

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30 M16-27

W.P. No. \_\_\_\_\_

CONT. No. \_\_\_\_\_

W. O. No. \_\_\_\_\_

STR. SITE No. 21 - 230

HWY. No. 401

LOCATION APPROACH TO PORT HOPE  
TWP. BRIDGE #15

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 2

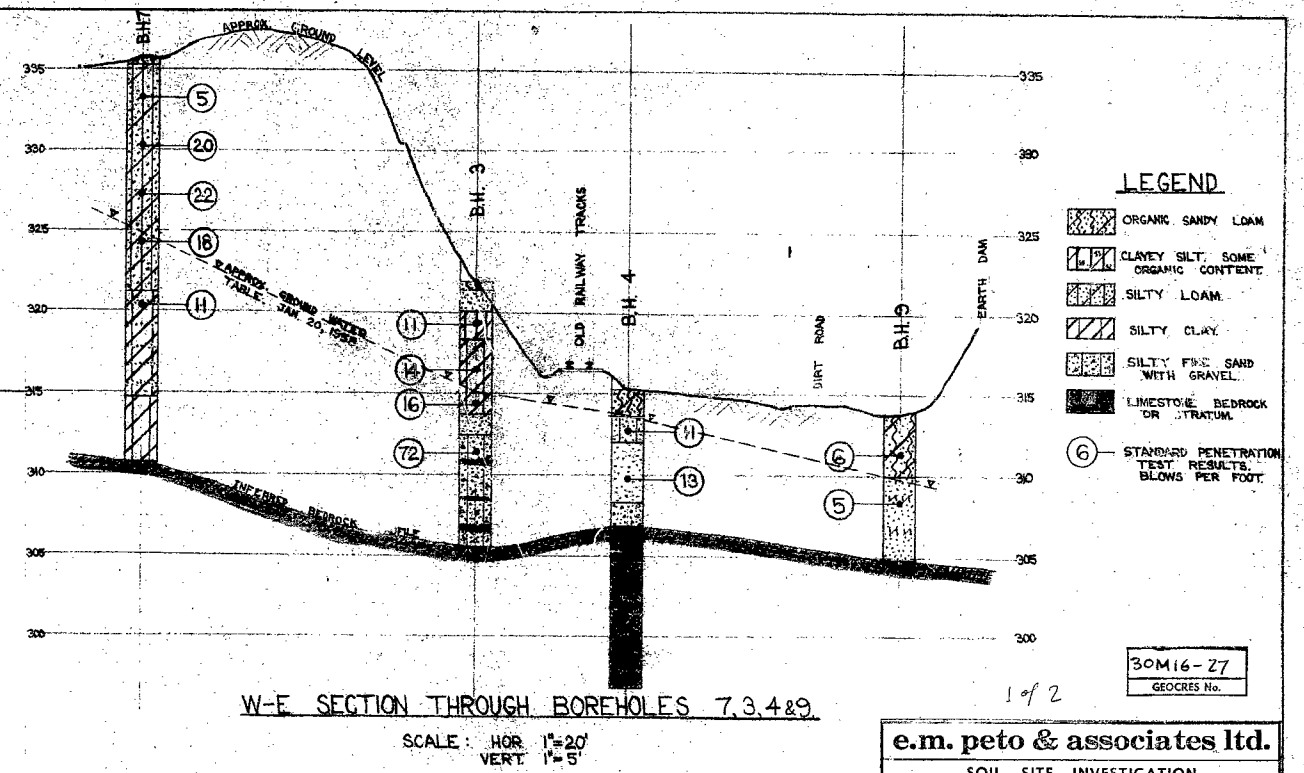
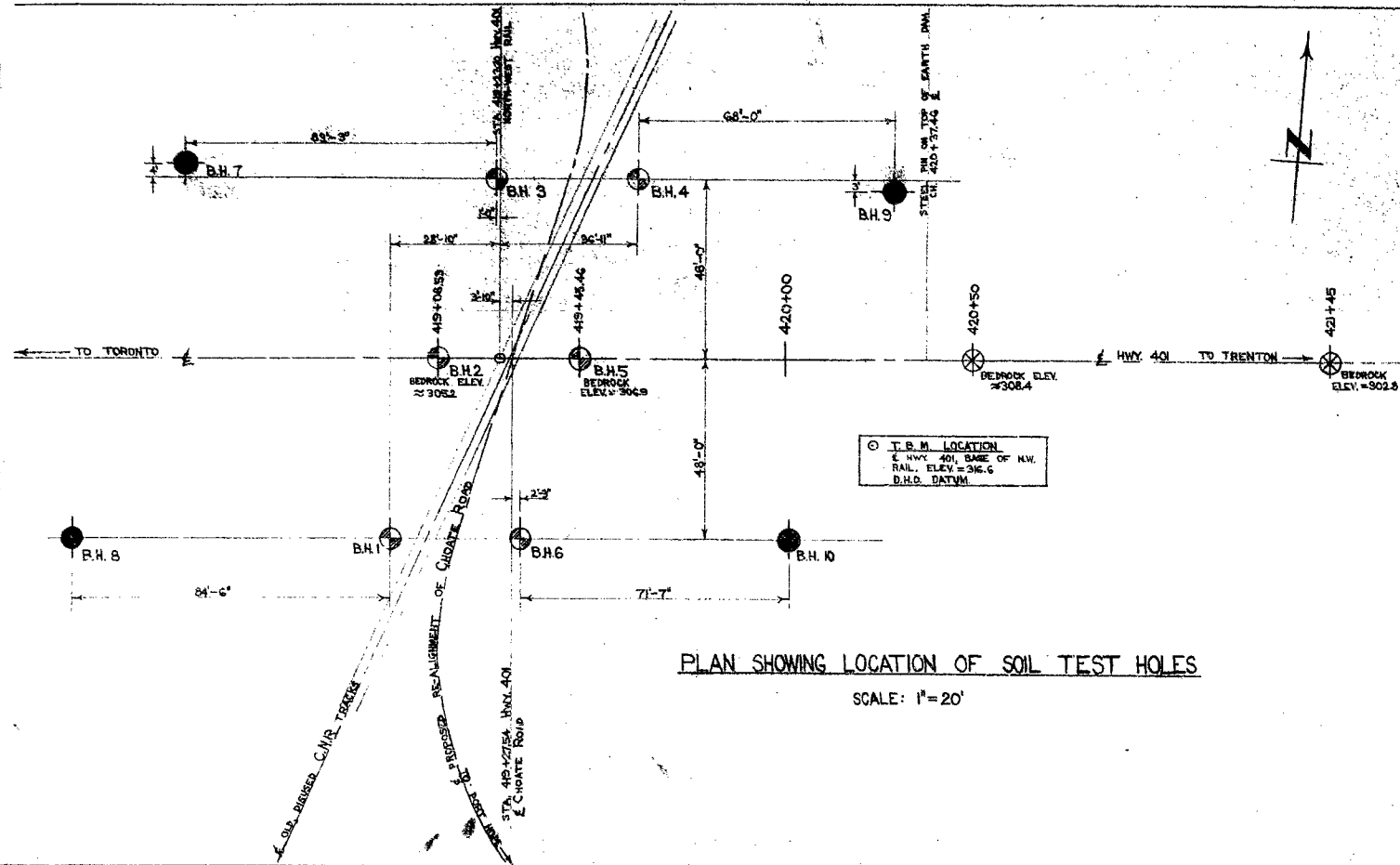
REMARKS: \_\_\_\_\_

