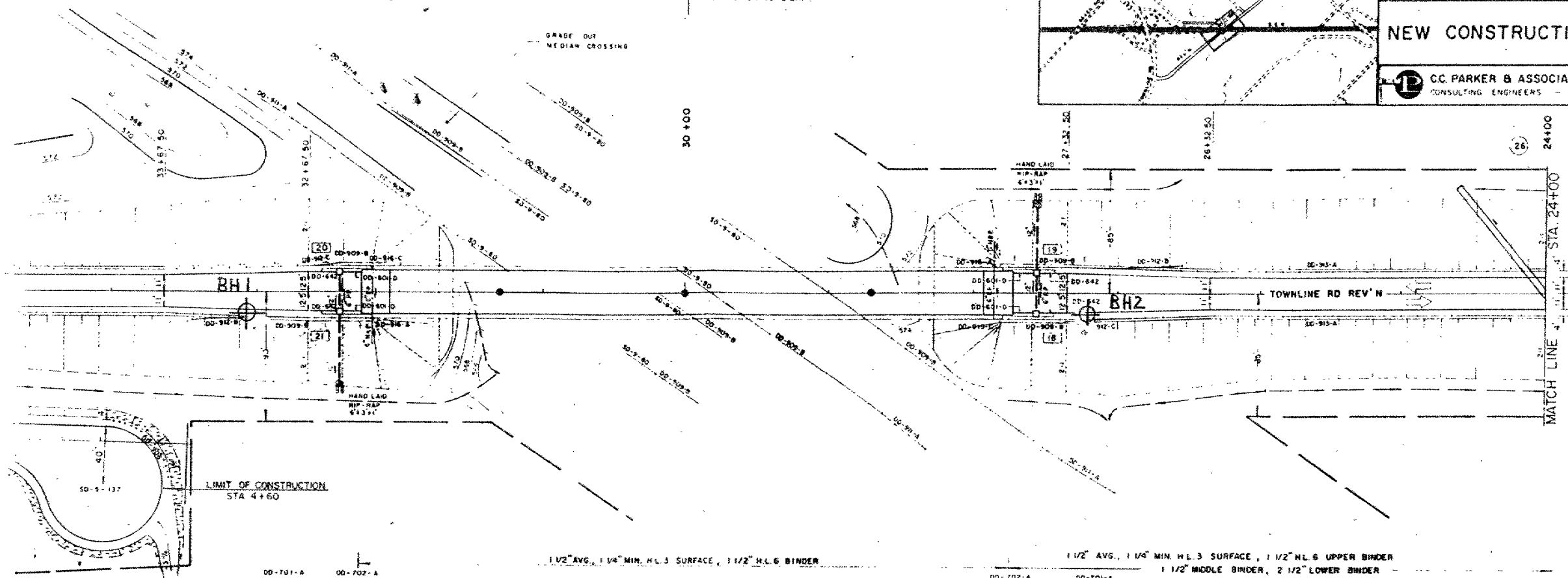
CONT. No. 77-42
W. P. No. 167-64-01

NEW CONSTRUCTION

CC. PARKER & ASSOCIATES LTD
CONSULTING ENGINEERS - HAMILTON

SHEET
26

DES. E.W.
ORN. J.P.
CHAD. H.



Sta. 24+00 - Sta 36+00	
EQ	221 CY
SP	330 CY
ED	360 CY
WE	0 CY
M/E	0 CY
EF	54,900 CY
RC	0 CY
SP	0 CY
RC	0 CY
MBA	0 CY
RF	0 CY

memorandum



To: Dennis Billings
Acting Head, Geotechnical Section
Central Region

Date: 1993 08 26

Attn: Rob Kohlberger

From: Foundation Design Section
Room 315, Central Building

Subject: Approach Embankments
QEW/Townline Road Overpass
W.O. 93-11006
District 4, Burlington

Further to your request for an investigation on the failure of the approach embankments for the above structure, a joint site visit was made on 93 08 24 with representatives from both offices (R. Kohlberger, M. Devata, B. Iyer and D. Kwok).

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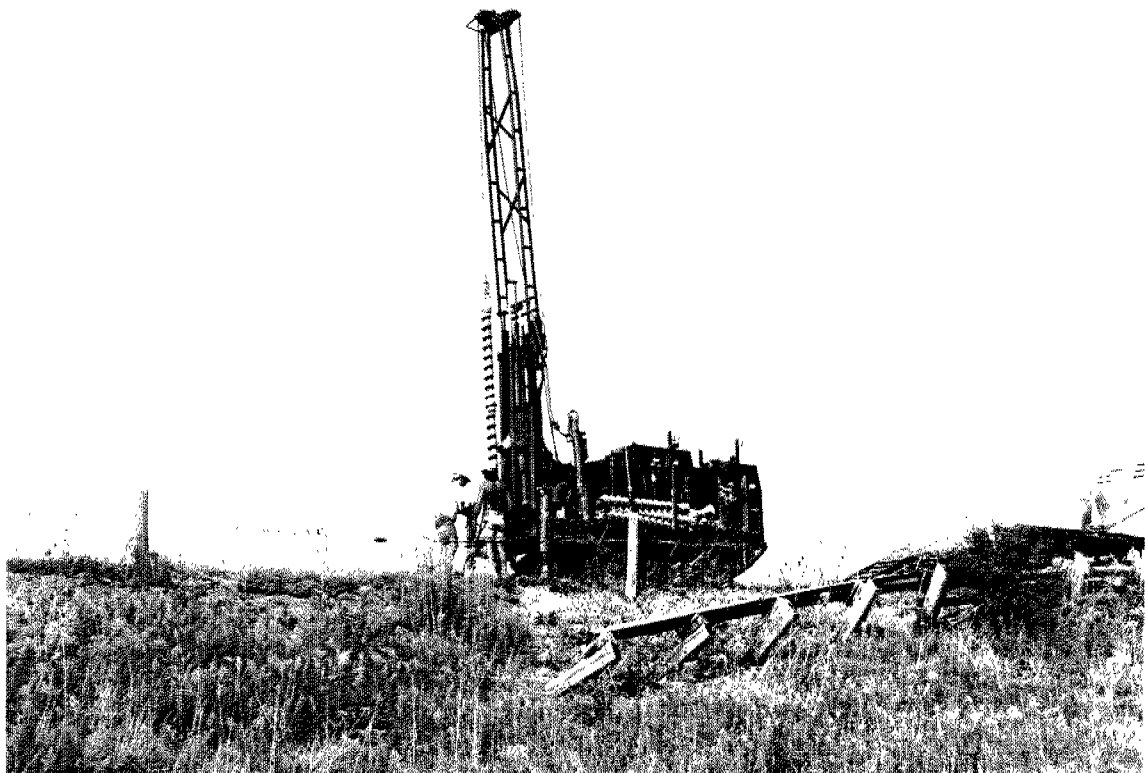
As discussed in the field, we recommend complete removal of the geotextile. The area should then be backfilled with excavated granular material to a gradient of 2H:1V or flatter. If the exposed original material is found to be subject to seepage problems, counterfort drains should be installed at about 20 m spacings.

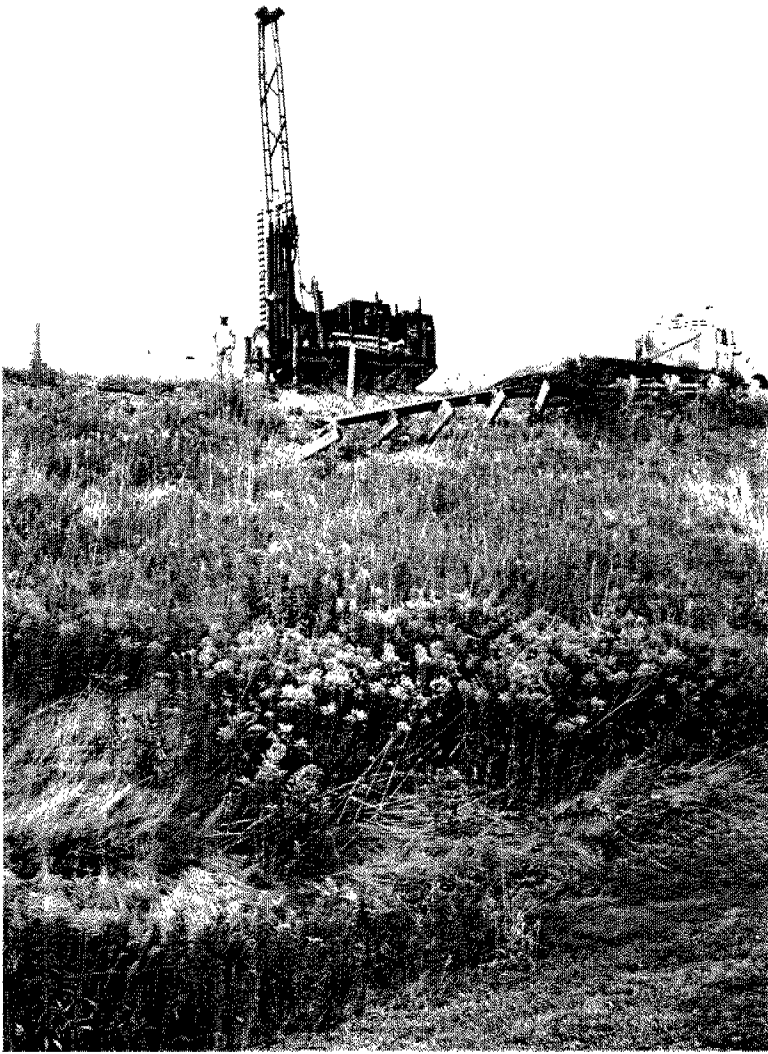
A field investigation will be carried out by this office in the week of 93 08 30 to reveal the subsurface conditions. In the meantime, please contact us should there be any questions.

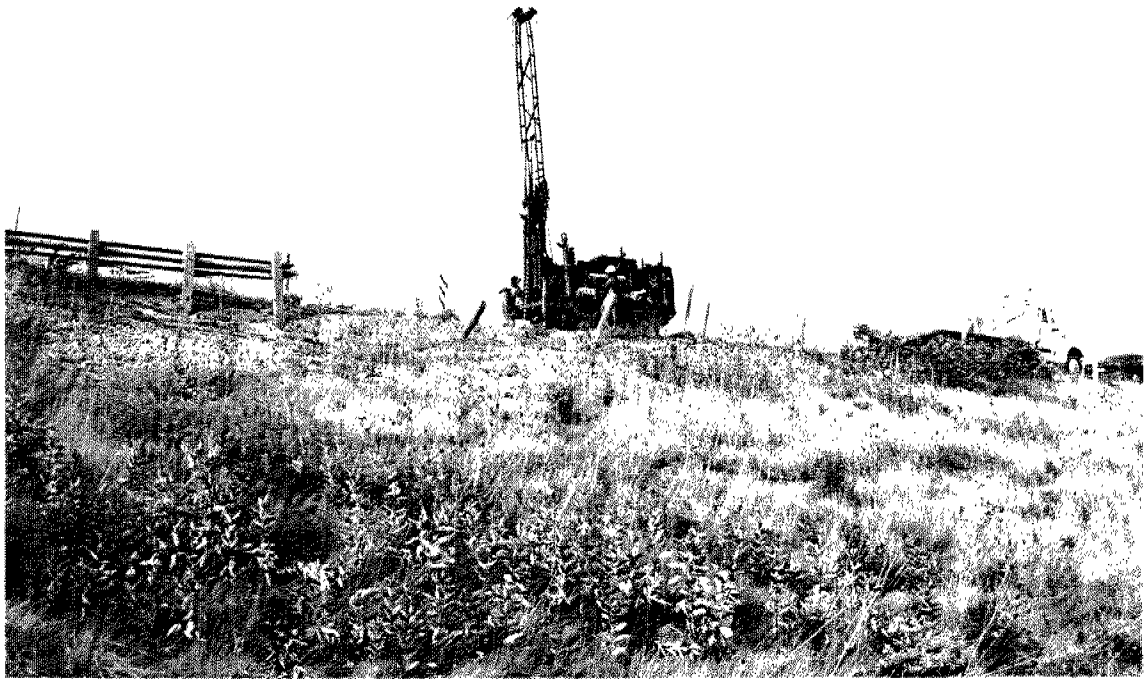
A handwritten signature in dark ink, appearing to read "B. Iyer", with a horizontal line underneath.