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GL-50 SEPT. 1976



1 of 2

**e.m. peto & associates Ltd.**

SOIL SITE INVESTIGATION  
 AT  
 APPROACHES TO PORT HOPE TWP.  
 NO. 15 BRIDGE  
 FOR  
 M. M. DILLON & CO. LTD.

OUR JOB No. 5809 DATE JAN. 22, 1958.  
 CLIENTS PLAN No. 323-42 P-1 PER. M.M.



BA 697-A

e. m. peto associates ltd., 850 roselawn avenue, Toronto 10, Ontario

Job No. 5803

Client's Ref. No. 928-42-10

Date January 23rd/58

Report on

SITE 21-230

SOM 16-27
CHIEF'S NO.

SOIL CONDITIONS

at

APPROACHES TO PORT HOPE TWP. BRIDGE NO. 15

for

DEPARTMENT OF HIGHWAYS OF ONTARIO

c/o M. M. DILLON AND CO. LTD.

TERMS OF REFERENCE:

Following the submission of our report for the Port Hope Township Bridge No. 15, the Consulting Engineers responsible for the design of this bridge authorized us, by letter dated January 7th, 1958, to extend the investigation to cover the treatment of the approach embankments. Four test holes were to be driven, on completion of which we were asked to advise on the possible creep action of the silty clay stratum occurring 40 - 45 feet approximately below the proposed final grade line of Highway 401.

All of the test holes were to be driven using BX (2-1/2" diameter) casing, and sampling ahead of the casing at 3 foot intervals or less. If the soft silty clay stratum was encountered, 2" (nominal size) brass liner samples or 2" Shelby tube samples were to be obtained. In other soil types the 2" standard split spoon sampler was to be used, with the standard penetration test results being recorded. All holes were to reach bedrock., although no rock coring was necessary since the rock type, soundness, etc., had been established in our previous investigations.

METHOD OF OPERATIONS:

The field work was performed using our number 4 unit, a skid-mounted Sullivan "12" drill rig, which was trucked to the site from our yard in Toronto on January 9th, 1958, when the work commenced. On completion on January 11th, the equipment was moved from the site to Toronto.

METHOD OF OPERATIONS: (Cont'd)

None of the test holes, particularly holes 9 and 10, attained a very great depth before meeting bedrock refusal, and there were therefore only a limited number of samples recovered. However, these samples were subjected to a comprehensive testing programme, details of which are included separately. Complete and detailed borehole logs were also drawn up and are included at the rear of this report.

The attached site plan shows the four boreholes at the proposed abutment locations, the boreholes for the bridge investigation and a profile of the soil stratigraphy along a line roughly parallel to the centre line of Highway 401. All field elevations taken at this site are referred to D.M.O. or geodetic datum, and are related to the bench mark used previously for our other soil investigations.

SOIL CONDITIONS:

The findings from the present investigation serve to corroborate and amplify the results obtained for the Hope Township Bridge No. 15 investigation (our report No. 57144).

The site at the abutment locations is presently overlain by up to 3'10" of organic sandy loam, and this stratum seems to be thicker on the East approach. At borehole 7, which is located at the top of an existing bank on the West approach, and at a much higher elevation than any of the other holes, there is only 6" of organic silty loam.

On the Eastern approach beneath the organic surface stratum, and directly overlying the bedrock, there is a stratum of gray-brown, stratified sand. The sand is loose, and is saturated, with natural moisture contents ranging from 20.1% to 23.8%.

Confirming a point brought out in our report number 57144, the stratified silty clay and clayey silt stratum was encountered only on the Westerly side of the abandoned railway tracks.

The various soil properties of the cohesive materials are either shown on the borehole logs or appear in the appendix of laboratory results at the rear of this report. The results of the unconfined and triaxial shear strength tests on the samples from boreholes 2, 3, 7 and 8 show a very wide variation. This is attributable to the fact that the natural moisture contents are variable, ranging from near the liquid limit to values intermediate between the liquid limit and the plastic limit, suggesting that this material is very sensitive to changes in moisture content in this range. The stratified condition of the cohesive strata, and the presence of sand seams would also contribute to the variations in the strength test results.

SOIL CONDITIONS: (Cont'd)

One feature of the grey-brown silty clay material which must be borne in mind is that the sand seams contained therein will provide drainage channels for excess pore water during the consolidation process of the silty clay stratum, as a result of the heavy superimposed earth bank.

A good average value of the shear strength of the grey silty clay directly overlying bedrock at depth on the West side is 300 p.s.f., and the cohesion is then 150 p.s.f. If we consider a roadway as a modified form of strip loading, then the ultimate shear strength of the grey silty clay, which is the critical material on this site, is 771 p.s.f. based on Prandtl's theory.

ENGINEERING CONSIDERATIONS:

1. At borehole 7 the proposed embankment height is approximately 28 feet. Assuming the unit weight of the compacted fill material, to be 120 p.c.f., the shear stress which will be developed in the weak grey silty clay stratum at a depth of 21 feet will be 908 p.s.f. At borehole 8, the critical clay stratum is only 5 feet below ground surface, whereas the proposed embankment height at this point is 40 feet. The calculated shear stress which will be developed in this case is 620 p.s.f. Since the ultimate shear stress of the grey silty clay material is 771 p.s.f. it is apparent that the shear stress developed on the highway centre-line will be critical.
2. Therefore, on the basis that the soil stratification and depth to bedrock at borehole 7 are representative of conditions at most of the Easterly approach to the Choate Road overpass, the critical height of embankment will be 24 feet.

RECOMMENDATIONS AND CONCLUSIONS:

1. There seems to be no major problem with the Easterly approach to the Choate Road overpass, since the native material on this side is sandy and there is only a shallow depth over bedrock. Accordingly it is reasonable to assume that the majority of this settlement will occur during construction.

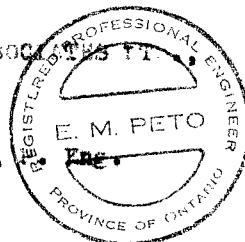
RECOMMENDATIONS AND CONCLUSIONS: (Cont'd)

2. Since a considerable portion of the Westerly approach embankment may exceed the critical height, careful consideration should be given to the placing of this fill. Accordingly we are suggesting that this work be done well ahead of the bridge construction, and that the operation be carried out in three stages, with suitable intervals between each stage. This method will introduce gradual loading of the silty clay stratum, which will permit natural drainage of this material followed by gradual consolidation and increase in resistance to imposed shearing forces.
3. The Consultant's suggestion regarding the excavation of the clay material on the West side of the bridge from the toe of the slope back a distance of 130 feet along the highway, is a possible solution but would seem to be uneconomical in view of the large volume of excavation and waste material involved. We feel that a more practical solution would be to place the approach embankments well in advance of the actual bridge construction. This will allow the subsoil conditions to adjust themselves to the superimposed load and to reach a state of equilibrium prior to bridge construction. *then much*
4. Once the embankments have been constructed and soil conditions have become stable, the open-type abutments and the piers for Hope Lwp. No. 15 bridge can be constructed. These should be based on steel H-piles driven through the compacted fill to bedrock. Considerable difficulty can be anticipated in driving the piles through the compacted fill, and it may even be necessary to auger down the holes part way ahead of the piles. When the piles have penetrated the fill the remainder of the driving should be relatively easy, except in one area containing boreholes number 2 and 3. Here there is up to 7 feet of dense sand beneath the clay and overlying the bedrock, complicated near borehole 3 by the existence of thin layers of limestone, and driving of piles in this area will be exceedingly difficult, but can be accomplished. All piles driven on this site must reach bedrock.
5. The reaction of the soils in the Port Hope area is alkaline, and in our opinion there is nothing in the soil which will be highly corrosive to steel H-piles.

E. M. PETO ASSOCIATES LTD.

*E. M. Peto*

E. M. Peto,





# e. m. peto associates ltd.

SOIL ENGINEERING SERVICE - TORONTO, ONTARIO

## BOREHOLE LOG

Job Name Approaches - Port Hope Twp. Bridge Job No. 5803 Borehole No. 7  
 Client D.H.O. c/o M.M. Dillon & Co Casing BX (2-1/2" diam.) Boring Date Jan. 10th, 1958  
 Datum D.H.O. Compiled By M. Mindess Checked By C.F. Freeman

### SAMPLE CONDITION

-  UNDISTURBED
-  FAIR
-  DISTURBED
-  LOST

### SAMPLE TYPE

- S.S. 2" STANDARD SPLIT TUBE SAMPLE
- S.L. SPLIT BARREL WITH LINERS
- S.T. THIN-WALLED SHELBY TUBE SAMPLE
- W.S. WASH SAMPLE
- R.C. ROCK CORE