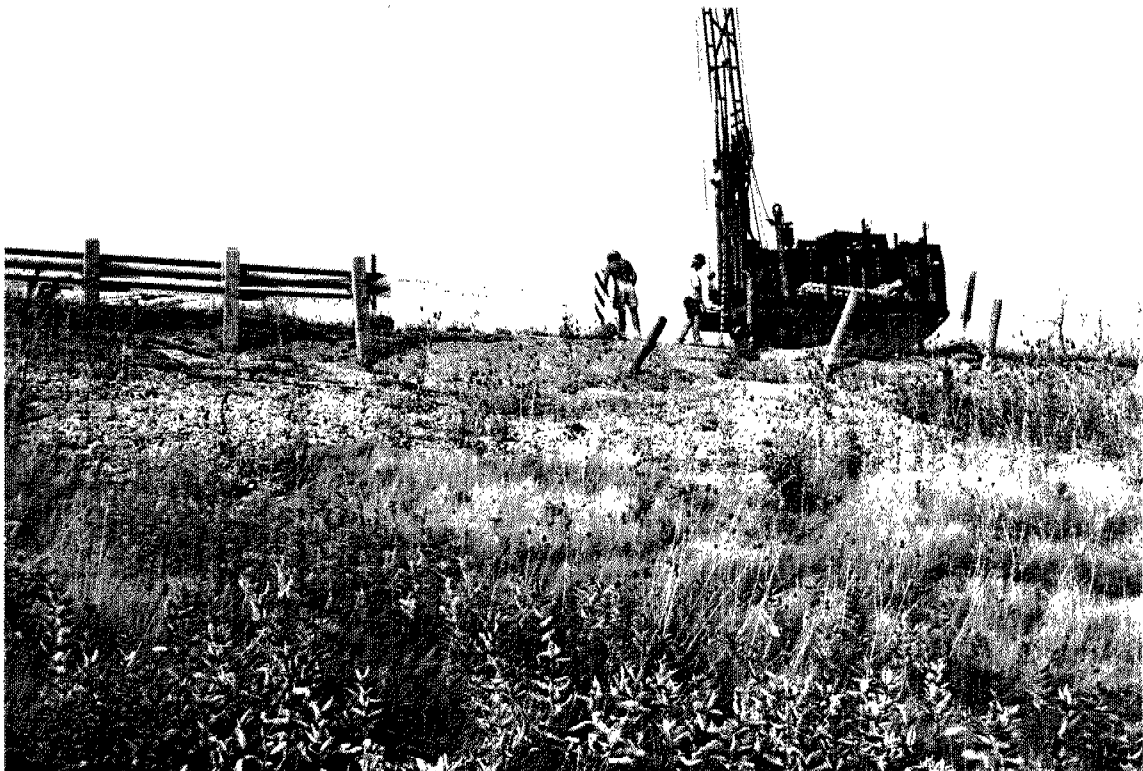
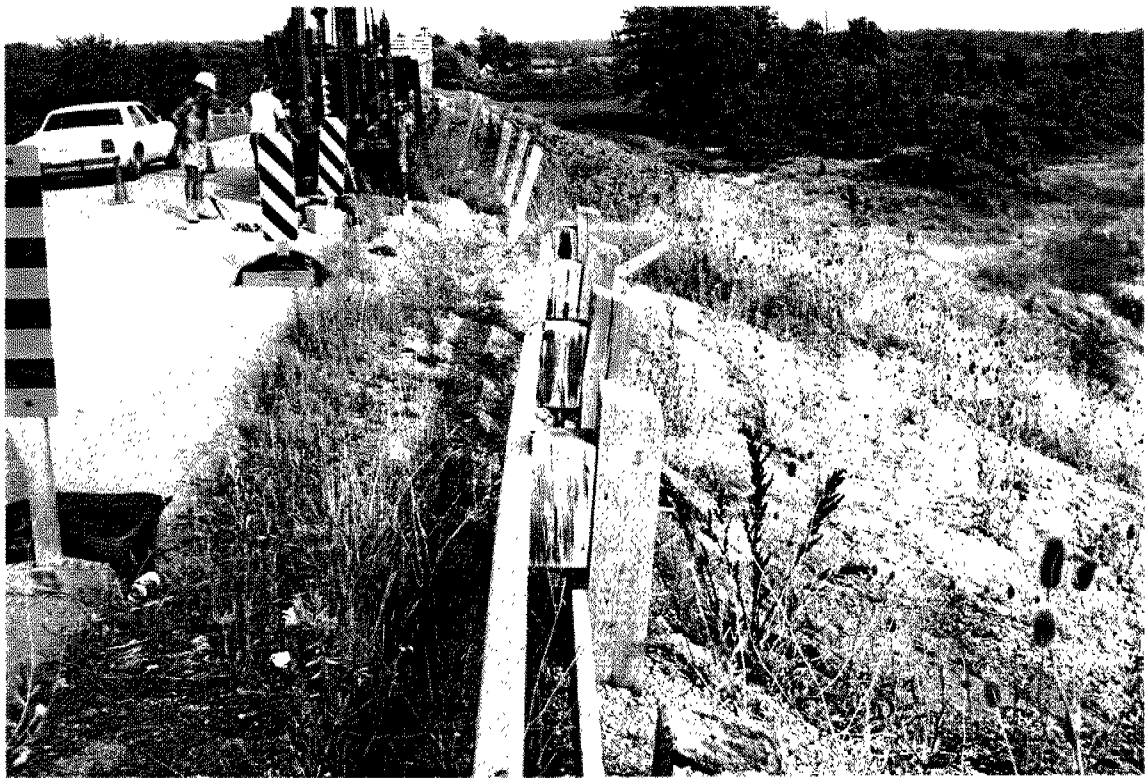
Balu Iyer, P. Eng.
Senior Foundation Engineer
for

Murty Devata, P. Eng.
Chief Foundation Engineer











memorandum



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Acting Head, Geotechnical Section
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A field investigation will be carried out by this office in the week of 93 08 30 to reveal the subsurface conditions. In the meantime, please contact us should there be any questions.

Balu Iyer, P. Eng.
Senior Foundation Engineer
for
Murty Devata, P. Eng.
Chief Foundation Engineer

MEMORANDUM

To: Mr. B. B. Davis,
Bridge Engineer,
Bridge Division,
Admin. Bldg.

FROM: Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

Attention: Mr. S. McCombie

DATE: July 12, 1968

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
Proposed Underpass at the Crossing of
Queen Elizabeth Way and
Revised Townline Road
Twp. of Willoughby, Cty. of Welland
District No. 4 (Hamilton)
W.J. 68-F-31 -- W.P. 167-64-01

Attached, we are forwarding to you, our detailed foundation investigation report on the subsoil conditions existing at the above structure site.

We believe that the factual data and recommendations contained therein, will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

AGS/MdeF
Attach.

cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
G. K. Hunter (2)
H. Greenland
W. S. Melinyshyn
T. J. Kovich
B. A. Singh

Foundations Files
Gen. Files

A. G. Stermac
A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

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(Glacial Till).
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FOUNDATION INVESTIGATION REPORT
For
Proposed Underpass at the Crossing of
Queen Elizabeth Way and
Revised Townline Road
Twp. of Willoughby, Cty. of Welland
District No. 4 (Hamilton)
W.J. 68-F-31 -- W.P. 167-64-01

1. INTRODUCTION:

The Foundation Section was requested to carry out a subsurface investigation at the site of the proposed crossing of the Q.E.W. and Revised Townline Road in Willoughby Twp., Welland Cty., some 12 miles south of Fort Erie. The request was contained in a memo from the Bridge Division (Mr. W. S. Melinyshyn, Regional Bridge Location Engineer), dated March 25, 1968, which also contained a request for foundation investigations at two other sites in the vicinity.

Subsequently, an investigation was carried out by this Section to determine the subsoil conditions at the above site. This report contains the results of the investigation, together with our recommendations for the design of the structure foundations and the stability of the approach embankments.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located some 12 miles south of Fort Erie on the Q.E.W. in the immediate vicinity of the existing Q.E.W. and Black Creek crossing. At this location the Q.E.W. is a 4-lane paved highway with associated median and gravel shoulders. The existing crossing of the Q.E.W. over Black Creek consists of twin 60-ft. span concrete structures supported on concrete piers and separated along the median by Standard concrete railing enclosures. Black Creek is a shallow meandering stream, the depth of water being of the order of 4 ft. The stream banks are some

cont'd. /2 ...

2. DESCRIPTION OF THE SITE AND GEOLOGY: (cont'd.) ...

10 ft. in height where the Q.E.W. crosses Black Creek. The surrounding ground is generally flat-lying with isolated areas of scrub bush growth.

Physiographically, the area is situated in the "Haldimand Clay Plain" region where lacustrine clay deposits overlie a glacial till stratum which in turn, is underlain by shales and dolomites of the Salina formation.

3. FIELD AND LABORATORY WORK:

A total of 13 boreholes, each accompanied by a dynamic cone penetration test, was carried out during the course of the field work. In addition, two dynamic cone penetration tests were driven to practical refusal. The boreholes and cone tests were carried out by means of a conventional diamond drill rig adapted for soil sampling purposes.

Samples were obtained at required depths in a 2" O.D. split-spoon sampler which was hammered into the soil, or by manually pushing 2" I.D. Shelby tubes in the cohesive material of the overburden. The method of driving the split-spoon sampler conformed to the specifications for the Standard Penetration Test. The same method was used to drive the dynamic cone penetration tests. Field vane tests were carried out wherever possible, in the cohesive deposits of the overburden, in order to determine the undrained shear strength. Bedrock was proven by core drilling in AXT size.

The locations and elevations of the boreholes and cone tests are shown on Drawing 68-F-31A, together with the estimated stratigraphical profile across the site. Surveying was undertaken by the Central Region Engineering Surveys Section personnel. The elevations are referenced to a geodetic datum.

All samples were subjected to a careful visual examination in the field and subsequently in the laboratory. Following this, representative samples were selected for testing in order to

cont'd. /3 ...

3. FIELD AND LABORATORY WORK: (cont'd.) ...

determine their physical properties, such as:

Natural Moisture Contents
Atterberg Limits
Bulk Densities
Undrained Shear Strengths
Organic Matter Contents
Grain-Size Distributions

The results of these tests are plotted on the individual Borelog sheets as well as on the Figures in the Appendix to this report.

4. SUBSOIL CONDITIONS:

4.1) General:

The subsoil at the site consists of a clayey fill some 6 to 17 ft. in thickness which is underlain by a silty clay deposit and/or a glacial till deposit overlying shale and dolomite bedrock. Bedrock is encountered between elevations 547 and 554, some 14 to 25 ft. below ground surface.

From ground surface downwards, the following strata were encountered:

4.2) Silty Clay to Clay (Fill Material):

A deposit of silty clay to clay fill material was encountered at Boreholes 5 to 12 inclusive to depths ranging from 6 to 17 ft. The deposit contained numerous organic inclusions. Physical properties of the deposit as determined in the field and laboratory, are as follows:

cont'd. /4 ...

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.2) Silty Clay to Clay (Fill Material): (cont'd.) ...

	<u>Range</u>
Natural Moisture Content (W) - %	28 - 43
Liquid Limit (WL) - %	51 - 55
Plastic Limit (Wp) - %	26 - 34
Bulk Density (γ) - p.c.f.	112 - 120
Organic Matter Content - %	5 - 7
Undrained Shear Strength (Cu) - p.s.f. ..	340 - 1360
Standard Penetration - Resistance 'N' Values - Blows/ft.	5 - 24

The physical properties were found to vary at random throughout the deposit. Based on the C_u and 'N' values, the deposit is considered to be of firm to very stiff consistency.

4.3) Silty Clay:

A stratum of reddish-brown silty clay with a trace of sand and occasional gravel was encountered below the fill material at Boreholes 5 and 6 as well as beneath a surficial cover of topsoil at Boreholes 2, 3, 13, 14 and 15. The stratum varied in thickness between 5 and 8 ft. Occasional mottling indicates that the deposit has been desiccated.

The physical properties of the deposit are as follows:

	<u>Range</u>
Natural Moisture Content (W) - %	23 - 28
Liquid Limit (WL) - %	41 - 47
Plastic Limit (Wp) - %	23 - 31
Bulk Density (γ) - p.c.f.	126 - 132
Undrained Shear Strength (C_u) p.s.f.	
- Boreholes 5, 6, 13 & 14	2400 (Avge.)
- Boreholes 2 & 3	1500 (Avgs.)

On the basis of these tests, the consistency of the stratum ranges from stiff to very stiff.

cont'd. /5 ...

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.4) Clayey Silt with Sand and Gravel (Glacial Till):

A deposit of clayey silt with sand and gravel (glacial till) was encountered at all borehole locations, between elevations 565 and 558. The deposit varied in thickness from about 6 ft. at Borehole 7 to 13 ft. at Borehole 3. The glacial till was found to be underlain by an interbedded shale and dolomite bedrock, the upper weathered portions of which have been incorporated into the basal portion of the deposit as a result of glaciation. The lower portions of the deposit, therefore, contain boulders and occasionally, lenses of sand and gravel. Occasional gypsum inclusions were observed within the upper portions of the deposit.

The physical properties of the stratum are listed below:

	<u>Range</u>
Natural Moisture Content (W) - %	7 - 13
Liquid Limit (W_L) - %	15 - 21
Plastic Limit (W_p) - %	11 - 14
Standard Penetration	
Resistance 'N' Values - Blows/ft.:	
- Upper Portions	7 - 30
- Lower Portions	> 100

Grain-size distribution curves are shown on Figure 4 in the Appendix. The 'N' values indicate a stiff to very stiff consistency generally, for the upper portions of the deposit and a hard consistency or very dense relative density for the lower portions.

4.5) Bedrock:

Bedrock was drilled in AXT size in all boreholes except Boreholes 1, 11, 14 and 16. Examination of cores recovered during the investigation reveals the bedrock to consist of interbedded shale and dolomite. The shale interbeds were found to be separated by seams of gypsum up to 18 inches in thickness. The dolomitic

cont'd. /6 ...

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.5) Bedrock: (cont'd.) ...

portions of the cores contained numerous gypsum inclusions.

At the west end of the site, bedrock was encountered at about elevation 547, whereas at the east end of the site, the bedrock was encountered at about elevation 553, indicating that the bedrock surface is sloping upwards towards the east. Core recoveries were generally 100%, indicating the bedrock to be sound.

5. GROUNDWATER CONDITIONS:

Observations of the groundwater level were made in the open boreholes upon completion of the field work. These observations indicate a groundwater level at about elevation 566, that is, some 1 to 10 ft. below the existing ground surface, depending on the location of the borehole. These observations also indicate that the groundwater level is generally 4 to 5 ft. higher than the water level in Black Creek.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to construct a 4-span structure to carry the Revised Townline Road (County Road #7) over the Queen Elizabeth Way and Black Creek. Present proposals call for two alternate schemes involving end spans of either 67 or 76 ft. and central spans of 132 ft. Maximum approach fill heights of the order of 25 ft. above the existing Q.E.W. grade are proposed.

Subsoil at the site consists of a clayey fill deposit overlying a silty clay stratum and/or a glacial till deposit which is underlain by bedrock at depths of 14 to 25 ft. below the existing ground level.

cont'd. /7 ...

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.2) Structure Foundations:

Subsoil conditions are such that spread footing support may not be achieved at a relatively shallow depth. It is therefore recommended that the entire structure for either scheme be supported on end-bearing piles driven to bedrock. In view of the presence of the very dense or hard glacial till stratum above the bedrock in certain locations, however, the piles may not reach the bedrock surface. In any case, the discrepancy in the pile lengths may not be greater than about 5 ft. The carrying capacity of the piles will depend on the section chosen; for example, a 14 BP 73 steel H-pile could be designed for a safe load of 90 tons/pile. Pile caps should be provided with adequate soil cover for frost protection.

In view of the relatively impermeable nature of the subsoil, no major dewatering problems are anticipated for the construction of the foundations.

6.3) Approach Embankments:

No major stability problems are anticipated for approach fills constructed with standard 2:1 side slopes. Settlement of the approach embankments, due to the consolidation of the silty clay stratum, will be negligible.

7. MISCELLANEOUS:

The field work, performed during the period April 13 - May 10, 1968, was undertaken by Mr. V. Korlu and Mr. P. B. Schnabel, Project Foundation Engineers. Equipment used was owned and operated by Dominion Soil Investigation Limited.

This report was prepared by Mr. C. Mirza, Project Foundation Engineer. The investigation was carried out under the general supervision of Mr. M. Devata, Supervising Foundation Engineer.

July, 1968.

APPENDIX I

DEPARTMENT OF HIGHWAYS - ONTARIO						RECORD OF BOREHOLE NO. 1				FOUNDATION SECTION	
MATERIALS & TESTING DIVISION											
JOB	68-F-31		LOCATION		Sta. 32 + 10 @ Prop. Revn. Townline Rd. o/s 16' Lt.				ORIGINATED BY		VK
W P	167=64-01		BORING DATE		May 1, 1968				COMPILED BY		VK
DATUM	Geodetic		BOREHOLE TYPE		Dynamic Cone Penetration Test				CHECKED BY		
SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT		PLASTIC LIMIT		WATER CONTENT	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	20	40	60	80	100
567.2	Ground Level										
554.7											
12.5	End of Cone Test										

(Note: A hand-drawn profile curve is visible across the middle section of the form, starting from the ground level and extending down to approximately 12.5 feet depth.)

○型少食或不吃蔬菜 ②型 中: 蔬菜摄入量不足 - ③型 吃了蔬菜10

RECORD OF BOREHOLE NO 2

CONCLUSION AND SECTION

MATERIALS & TESTING DIVISION

68-F-31

LOCATION Sta. 32 + 24 @ Prop. Revn. Townline Rd. o/s 18' Rt.

ORIGINATED BY **VL**

W 0 167-64-01

BORING DATE May 1, 1968

FORM NO. 10-67

CM

DAY 4 Geodetic

BOREHOLE TYPE Diamond Drill NX Casing

RECEIVED BY _____

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE	PLASTIC LIMIT	WATER CONTENT	UNIT WEIGHT	REMARKS
S.E.V. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT				
567.5	Ground Level					20 40 60 80 100				
0.0	Silty clay with trace sand & gravel.	1	TW	PM						
	Stiff to very stiff									
560.5	Reddish Brown	2	TW	PM	560					126
7.0	Clayey silt with sand & gravel(glacial till)	3	SS	25						
	occ. sand seams	4	SS	33						
552.5	Very stiff to hard.									
15.0	with Boulders	5	AXT	5%	550					
547.5				RC Rec						
20.0	Interbedded shale & dolomite bedrock with	6	AXT	100%						
543.0	gypsum inclusions.			RC Rec						
24.5	End of Borehole				540					

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RECORD OF BOREHOLE NO 3

FOUNDER ON SECTION

MATERIALS & TESTING DIVISION

68-F-31

LOCATION Sta. 31 + 78 @ Prop. Revn. Townline Rd. o/s 16' Lt.

ORIGINATED BY VR

W 2 167-64-01

BORING DATE May 2, 1968

Supplied by CM

DAYUM Geodetic

BOREHOLE TYPE Diamond Drill - NX Casing

CHECKED BY _____

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	PLASTIC LIMIT WATER CONTENT	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE				
506.9	Ground Level				20 40 60 80 100		
0.0	Silty clay with trace sand & gravel. occ. gypsum pockets. Stiff to very stiff.	1	SS	16			
559.9	Reddish Brown	2	TW	P	560		128
7.0	Clayey silt with some sand & gravel (gl. till)	3	SS	24			
	Very stiff to hard.	4	SS	100/5"			
		5	SS	187	550		
546.9	20.0 Dolomite bedrock with gypsum inclusions.	6	AXT RC	100% Rec			
541.0	End of Borehole				540		

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO 4

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 68-7-31

LOCATION Sta. 31+08 @ Prop. Revn. Townline Rd. o/s 16' Lt.

ORIGINATED BY V PBS

W P 167-64-01

BORING DATE April 15, 1968

COMPILED BY TC

DATUM Geodetic (raft)

BOREHOLE TYPE Diamond Drill BX Casing

CHECKED BY

SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT		REMARKS
ELEV	DEPTH	NUMBER	TYPE	BLOWS / FT	ELEV SCALE	BLOWS / FOOT	20	40	60	80	100	
561.3	Water Level											
0.0					560							
557.3	Creek Bottom											
4.0	Clayey silt with sand and gravel (glacial till)	1	SS	41								
	Very stiff to hard.	2	SS	21	550							
	Reddish Brown to Grey	3	SS	60								
544.9		4	SS	107/104"								
16.5	Interbedded shale & dolomite bedrock. Occ. seams of gypsum.	5	RC	30% Rec	540							
536.8		6	RC	74% Rec								
24.5	End of Borehole											
					530							

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 5

FOUNDATION SECTION

JOB 68-F-31

LOCATION Sta. 31+30 Ø Prop. Revn. Townline Rd.

ORIGINATED BY WK

W.P. 167-64-01

BORING DATE May 31, 1968

COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE Diamond Drill NX Casing

CHECKED BY

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — % PLASTIC LIMIT — % WATER CONTENT — %		SOLIDS GRAVITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		20	40	60	80	100	W.P.	W.L.		
572.5	Ground Level													
0.0	Silty clay to clay with organic inclusions Stiff.		1	SS	13									5.5% org.
565.0	(Fill Material)		2	SS	14									
7.5	Silty clay with trace sand, occ. gravel. Very stiff		3	2"TW	PM								128	
557.5	Reddish Brown		4	2"TW	PM								124	
15.0	Clayey silt with some sand & gravel (Glacial Till) occ. boulders		5	SS	68									
			6	SS	177/11"									
			7	SS	176									
547.1	Hard		8	SS	100/4"									
545.2	Interbedded shale & dolomite bedrock		9	AYM BC	502 Rsc									
27.3	End of Borehole													

15 — 5 % Strain at failure

10

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO 6

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 68-P-31

LOCATION Sta. 31+54 @ Prop Revn. Townline Rd. o/s 18' Rt.

ORIGINATED BY VK

W P 167-64-01

BORING DATE May 3, 1968

SAMPLED BY CM

DATUM Geodetic

BOREHOLE TYPE Diamond Drill - NX Casing

CHECKED BY

SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE					PLASTIC LIMIT			REMARKS
ELEV	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV SCALE	20	40	60	80	100	WATER CONTENT %	
573.5	Ground Level						500	1000	1500	2000	2500	15 30 45	
0.0	Silty clay to clay with organic inclusions (Fill Material)		1	SS	14	570							1.1% org.
566.0	Stiff		2	SS	16								
7.5	Silty clay with trace sand & gravel. Very stiff.		3	TW	P								
			4	TW	P								
558.0	Reddish Brown		5	SS	100/4"	560							132
15.5	Clayey silt with sand & gravel (Glacial Till) occ. gypsum pockets.		6	SS	128								125
	Hard or Very dense.					550							
547.5			7	SS	178								
26.0	Interbedded shale & dolomite bedrock with gypsum inclusions.		8	AXT 100% RC Rec									
542.5													
31.0	End of Borehole					540							

0
15 5 % Strain at failure
10

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫ ⑬ ⑭ ⑮ ⑯ ⑰ ⑱ ⑲ ⑳ ㉑ ㉒ ㉓ ㉔ ㉕ ㉖ ㉗ ㉘ ㉙ ㉚ ㉛ ㉜ ㉝ ㉞ ㉟ ㊱ ㊲ ㊳ ㊴ ㊵ ㊶ ㊷ ㊸ ㊹ ㊺ ㊻ ㊼ ㊽ ㊾ ㊿

RECORD OF BOREHOLE NO 8

CONCLUSION SECTION

MATERIALS & TESTING DIVISION

100 69-3-21

LOCATION Sta. 30+00 @ Prop. Revm. Towline Rd.