### ABBREVIATIONS

- V.T. IN SITU VANE SHEAR TEST
- Q<sub>u</sub> UNCONFINED COMPRESSIVE STRENGTH
- W.L. WATER LEVEL IN CASING
- W.T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
ORGANIC SILTY TOPSOIL.	BROWN		0' 0" 335.7					
VERY FINE SANDY SILT MINOR ORGANIC CONTENT, AND CLAY CONTENT.	GREY-BROWN	LOOSE	5' 0"	1	S.S.	5		NAT. M.C. = 20.7% LL = 31.7, PL = 17.6, PI = 14.1 81.2% PASSING #200 SIEVE.
VERY FINE SANDY SILT, MINOR CLAY CONTENT.	" "	COMPACT		2	S.S.	20		MOIST. TENDS TO BE STRATIFIED.
AS ABOVE, POCKETS OF YELLOWISH-BROWN SILT. GRADING TO	" "	"	10' 0"	3	S.S.	22		NAT. M.C. = 17.5% Q <sub>u</sub> = 1296 P.S.F.
CLAYEY SILT, SOME V. FINE SAND, POCKETS OF SILT	GREY-BROWN	FIRM TO COMPACT		4	S.S.	18		W.L. = 9' 6" JAN. 11, 1958 NAT. M.C. = 24.8% Q <sub>u</sub> = 1304 P.S.F.
VERY SILTY CLAY, STRATA OF FINE BROWN SAND UP TO 2" THICK.	BROWNISH- GREY	FIRM	14' 6" 321.2	5	S.L.	11		NAT. M.C. SA.SA = 31.5%, C = 860 P.S.F. NAT. M.C. SA.SB = 24.0%, Q <sub>u</sub> = 322 P.S.F. TRIAXIAL TEST INCONCLUSIVE BUT $\phi \approx 0^\circ$ .
AS ABOVE	"							
VARVED SILTY CLAY	GREY	VERY SOFT	21' 0" 314.7	6	2" S.T.	PUSHED		MUCH WETTER THAN PLASTIC LIMIT Q <sub>u</sub> 21'-22' = 346 P.S.F. DRY DENSITY 21'-22' = 94.2 P.C.F. @ NAT. M.C. = 29.5% LL = 34.3, PL = 18.6, PI = 15.7 99.2% PASSING #200 SIEVE
			25' 0" 310.7					
								REFUSAL. PROBABLY BEDROCK.



SOIL ENGINEERING SERVICE - TORONTO, ONTARIO

Job Name Approaches - Port Hope Twp Job No. 5803 Borehole No. 8  
Bridge  
Client D.H.O. c/o M.M. Dillon & Co Casing BX (2-1/2" diam.) Boring Date Jan. 11th, 1958  
Datum D.H.O. Compiled By M. Mindess Checked By C.F. Freeman

## ABBREVIATIONS

V. T. IN SITU VANE SHEAR TEST  
Q/u UNCONFINED COMPRESSIVE STRENGTH  
W. L. WATER LEVEL IN CASING  
W. T. GROUND WATER TABLE IN SOIL

[illegible]

## BOREHOLE LOG

Borehole No. 9

Boring Date Jan. 10th, 1958

Checked By ..... C.F.Freeman

## ABBREVIATIONS

### V.T. IN SITU VANE SHEAR TEST

**Q/u UNCONFINED COMPRESSIVE STRENGTH**

W.L. WATER LEVEL IN CASING

W. T. GROUND WATER TABLE IN SOIL

R. C. ROCK CORE

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft	WATER LEVELS, SOIL MOISTURE & REMARKS
SANDY LOAM: ORGANIC CLAYEY AND SILTY FINE SAND.	DARK BROWNISH- GREY MOTTLED.	LOOSE	0' 0" 313.8		1	S.S.	6	NAT. M.C. = 21.1% ▽ W.L. = 4'0", JAN. 11, 1958.
STRATIFIED FINE TO MEDIUM SAND. OCCASIONAL THIN SEAMS OF CLAYEY SILT.	GREY- BROWN	LOOSE	3' 10" 310.8		2	S.S.	5	SATURATED. NAT. M.C. = 20.1%
			9' 1" 304.7					REFUSAL. BEDROCK.