ORIGINATED BY VK

167-6

REPORTING DATE May 6, 1968

DATE _____

Geodetic

BOREHOLE TYPE Diamond Drill - NX Casing

SECRET 80

SOIL PROFILE		SAMPLES		ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	SHEAR STRENGTH PSF + Field Vane ○ Unconfined x Lab Vane	WATER CONTENT % PLASTIC LIMIT % FLUIDITY INDEX	REMARKS
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE					
575.7	Ground Level							
0.0	Silty clay with organic inclusions. Firm to stiff.	1	SS	15				
		2	SS	5				
		3	SS	6				
	(Fill material)	4	SS	7				
		5	TW	P				
558.2								
17.5	Clayey silt with sand & gravel. (Glacial Fill)	6	SS	19				
		7	SS	100				
549.7	Very stiff to hard.							
26.0	Intertbedded shale & dolomite bedrock with	8	AXT	100				
544.7	gypsiferous seams.		RC	Rec.				
31.0	End of Borehole							

已讀即為我下地發現了 沙中 其 應以解脫下地 這就了凡得！

RECORD OF BOREHOLE NO 10

CONCLUSION

MATERIALS & TESTING DIVISION

JOB 68-F-31

LOCATION Sta. 28+48 Prop. Rev. Townline Rd. o/s 16' Lt.

ORIGINATED BY UK

W F 167-4-01

BORING DATE May 8, 1968

COMPLTD BY VK

DATA* Geodetic

BORE HOLE TYPE Diamond Drill - NY Casing

CHECKED BY

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100	WATER CONTENT % 15 30 45	REMARKS
ELEV. DEPTH.	DESCRIPTION	NUMBER	TYPE				
572.3	Ground Level						
0.0	Silty clay with organic inclusions. Very stiff.	1	SS	10			
565.8	(Fill material)	2	SS	29			
6.5	Clayey silt with sand & gravel. (Glacial Till)	3	SS	29			
	Hard.	4	SS	37			
553.3		5	SS	100/5"			
19.0	Interbedded shale & dolomite bedrock with gypsum inclusions.	6	AXT RC	100% Rev.			
549.8							
22.5	End of Borehole						

RECORD OF BOREHOLE NO 11

① 如何求出了这个数？ ② 为什么这个数是这个数？ ③ 为什么这个数是这个数？

MATERIALS & TESTING DIVISION

104 68-F-31

LOCATION Sta. 28+70 @ Prop. Rev. Townline Rd.

74 59 18 10 2

167-64-01

BORING DATE May 10, 1968

[illegible]

DATUM Geodetic

BOREHOLE TYPE Diamond Drill NX Casing

1982-1983

SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT						PLASTICITY INDEX		REMARKS						
ELEV. DEPTH	DESCRIPTION	STRAT. PLCT.	NUMBER	TYPE	BLOWS / FOOT	FEEV SCALE	20	40	60	80	100	WATER CONTENT %	Gr. Sa. Si. Cl.					
571.0	Ground Level						SHEAR STRENGTH P.S.F. ○ Unconfined ○ 5 % Strain at failure 500 1000 1500 2000 2500						15 30 45					
0.0	Silty clay with organic inclusions. Very stiff.	X	1	TW	P	570												
563.8	(Fill material)		2	TW	F													112
8.0	Clayey silt with sand & gravel. (Glacial Till)		3	SS	19	560												12 32 42 14
	Very stiff to hard.		4	SS	25													
553.3			5	SS	100/5"													
18.5	End of borehole (Refusal) Probably Bedrock					550												

FOUNDATION SECTION

ORIGINATED BY VK

COMPILED BY _____ VK

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT ——— % PLASTIC LIMIT ——— % WATER CONTENT ——— %	BULK DENSITY P C F	REMARKS
ELEV DEPT +	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT		20 40 60 80 100	SHEAR STRENGTH P S F x Lab Vane o Unconfined 500 1000 1500 2000 2500		
571.6	Ground Level									
0.0	Silty clay with trace of sand & organics. Firm to very stiff.	X	1	TW	P	570	x s=1 b			119
564.1	(Fill material)	X	2	SS	24					
7.5	Clayey silt with some sand & gravel. (Glacial till) Very stiff to hard.	o	3	SS	22					
		o	4	SS	91	560				
		o	5	SS	44					
553.1		o	6	AXT	60%	550				
18.5	Bolomite Bedrock with gypsiferous seams.	o		RC	Rec					
548.1										
23.5	End of Borehole						0 15 — o — 5 % strain at failure 10			

DEPARTMENT OF HIGHWAYS - ONTARIO		RECORD OF BOREHOLE NO. 13		FOUNDATION SECTION	
MATERIALS & TESTING DIVISION					
JOB	68-F-31	LOCATION	Sta. 27+78 1/2 Prop.Rev.Townline Rd. o/s 16' Lt.	ORIGINATED BY	PBS
W.P.	167-64-01	BORING DATE	April 13, 1968	COMPILED BY	CM
DATUM	Geodetic	BOREHOLE TYPE	Diamond Drill - NX Casing	CHECKED BY	

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— % PLASTIC LIMIT ——— % WATER CONTENT ——— %			BULK DENSITY pcf	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT											
							20	40	60	80	100					
567.6	Ground Level					x Lab Vane					WATER CONTENT % 15 30 45					
0.0	Silty clay with trace of sand. Stiff.															
562.1	Reddish Brown.		1	2"TW	PM	x s = 4									565. ▼	
5.5	Clayey silt with some sand & gravel. (Glacial till)		2	SS	30											
	Occ. boulders.		3	SS	101											
554.1	Hard.		4	RC	85% rec.											
13.5	Interbedded shale & dolomite bedrock with gypsum inclusions.		5	RC	70% Rec											
549.1																
18.5	End of Borehole															

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO 14

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 68-F-31

LOCATION Sta. 28+00 @ Prop. Rev. Townline Rd.

ORIGINATED BY PBS

W P 167-64-01

BORING DATE April 13, 1968

COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE Diamond Drill - NX Casing

CHECKED BY

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

108 68-F-31

W P 167-61-01

DATUM Geodetic

RECORD OF BOREHOLE NO. 15

LOCATION Sta. 28+24 @ Prop. Rev. Townline Rd. o/s 18' Rt.

BORING DATE May 10, 1968

BOREHOLE TYPE Diamond Drill NX Casing

FOUNDATION SECTION

ORIGINATED BY VK

COMPILED BY CM

CHECKED BY

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 16

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 68-F-31

LOCATION Sta. 27+93 @ Prop. Rev. Townline o/s 18¹ Rt.

ORIGINATED BY VK

W P 167-64-01

BORING DATE April 14, 1968

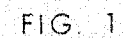
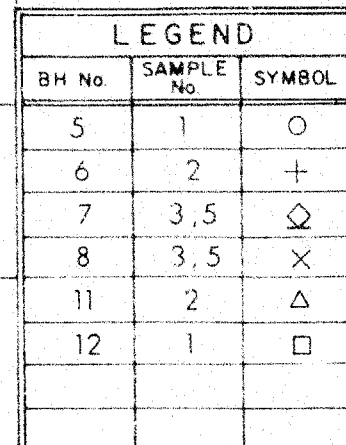
COMPILED BY VK

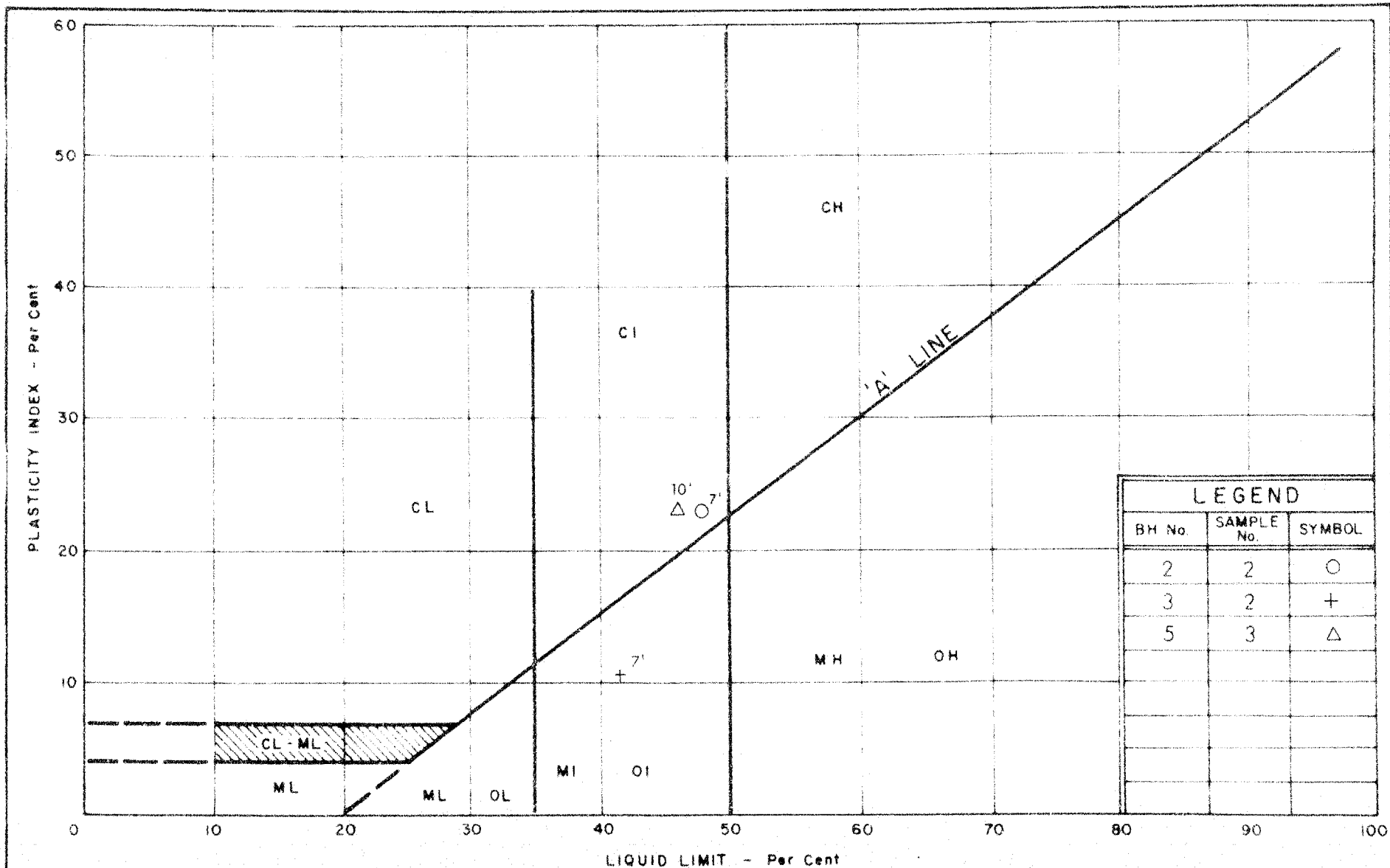
DATUM Geodetic

BOREHOLE TYPE Dynamic Cone Penetration Test

CHECKED BY [Signature]

SOIL PROFILE		SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT — w_L		BULK DENSITY	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		BLOWS / FOOT	PLASTIC LIMIT — w_p	WATER CONTENT — w		
571.4	Ground Level					20 40 60 80 100				
560.4					570					
11.0	End of Cone Test				560					