## BOREHOLE LOG

Checked By C.F. Freeman

## ABBREVIATIONS

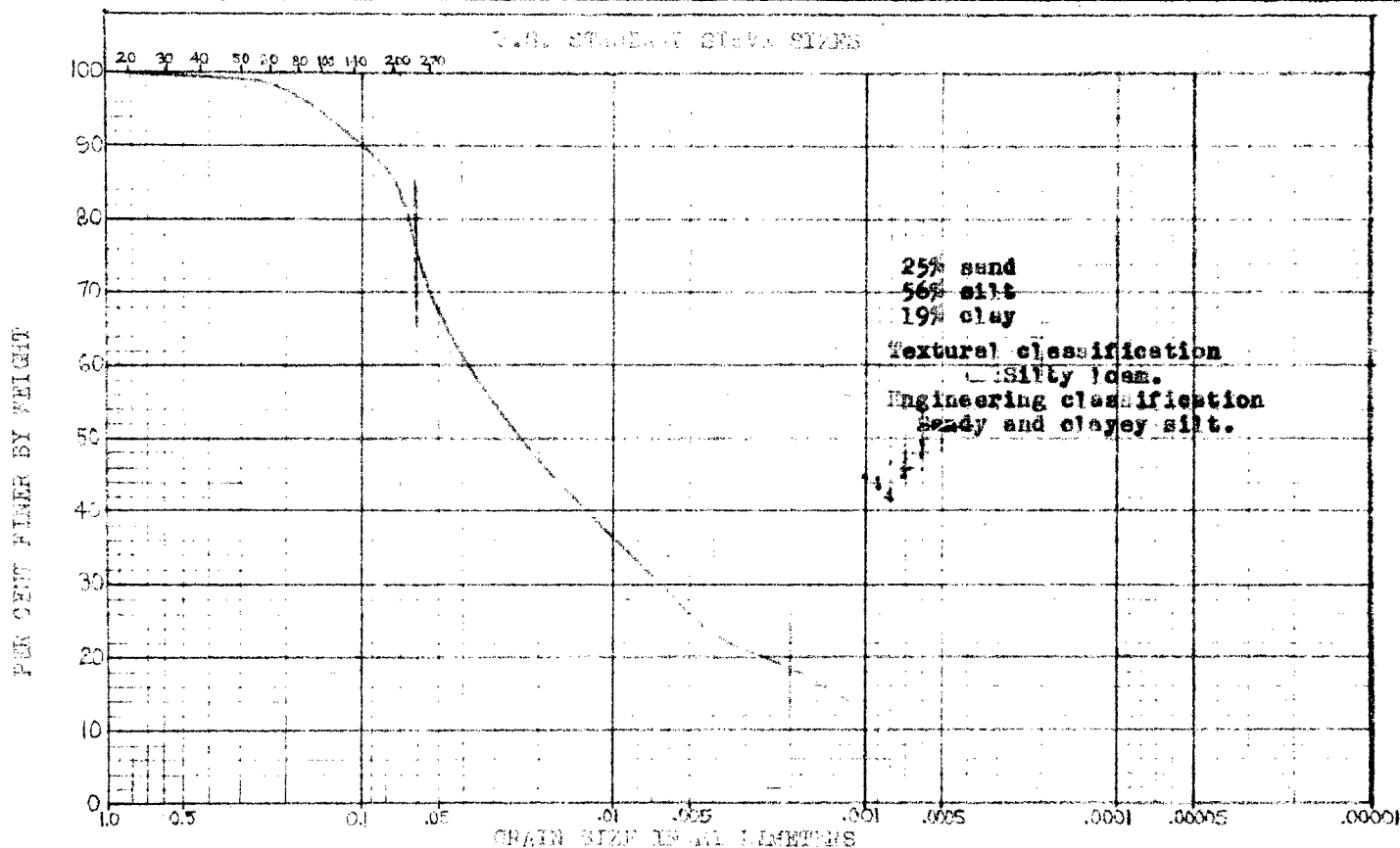
R. C. ROCK CORE

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
ORGANIC SANDY LOAM	DK. BROWNISH-GREY		0' 9" 308.7					
VERY FINE TO FINE SAND, SLIGHTLY SILTY. ORGANIC CONTENT.	GREY-BROWN	LOOSE	1' 10" 306.9		1 X	S.S.	7	W.L. = 1' 6", JAN. 11, 1958. SATURATED. NAT. M.C. = 238%
			4' 2" 304.5					
				REFUSAL. BEDROCK.				

E. M. PETO AND C. L. DE WED.

UNIFIED SOIL CLASSIFICATION SYSTEM

U.S. STANDARD SIZE SIEVES



MEDIUM SAND	FINE SAND	COARSE SILT	MEDIUM SILT	FINE SILT	CLAY	ROCK, FILL & COLLOR
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U.S. STANDARD CLASSIFICATION

Approaches Port Hope Twp. Bridge 5803

Job Name..... Job. No. .... Borehole No. 7..... Sample No. 1 22

Depth 2'-6" Approx. Specific Gravity = 2.72

Elevation ..... Remarks .....