LEGEND		
BH No.	SAMPLE No.	SYMBOL
2	2	○
3	2	+
5	3	△



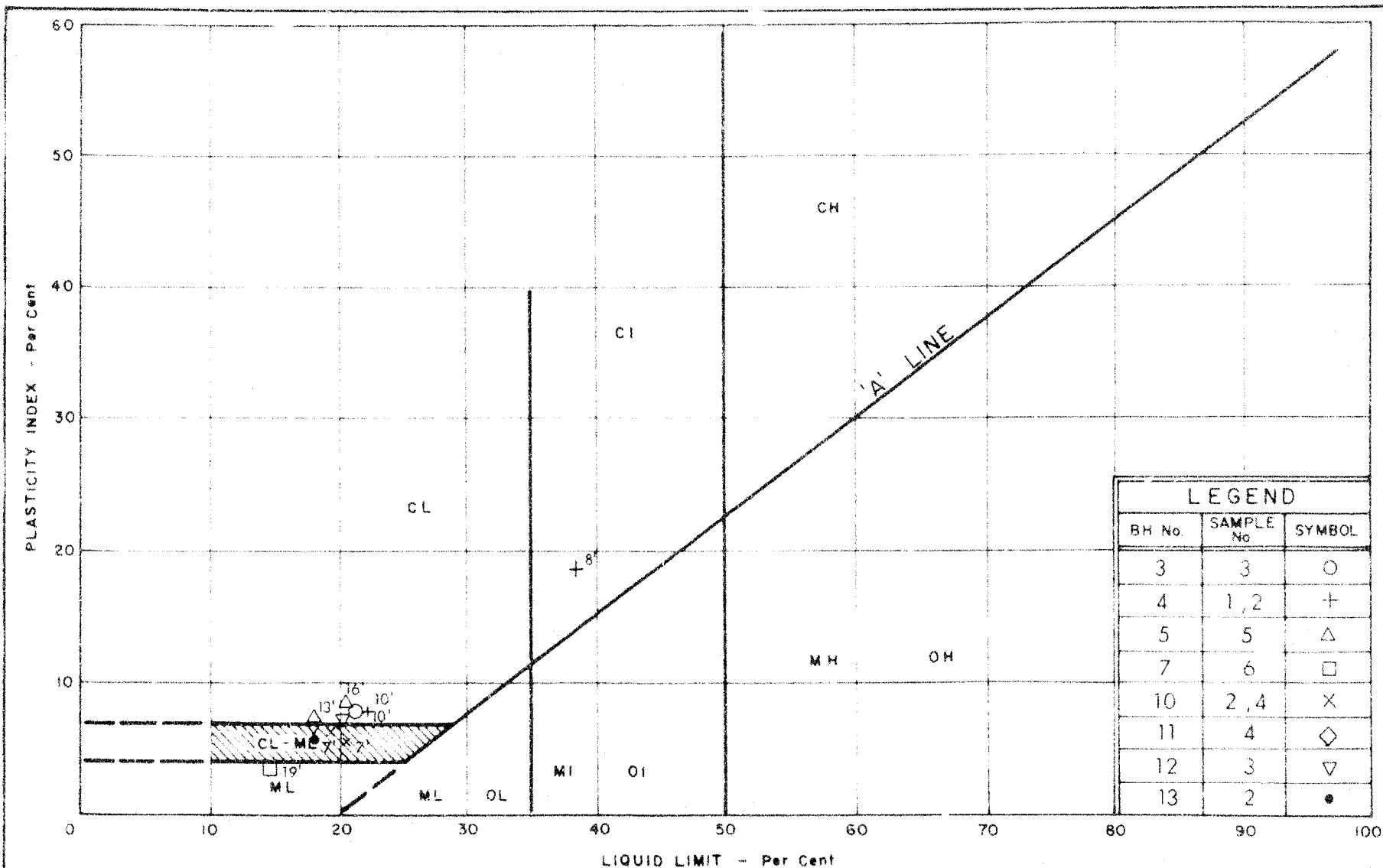
DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

PLASTICITY CHART SILTY CLAY

W.P. No. 167-64-01

JOB No. 68-F-31

FIG. 2



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

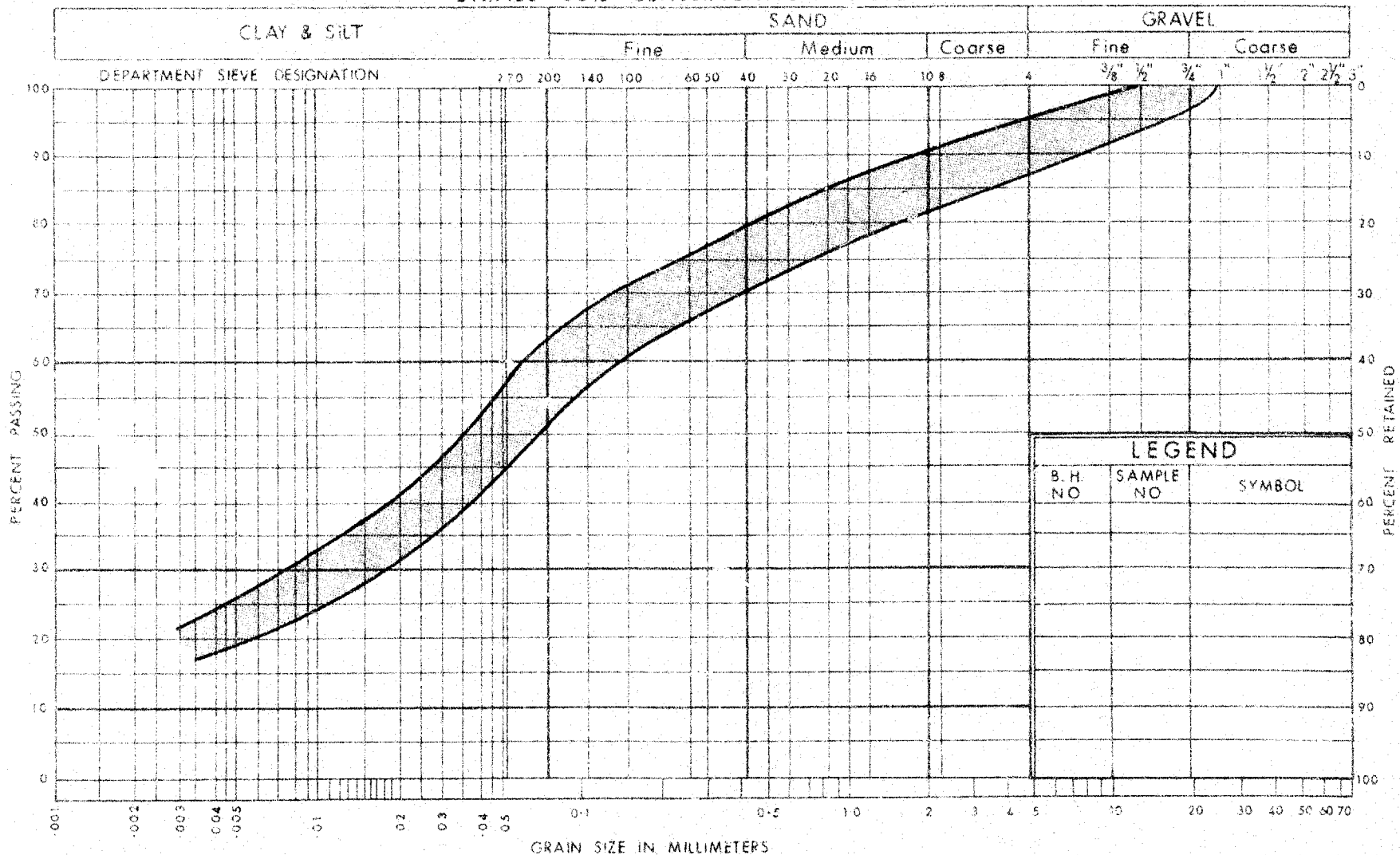
PLASTICITY CHART GLACIAL TILL

WP No. 167-64-01

JOB No. 68-F-31

FIG. 3

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
B. H. NO.	SAMPLE NO.	SYMBOL



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

GRAIN SIZE DISTRIBUTION
GLACIAL TILL

W.P. No. 167-64-01
JOB No. 68-F-31
FIG. 4

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S	SPLIT SPOON	T.W	THINWALL OPEN
W.S	WASHED SAMPLE	T.P	THINWALL PISTON
S.B	SCRAPER BUCKET SAMPLE	O.S	OESTERBERG SAMPLE
A.S	AUGER SAMPLE	F.S	FOIL SAMPLE
C.S	CHUNK SAMPLE	R.C	ROCK CORE
S.T	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Q _u	UNCONFINED COMPRESSION	L.V	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V	FIELD VANE
Q _{cu}	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q _d	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
C_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{C_v t}{d^2}$ (d DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_i	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ or $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ or $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

MEMORANDUM

ALS

Mr. D. A. Barr,
Scheduling and Systems Engineer,
Program Office,
Admin. Bldg.

FROM: Foundation Section,
Materials & Testing Office,
Room 107, Lab. Bldg.

ATTENTION:

DATE: March 12, 1971

OUR FILE REF.

IN REPLY TO

SUBJECT:

Re: Preloading of Approaches --
W.P. 167-64-01, 03, W.P. 446-65
W.P. 447-65 and W.P. 165-64
District #4 (Hamilton), Q.E.W.

68-F-31

Further to the request of Mr. R. Fitzgibbon with regard to preloading of approach embankments of the above mentioned projects, we have reviewed our Foundation Reports and submit the following comments:

1. Underpass Structure - Townline Road (W.P. 167-64-01):

- No preloading of fills required.

2. Underpass Structure - Service Road (W.P. 167-64-03):

- No preloading of fills required.

- All organic material, located within the plan limits of the approaches, should be completely sub-excavated. The sub-excavation so formed, should be backfilled with non-cohesive material.

3. Overpass Structure - Black Creek (an old Townline Rd.) - (W.P. 446-65):

- No preloading of fills required.

4. Underpass Structure - Ridgemount Rd. (W.P. 165-64):

- No preloading of fills required. It would be beneficial, however, to have the fills placed as early as possible, prior to construction of the spread footing foundations, in order to reduce post-construction settlements.

Mr. D. A. Barr,
Scheduling and Systems Engineer,
Program Office,
Admin. Bldg.

2

March 12, 1971

Re: Preloading of Approaches --
W.P. 167-64-01,03, W.P. 446-65
W.P. 447-65 and W.P. 165-64
District #4 (Hamilton), Q.E.W.

.....

5. Underpass Structure - Sunset Drive (W.P. 447-65):

- No preloading of fills required.

MD/MdeF

M. Devata
M. Devata
SUPERVISING FOUNDATION ENGR.
For:
A. G. Stermac
PRINCIPAL FOUNDATION ENGR.

cc: Messrs. G. K. Hunter (2)
S. McCombie
C. S. Grebski
G. C. E. Burkhardt (2)
R. Fitzgibbon

Foundations Files
Gen. Files

Department of Highways Ontario

Copy for the information of

FOUNDATION OFFICE

Mr. A. Stermac
Principal Foundation Engineer
Room 107, Central Building

C.S. Grebski
Structural Design Engineer
Structural Office - West Bldg.

July 7, 1972

Townline Road Underpass
(over the O.P.W.)
W.P. 167-64-01 Site 34-221
District 4

Attached herewith we are submitting the final bridge drawings which show the foundation design for this structure.

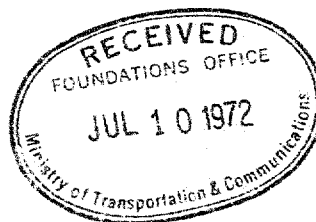
Kindly give us your comments at your earliest convenience.

CSG/hvh
Encls.

C.S. Grebski
Structural Design Engineer

cc Foundation Office

Comments As per letter dated July 25/72
JN Devata



Mr. C. S. Grebski,
Structural Design Engineer,
Structural Office,
West Bldg., Downsview.

Foundations Office,
Design Services Branch,
West Bldg., Downsview.

July 25, 1972.

Townline Road Underpass (Over the Q.E.W.)
W.P. 167-64-01 Site 34-221
District #4 (Hamilton)

68-F-31

We have reviewed the final Bridge Drawings No. 34-221-1 and 34-221-3 and submit the following comments.

The pile lengths for the abutments and piers should be reduced as follows:

East abutment	-	Reduced from 62 to 42
West Abutment	-	Reduced from 62 to 42
Pier 'A'	-	Reduced from 43 to 24
Pier 'B'	-	Reduced from 43 to 23
Pier 'C'	-	Reduced from 43 to 16

Shaheen Ahmad

Shaheen A. Ahmad,
Project Foundations Engineer,
M. Devata,
Supervising Foundations Engineer.

SAA/ao

For:

cc: Foundations Files ✓
Documents

CHECKING PILE LENGTHS.

WEST. ABUTMENT
EAST ABUTMENT.

(worse condition 1:4 batter)

$$\frac{4}{\sqrt{17}} \times 62 = 60 \text{ feet vertical projection}$$

$$\begin{array}{r} 536.25 \\ 60.00 \\ \hline 526.25 \end{array}$$

$$\frac{8}{\sqrt{65}} \times 61 = 60.5 \text{ feet vertical projection}$$

TIP ELEV. 526.25. \therefore THIS IS TOO LONG

REDUCE PILE LENGTH TO 42 FEET.

EAST PIER
CENTRE PIER
WEST PIER

(worse case 1:6 batter.)

$$\frac{6}{\sqrt{37}} \times 43 = 42.5$$



No batter. 42 =

Cut - 41 elevation
Vertical projection
Tip elevation

Pier A & C	Pier B
568.25	571.25
42.00	42.00
<u>526.25</u>	<u>529.25</u>

$$\begin{array}{r} 549 \\ 529 \\ \hline 20 \text{ feet.} \\ \text{Pier B.} \end{array}$$

$$\begin{array}{r} 553 \\ 526 \\ \hline 27 \text{ feet.} \\ \text{Pier 'C'}$$

$$\begin{array}{r} 545 \\ 526 \\ \hline 19 \text{ feet. Pier 'A'}$$

FOUNDATION INVESTIGATION REPORT

For

Townline Road Underpass Over Q.E.W.
Town of Fort Erie
Regional Municipality of Niagara Falls
Q.E.W., District 4, Hamilton
W.P. 167-64-01

INTRODUCTION

This report contains the results of a foundation investigation which was carried out at the site of the above mentioned project. The fieldwork was done during the period April 13 - May 10, 1968, utilizing a conventional diamond drill adapted for soil sampling purposes. Borings were cased with NX size (3-inch I.D.) casing and holes were advanced using washboring techniques. Bedrock was proved by obtaining AXT size (1 9/32 inch dia.) rock core samples.

SITE DESCRIPTION

The site is located just south of the north boundary of the Town of Fort Erie on the Q.E.W. in the immediate vicinity of the existing Q.E.W. in the immediate vicinity of the existing Q.E.W. and Black Creek crossing. At this location the Q.E.W. is a 4 lane paved highway with associated median and gravel shoulders. The existing crossing of the Q.E.W. over Black Creek consists of twin 60 foot span concrete structures supported on concrete piers and separated along the median by standard concrete railing enclosures. Black Creek is a shallow meandering stream, the depth of water being of the order of 4 feet. The stream banks are some 10 feet in height where the Q.E.W. crosses Black Creek. The surrounding ground is generally flat-lying with isolated areas of scrub bush growth.

Physiographically the area is situated in the "Haldimand Clay Plain" region where lacustrine clay deposits overlie a glacial till stratum which in turn is underlain by shales and dolomites of the Salina formation.

SUBSURFACE CONDITIONSGeneral

Reference should be made to the Record of Borehole Sheets which are contained in the Appendix and to Drawing #34-221-2 of the Contract Drawings.

The subsoil at the site consists of a clayey fill some 6 to 17 feet in thickness which is underlain by a silty clay deposit and/or a glacial till deposit overlying shale and dolomite bedrock. Bedrock is encountered between elevations 547 and 554, some 14 to 25 feet below ground surface.

From ground surface downwards the different strata are described in some detail as follows.

Silty Clay to Clay (Fill Material)

A deposit of silty clay to clay fill material was encountered at Boreholes 5 to 12 inclusive to depths ranging from 6 to 17 feet. The deposit contained numerous organic inclusions. Physical properties of the deposit as determined in the field and laboratory are as follows.

	<u>Range</u>
Natural Moisture Content (W) - %	28 - 43
Liquid Limit (W_L) - %	51 - 55
Plastic Limit (W_P) - %	26 - 34
Bulk Density (γ) - p.c.f.	112 - 120
Organic Matter Content - %	5 - 7
Undrained Shear Strength (C_u) - p.s.f.	340 - 1360
Standard Penetration - Resistance 'N' Values - Blows/Ft.	5 - 24

The physical properties were found to vary at random throughout the deposit. Based on the C_u and 'N' values, the deposit is considered to be of firm to very stiff consistency.

Silty Clay

A stratum of reddish-brown silty clay with a trace of sand and occasional gravel was encountered below the fill material at Boreholes 5 and 6, as well as beneath a surficial cover of topsoil at Boreholes 2, 3, 13, 14 and 15. The stratum varied in thickness between 5 and 8 feet. Occasional mottling indicates that the deposit has been desiccated.

The physical properties of the deposit are as follows.

	<u>Range</u>
Natural Moisture Content (W) - %	23 - 28
Liquid Limit (W_L) - %	41 - 47
Plastic Limit (W_p) - %	23 - 31
Bulk Density (γ) - p.c.f.	126 - 132
Undrained Shear Strength (C_u) - p.s.f.	
- Boreholes 5, 6, 13 & 14	2400 (avge.)
- Boreholes 2 & 3	1500 (avge.)

On the basis of these tests, the consistency of the stratum ranges from stiff to very stiff.

Clayey Silt With Sand and Gravel (Glacial Till)

A deposit of clayey silt with sand and gravel (glacial till) was encountered at all borehole locations, between elevations 565 and 558. The deposit varied in thickness from about 6 feet at Borehole 7 to 13 feet at Borehole 3. The glacial till was found to be underlain by an interbedded shale and dolomite bedrock, the upper weathered portions of which have been incorporated into the basal portion of the deposit as a result of glaciation. The lower portions of the deposit, therefore, contain boulders and occasionally lenses of sand and gravel. Occasional gypsum inclusions were observed within the upper portions of the deposit.

The physical properties of the stratum are listed below.

	<u>Range</u>
Natural Moisture Content (W) - %	7 - 13
Liquid Limit (W_L) - %	15 - 21
Plastic Limit (W_p) - %	11 - 14
Standard Penetration	
Resistance 'N' Values - Blows/Ft.	
- Upper Portions	7 - 30
- Lower Portions	>100

Grain size distribution curves are shown on Figure 4 in the Appendix. The 'N' values indicate a stiff to very stiff consistency generally, for the upper portions of the deposit, and a hard consistency or very dense relative density for the lower portions.

Bedrock

Bedrock was drilled in AXT size in all boreholes except Boreholes 1, 11, 14 and 16. Examination of cores recovered during the investigation reveals the bedrock to consist of interbedded shale and dolomite. The shale interbeds were found to be separated by seams of gypsum up to 18 inches in thickness. The dolomitic portions of the cores contained numerous gypsum inclusions.

At the west end of the site bedrock was encountered at about elevation 547, whereas at the east end of the site the bedrock was encountered at about elevation 553, indicating that the bedrock surface is sloping upwards towards the east. Core recoveries were generally 100%, indicating the bedrock to be sound.

Groundwater

Observations of the groundwater level were made in the open boreholes upon completion of the fieldwork. These observations indicate a groundwater level at about elevation 566, that is, some 1 to 10 feet below the existing ground surface, depending on the location of the borehole. These observations also indicate that the groundwater level is generally 4 to 5 feet higher than the water level in Clack Creek.

K. G. Selby

K.G. Selby, P. Eng.
Supervising Engineer

KGS/gs
March, 1977

APPENDIX

RECORD OF BOREHOLE NO 1

SCHL PROFILE		SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT	LIQUID LIMIT ———— w_L	UNIT WEIGHT γ	REMARKS		
FLEV DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE		'N' VALUES	20 40 60 80 100			PLASTIC LIMIT ———— w_p	
							SHEAR STRENGTH			WATER CONTENT ———— w	
							\circ UNCONFINED + FIELD VANE			\bullet QUICK TRIAXIAL x LAB VANE	w_p ———— w ———— w_L
							WATER CONTENT %	% OR SA SI CI			
567.2	Ground Level										
0.0											
554.7											
12.5	End of Cone Test										

20
15 ϕ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2

WP 167-64-01 LOCATION Sta. 32 + 24 f Prop. Ravn. Townline Rd. o/s 18' Rt. ORIGINATED BY VK
 DIST 4 HWY QEW BORING DATE May 1, 1968 COMPILED BY CM
 DATUM Geodetic BOREHOLE TYPE Diamond Drill NX Casing & Cone Test CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT		LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W		UNIT WEIGHT γ PCF	REMARKS % OR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100	20 40 60	20 40 60			
567.5	Ground Level											
0.0	Silty clay with trace sand & gravel. Stiff to very stiff		1	TW	FM						126	
560.5	Reddish Brown		2	TW	FM						126	
7.0	Clayey silt with sand & gravel (glacial till) occ. sand seams		3	SS	25							
552.5	Very stiff to hard.		4	SS	33							
15.0	With boulders		5	AXT	5% RC Rec							
547.5			6	AXT	100% RC Rec							
20.0	Interbedded shale & dolomite bedrock with gypsum inclusions.											
543.0												
24.5	End of Borehole											

20
15 ϕ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3

WP 167-64-01

LOCATION Sta. 31 + 78 & Prop. Revn. Townline Rd. o/s 16' Lt.

ORIGINATED BY VK

DIST 4 HWY QEW

BORING DATE May 2, 1968

COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE Diamond Drill NX Casing & Cone Test

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L WATER CONTENT % 20 40 60			UNIT WEIGHT γ PCF	REMARKS % OR SA SI CI
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100					
							SHEAR STRENGTH PSF									
							O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE									
566.9	Ground Level					400	800	1200	1600	2000	20	40	60	128		
0.0	Silty clay with trace sand & gravel. occ. gypsum pockets. Stiff to very stiff. Reddish Brown		1	SS	16	560										
559.9			2	TW	P											
7.0	Clayey silt with some sand & gravel (glacial till) Very stiff to hard.		3	SS	24	5"										
			4	SS	100	550										
			5	SS	187											
546.0																
20.0	Dolomite bedrock with gypsum inclusions.		6	AXT	100% RC Rec											
541.9																
25.0	End of Borehole					540										

20
15 ϕ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4

WP 167-54-01 LOCATION Sta. 31 + 08 & Prop. Revn. Townline Rd. o/s 16' Lt. ORIGINATED BY V. PHS
 DIST 4 HWY QEW BORING DATE April 15, 1968 COMPILED BY TC
 DATUM Geodetic (raft) BOREHOLE TYPE Diamond Drill EX Casing & Cone Test CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
561.3	Water Level															GR SA SI CL
0.0						560										
557.3	Creek Bottom															
4.0	Clayey silt with sand and gravel (glacial till) Very stiff to hard.		1	SS	41							0				
			2	SS	21	550						0				
	Reddish Brown to Grey		3	SS	60							0				21 40 (39)
544.8			4	SS	107	10 1/2'										
16.5	Interbedded shale & dolomite bedrock. Occ. seams of gypsum		5	RC	30% Rec	540										
536.8			6	RC	74% Rec											
24.5	End of Borehole					530										

20
15 \pm 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 5

V.P. 167-64-01

LOCATION, Sta. 31 + 30 & Prop. Revn. Townline Rd.

ORIGINATED BY VE

DIST. 4 HWY QEW

BORING DATE May 31, 1968

COMPILED BY CI

DATUM Geodetic

BOREHOLE TYPE Diamond Drill NX Casing & Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE (POUND)					LIQUID LIMIT			UNIT WEIGHT γ	REMARKS
FLV	DEPTH	DESCRIPTION	NUMBER	TYPE	N' VALUES		20	40	60	80	100	W _p	PLASTIC LIMIT	W _p		
572.5		Ground Level														
0.0		Silty clay to clay with organic inclusions	1	SS	13	570										5.57 org.
565.0		Silt (Fill Material)	2	SS	14											
7.5		Silty clay with trace sand, occ. gravel. Very stiff	3	TW	PM											
557.5		Reddish Brown	4	TW	PM											
10.0		Clayey silt with some sand & gravel (Glacial Till) occ. boulders	5	SS	68											
547.1		Hard	6	SS	177	550										
22.5		Intertedded shale & dolomite bedrock	7	SS	176											
545.2			8	SS	100											
27.3		End of Borehole	9	RC	Rec	540										

20
15 0-5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 6

WP 167-64-01

LOCATION 31 + 54 & Prop Revn. Townline Rd. o/s 18' Rt.