# e. m. peto associates ltd.

## SOIL TESTING LABORATORY

### LIQUID LIMIT TEST

### FLOW LINE CHARTS

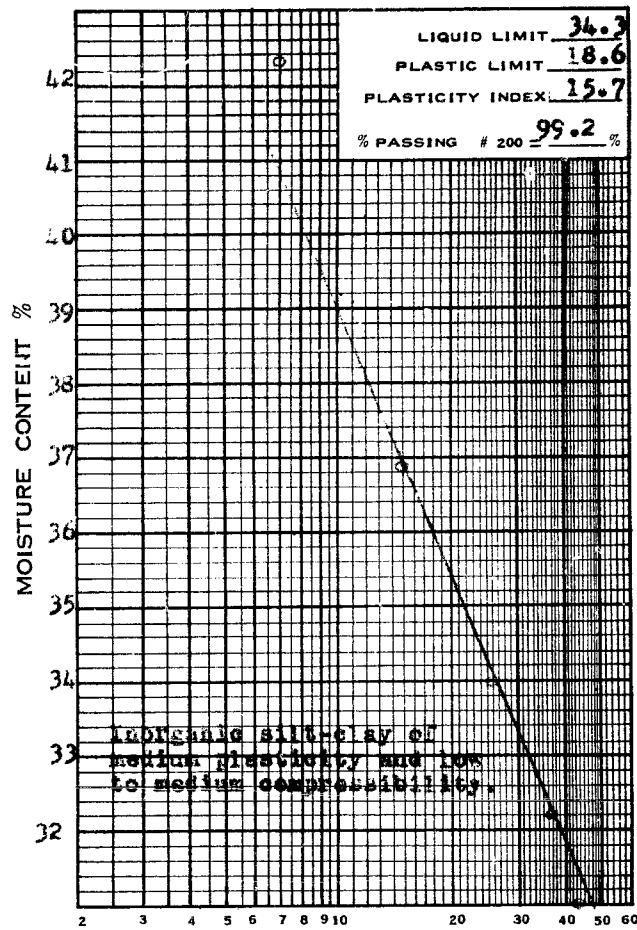
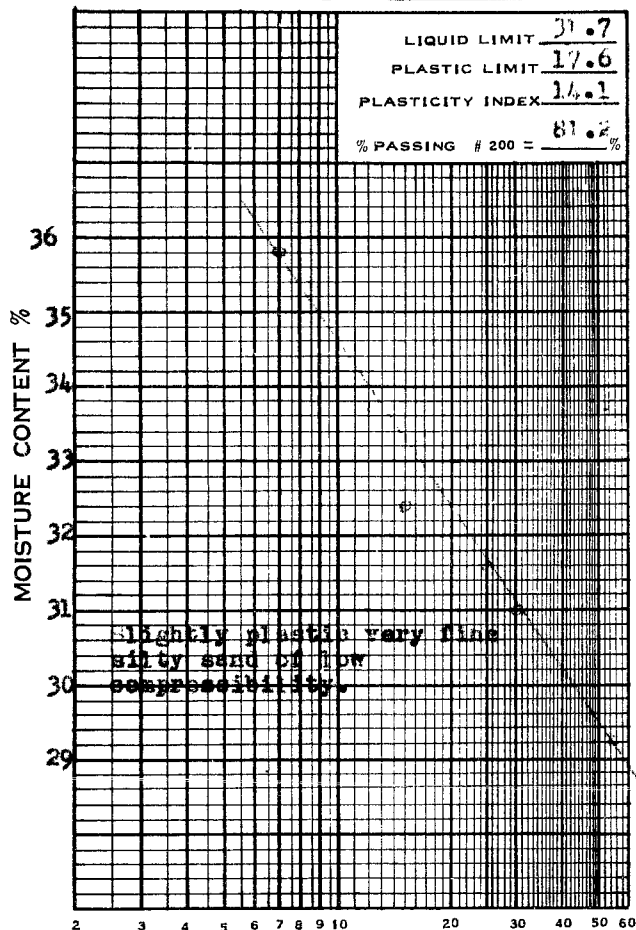
JOB No. 5803 PROJECT Approaches-Port Hope Twp. No. 15 Bridge

SAMPLE FROM B.H. 7, Sample No. 1-2

SAMPLE FROM B.H. 7 Sample 6

DEPTH 2'-6"

DEPTH 21'5" - 22'5"



NO. OF BLOWS (LOG SCALE)