ORIGINATED BY VK

DIST 4 HWY OEW

BORING DATE May 3, 1968

COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE Diamond Drill NX Casing & Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ PCF	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
573.5	Ground Level															
0.0	Silty clay to clay with organic inclusions (Fill Material) Stiff		1	SS	14	570										1.17 org.
566.0			2	SS	16											
7.5	Silty clay with trace sand & gravel. Very stiff. Reddish Brown		3	TW	P											
558.0			4	TW	P	560										
15.5	Clayey silt with sand & gravel (Glacial Till) occ. gypsum pockets. Hard or very dense.		5	SS	100/	4"										
547.5			6	SS	128	550										
26.0	Interbedded shale & dolomite bedrock with gypsum inclusions.		7	SS	178											
542.5			8	AXT	100% RC Rec											
31.0	End of Borehole Water Level not established					540										

20
15 ϕ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 7

WP 167-64-01 LOCATION Sta. 25 + 78 & Prop. Revn. Townline Rd. o/s 16' Lt. ORIGINATED BY VK
 DIST 4 HWY QEW BORING DATE May 7, 1968 COMPILED BY VK
 DATUM Geodetic BOREHOLE TYPE Diamond Drill NX Casing & Cone Test CHECKED BY 25

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT PLASTIC LIMIT WATER CONTENT			UNIT WEIGHT γ	REMARKS
			NUMBER	TYPE	N VALUES		20	40	60	80	100	w_p	w	w_L		
575.2	Ground Level						SHEAR STRENGTH PSF					WATER CONTENT %			PCF	%
							O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE					20 40 60				
							400	800	1200	1600	2000					
0.0	Silty clay to clay with organic inclusions. Firm to stiff. (Fill Material)		1	SS	12	570									120	
			2	TW	P										115	
			3	TW	P										116	
			4	TW	P										113	
558.2			5	TW	P	560										
17.0	Clayey silt with sand & gravel (Glacial Till). Very stiff to hard.		6	SS	18											11 37 39 13
551.9			7	SS	100/L"											
23.3	Interbedded shale & dolomite bedrock with gypsiferous seams.		8	AXT RC	100% Rec	550										
548.2																
27.0	End of Borehole															
						540										

20
15-5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 6

WP 167-64-01 LOCATION Sta. 30 + 00 & Prop. Revn. Townline Rd. ORIGINATED BY VK
 DIST 4 HWY QEW BORING DATE May 6, 1968 COMPILED BY CM
 DATUM Geodetic BOREHOLE TYPE Diamond Drill NX Casing & Cone Test CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ PCF	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
575.7	Ground Level															
0.0	Silty clay with organic inclusions. Firm to stiff. (Fill Material)		1	SS	1.1	570										6.3" exp.
			2	SS	5											
			3	SS	6											
			4	SS	7											
558.2			5	TW	P	560									97	
17.5	Clayey silt with sand & gravel. (Glacial Till)		6	SS	10											
549.7	Very stiff to hard.		7	SS	100	4"										
26.0	Interbedded shale & dolomite bedrock with gypsiferous seams.		8	AXT	100%											
544.7				RC	Rec											
31.0	End of Borehole Water Level not established															

20
15 ϕ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 10

WP 167-64-01

LOCATION Sta. 28 + 48 Prop. Rev. Townline Rd. o/s 16' Lt.

ORIGINATED BY: VK

DIST 4 HWY QEW

BORING DATE May 8, 1968

COMPILED BY: VK

DATUM Geodetic

BOREHOLE TYPE Diamond Drill NX Casing & Cone Test

CHECKED BY: ---

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT --- w_L PLASTIC LIMIT --- w_p WATER CONTENT --- w			UNIT WEIGHT Y	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N VALUES		20	40	60	80	100	w_p	w	w_L		
572.3	Ground Level															
0.0	Silty clay with organic inclusions. Very stiff (Fill material)		1	SS	18	570										
565.8			2	SS	28											
6.5	Clayey silt with sand & gravel. (Glacial Till)		3	SS	29											
	Hard		4	SS	37	560										
553.3			5	SS	100/5"											
19.0	Interbedded shale & dolomite bedrock with gypsum inclusions.		6	AXT RC	100% Rec	550										
549.8																
22.5	End of Borehole															

20
15
10
% STRAIN AT FAILURE

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 11

WP 167-64-01

LOCATION Sta. 28 + 70 & Prop. Rev. Townline Rd.

ORIGINATED BY VK

DIST 4 HWY QEW

BORING DATE May 10, 1968

COMPILED BY VK

DATUM Geodetic

BOREHOLE TYPE Diamond Drill MX Casing & Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ PCF	REMARKS % OR 5A 51 C	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		SHEAR STRENGTH PSF					w_p w w_L					
							O UNCONFINED + FIELD VANE										
							● QUICK TRIAXIAL x LAB VANE										
							WATER CONTENT %										
							400 800 1200 1600 2000					20 40 60					
571.8	Ground Level						570										
0.0	Silty clay with organic inclusions. Very stiff.		1	TW	P										112		
563.8	(Fill material)		2	TW	P												
8.0	Clayey silt with sand & gravel. (Glacial Till)		3	SS	19												
			4	SS	25		560									12 32 42 14	
	Very stiff to hard.																
553.3			5	SS	100/5"												
18.5	End of Borehole (Refusal) Probably Bedrock Water Level not established																

40
15 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 12

WP 167-64-01 LOCATION Sta. 28 + 94 ± Prop. Prov. Townline Rd. o/s 18' Rt. ORIGINATED BY VR
 DIST 4 HWY QEW BORING DATE May 9, 1968 COMPILED BY VR
 DATUM Geodetic BOREHOLE TYPE Diamond Drill EX Casing & Cone Test CHECKED BY *VR*

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT PLASTIC LIMIT			UNIT WEIGHT	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	W _p	W _L	W _U		
571.6	Ground Level						SHEAR STRENGTH PSF					WATER CONTENT %			Y	%
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					20 40 60			PCF	GR. SA. GL. CL
0.0	Silty clay with trace of sand & organics. Firm to very stiff (Fill Material)		1	TV	P	570									119	
564.1			2	SS	24											
7.5	Clayey silt with some sand & gravel. (Glacial Till) Very stiff to hard.		3	SS	22	560										
			4	SS	91											
553.1			5	SS	44											
18.5	Dolomite Bedrock with gypsiferous seams.		6	AXT RC	60% Rec	550										
548.1																
23.5	End of borehole Water Level not established.															

20
 15
 10
 % STRAIN AT FAILURE

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 13

WP. 167-64-01 LOCATION Sta. 27 + 78 & Prop. Hwy. Townline Rd. o/s 16' lt. ORIGINATED BY PMS
 DIST 4 HWY QEN BORING DATE April 13, 1968 COMPILED BY CH
 DATUM Geodetic BOREHOLE TYPE Diamond Drill NX Casing & Cone Test CHECKED BY C

SOIL PROFILE		SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	20	40	60	80	100	w_p	w	w_L		
567.6	Ground Level														
0.0	Silty clay with trace of sand. Stiff. Reddish Brown		1	TH	PM										
562.1			2	SS	30										
5.5	Clayey silt with some sand & gravel. (Glacial Till) Occ. boulders		3	SS	101										
554.1	Hard.		4	RC	855 Rec										
13.5	Interbedded shale & dolomite bedrock with gypsum inclusions.		5	RC	702 Rec										
549.1															
18.5	End of Borehole														

20
15 ϕ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 14

WP 167-64-01 LOCATION Sta. 28 + 00 & Prop. Rev. Townline Rd. ORIGINATED BY PES
 DIST 4 HWY QEW BORING DATE April 13, 1968 COMPILED BY CM
 DATUM Geodetic BOREHOLE TYPE Diamond Drill NX Casing & Cone Test CHECKED BY

SOIL PROFILE			SAMPLES		GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT - w_L PLASTIC LIMIT - w_p WATER CONTENT - w			UNIT WEIGHT γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		20	40	60	80	100	w_p	w	w_L		
567.4	Ground Level				ELEV	400	800	1200	1600	2000	20	40	60		GR SA ST CL
0.0	Silty clay with trace sand. Stiff. Reddish Brown		1	JW 1M											
562.4			2	SS 10	560										
5.0	Clayey silt with sand & gravel. (Glacial Till)		3	SS 100/11"											
	Soft to hard.		4	SS 3											
549.4			4A	ST -	550										
18.0	End of Borehole Refusal. Probably Bedrock. Water Level not established.														

20
15 ϕ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 15

WP 167-64-01

LOCATION Sta. 28 + 24 e Prop. Rev. Townline Rd. o/s 18¹ Rt.

ORIGINATED BY VR

DIST 4 HWY QEW

BORING DATE May 10, 1968

COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE Diamond Drill NX Casing & Cone Test

CHECKED BY *JD*

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT PLASTIC LIMIT WATER CONTENT			UNIT WEIGHT Y	R. MARKS
			NUMBER	TYPE	N' VALUES		20	40	60	80	100	W _p	W _L	W		
567.2	Ground Level															
0.0	Silty clay with trace sand & gravel. Very stiff. Reddish Brown		1	TM	PH											
561.7			2	SS	24	560										
5.5	Clayey silt with sand & gravel. (Glacial Till) Firm to very stiff.		3	SS	7											
			4	SS	0											
550.2						550										
17.0	Interbedded shale & dolomite bedrock with gypsiferous seams		5	AXT RC	100% Rec											
545.2																
22.0	End of Borehole Water Level not established.															

20
15 ϕ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 16

WP 167-64-01

LOCATION Sta. 27 + 93 & Prop. Rev. Townline o/s 18' Rt.

ORIGINATED BY VE

DIST 4 HWY QEW

BORING DATE April 14, 1968

COMPILED BY VR

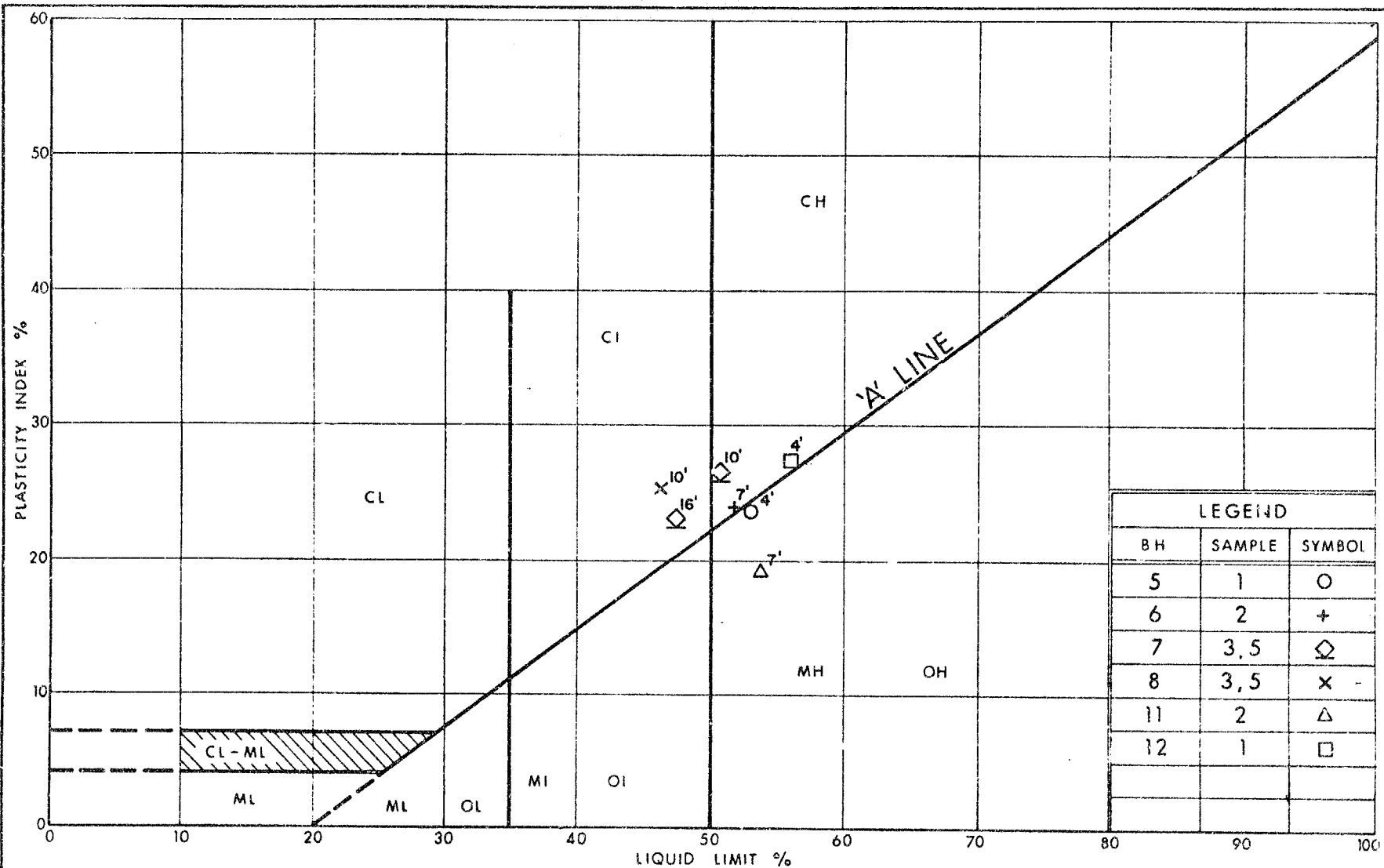
DATUM Geodetic

BOREHOLE TYPE Dynamic Cone Penetration Test

CHECKED BY *VR*

SOIL PROFILE		SAMPLES		GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT - w_L PLASTIC LIMIT - w_p WATER CONTENT - w		UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER		TYPE	'N' VALUES	20	40	60	80	100		
571.4	Ground Level												
560.4													
11.0	End of Cone Test												

20
15 ϕ 5 % STRAIN AT FAILURE
10

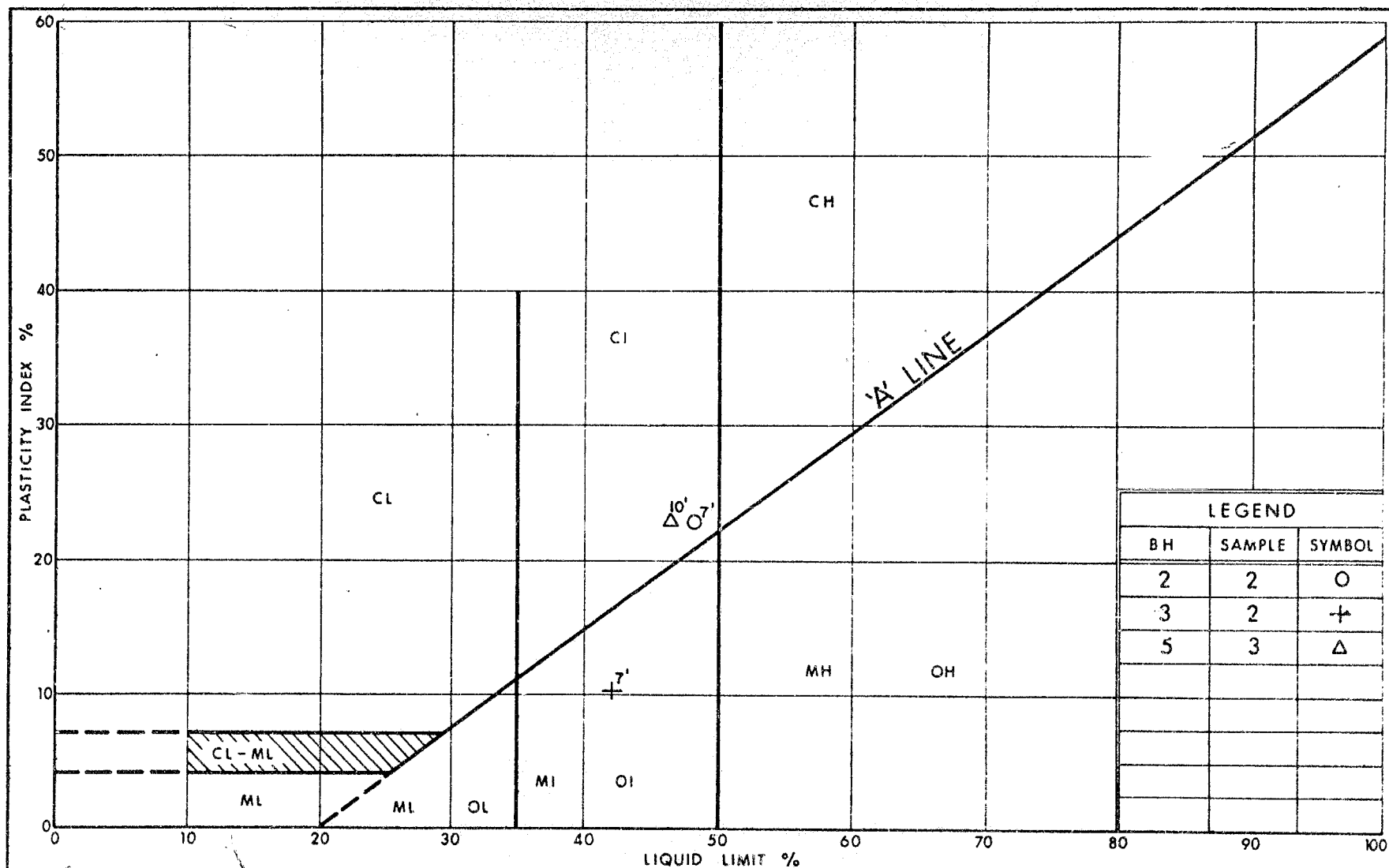


Ministry of
Transportation and
Communications

PLASTICITY CHART FILL MATERIAL

FIG No 1

W P 167-64-01

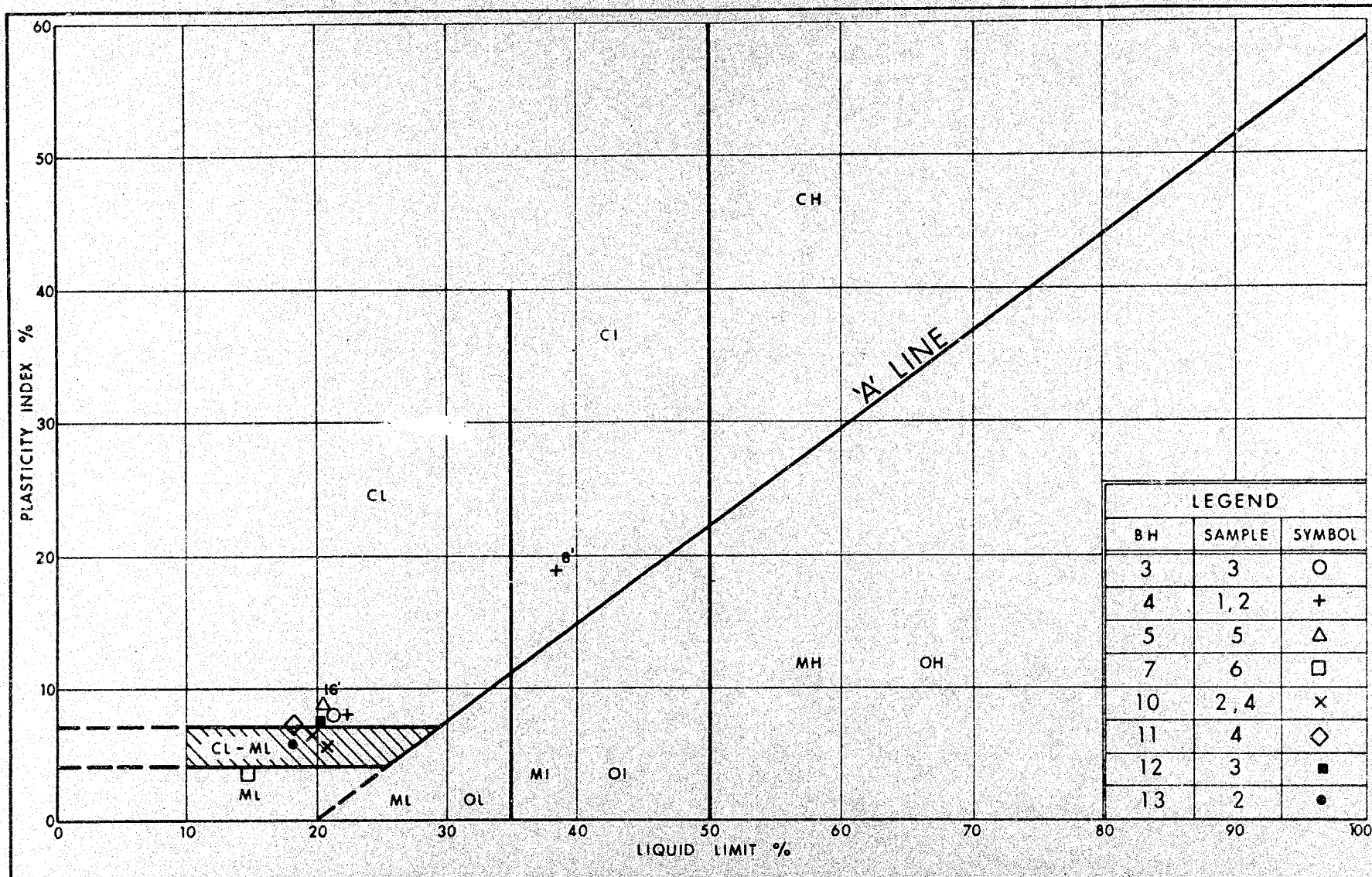


Ministry of
Transportation and
Communications

PLASTICITY CHART SILTY CLAY

FIG No 2

W P 167-64-01



Ministry of
Transportation and
Communications

PLASTICITY CHART GLACIAL TILL

FIG No 3



W P 167-64-01

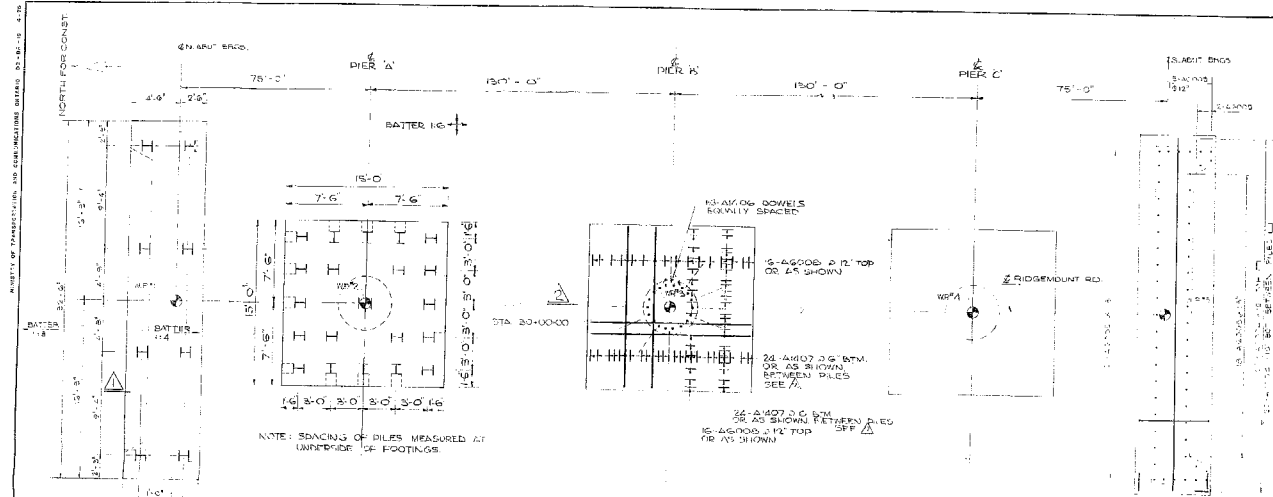


GRAIN SIZE DISTRIBUTION GLACIAL TILL.

WP 167-64-01

302.14-31

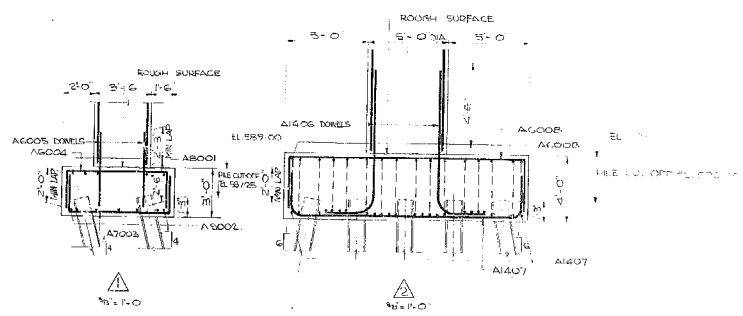
DISTRICT 4		
CONT No		
WP No 165-64-02		
RIDGEMOUNT ROAD UNDERPASS		SHEET
OVER THE D.E.W. FOOTINGS		
 C.C. PARKER & ASSOCIATES LTD. CONSULTING ENGINEERS HAMILTON		



PILE LAYOUT (TYP)

FOOTING LAYOUT

REINFORCEMENT DETAILS (TYP)



PILE DATA				
LOCATION	SUBMENTS			
PATER	114	115	116	0
	117	118	119	120
NO	121	122	123	124
LENGTH	125	126	127	128
TYPE	HP12-1M			

30214-31

