

#58-F-235-C

W.P. 72-57

HWY #401

RAISIN RIVER

BRIDGE

E. M. PETO ASSOCIATES LIMITED

Russell 9-1126-7

1287 Caledonia Road,  
Toronto 19, Ontario.

CONT. 58-168

23-58-168

Job Number 57147

February 10th, 1958.

SUPPLEMENTARY COPY

58 F 235 C

Office of the Bridge Engineer,  
Department of Highways of Ontario,  
280 Davenport Road,  
Toronto, Ontario.

Attention: Mr. J. C. McAllister.

W.P. 72-57

Dear Sirs,

Re: Raisin River - Highway 401 Bridge  
(Soil Site Investigation.)

We have completed the site investigation for the Raisin River - Highway 401 bridge crossing in accordance with our usual terms of reference, and with some amendments to the original program, as explained in the report attached hereto.

For ease of reference, we summarize briefly our recommendations in respect to the soil conditions on this site.

1. The piers and at least the West abutment should be carried on steel piling driven through the sandy till stratum to the bedrock. This type of foundation is particularly desirable if a rigid or continuous girder type superstructure is contemplated.

"Continued"

2. Alternatively, and providing some minor differential settlement can be tolerated, the piers and abutments can be founded in the sandy fill layer, preferably at least 5 ft. below the top surface of this stratum. (i.e. at elevation 136.0 ft., except at the West abutment where this elevation can be raised to about 136.0 ft.).

3. Unless the West approach fill is placed well in advance of the bridge construction (say 6 months to 1 year in advance) it would be advisable to remove the organic fill overlying the sandy fill for a distance of at least 100 ft. beneath the West abutment for the full width of the abutment.

4. There was no indication of any abnormal water problems or difficulty in de-watering any pier or abutment excavation. Some minor difficulty due to small boulder interference may be encountered in driving sheet piling into the sandy fill stratum.

In accordance with our usual practice, we have forwarded one copy of this report complete to your Consulting Engineers, C. C. Barker and Associates Ltd., responsible for the bridge design and this project, in order to allow them to expedite their preliminary design proposal. Some limited information was supplied verbally to the Consultants as the field work was being completed, at their request, in view of the advanced bridge design completion date.

Should your Consultants require additional advice with regard to our soils report, perhaps due to a change of pier locations, we shall be pleased to be of additional service.

Yours very truly,

E. M. DETO ASSOCIATES LTD.

E. M. Deto, P. Eng.

EMP/10

SOIL SITE INVESTIGATION

AT

HIGHWAY 401 GABIN RIVER BRIDGE

F O R

DEPARTMENT OF HIGHWAYS OF ONTARIO

B. H. FINE ASSOCIATES LTD.,  
1807 California Road,  
Toronto 18, Ontario.



TERMS OF REFERENCE

We were instructed by letter dated December 6th, 1957, from Mr. J. C. McAllister, acting for the Chief Bridge Engineer, Mr. A. M. Doyle, to carry out the soil investigation for the proposed new Highway 401 bridge across the Raisin River East of Cornwall. The investigation was to be carried out in accordance with our standard practice. A marked site plan, drawing P-3842-1, indicating the location of twelve test holes on this site, was forwarded with the letter of authority.

After examination of the site, and as a result of the preliminary soil test results, it was decided that one additional test hole should be performed some 50 feet back from the waters edge on the highway centre line at the East side of the crossing. In addition, two further test holes were to be put down on the swampy ground along the centre line immediately West of the proposed Western abutment location. These additional test holes were sunk to determine the possibility of failure beneath the bridge approach embankments.

## METHOD OF OPERATIONS

This site investigation was carried out by our number 3 unit, a Sullivan "12" skid-mounted diamond drill rig, which commenced work on December 18th, 1957. After a long Christmas break and some delay during the first week of January because of illness of the field crew, work was completed on January 24th, 1958.

Each test hole was sunk by driving and cleaning BX drill casing, sampling ahead of the casing at frequent intervals, with either a 3" split barrel sampler or 2" Shelby tube. Standard penetration test results were recorded whilst sampling with the split barrel sampling tube.

A number of the test holes were diamond drilled in order to prove the reliability and continuity of bedrock. In at least one test hole, an attempt was made to penetrate as far as possible, without core drilling, by means of chopping bit and by running an open end A rod in the diamond drill head.

Several test holes were bailed, or pumped dry, at various stages of the work and the water level reading was recorded the following morning. The natural moisture contents of numerous samples were also determined.



METHOD OF OPERATIONS - Cont'd

The test results are shown on each test hole log, together with the site plan showing test hole locations. The site plan includes a longitudinal section through the test holes located on the Highway Centre Line. The relative depths for the test holes located to both the North and South of the centre line are shown for ease of comparison.

Unfortunately, the D.R.O. reference bench mark on this site had been removed, and a D.R.O. boundary monument was used instead for a reference elevation. After completion of the field work, but during preparation of the drawing it was found that the D.R.O. did not have the elevation of this point. The profile and the ground elevations as shown, are all correctly inter-related, and have been related to an approximate ground elevation of 159.72 feet at station 9+00 as read from D.R.O. drawing T-2242-1. It is therefore possible that there is some slight error up to  $\pm .5'$  in the elevations shown.



## SITE AND GEOLOGY

This site is located in the physiographic region known as the Glengarry till plain. This till plain has a region of low relief forming the drainage divide between the international section of the St. Lawrence River and the Ottawa basin, from Prescott to the Quebec boundary. The surface is undulating to rolling, consisting of long drumlinoidal ridges and a few well-formed drumlins together with intervening clay flats and swamps.

The drainage pattern is peculiar in that the head waters of the river systems in this area flow sluggishly for long distances between ridges before finding outlets to the main stream.

The Raisin River has its source at Newington in Canabrock Township. This river flows in an Easterly direction approximately parallel to the St. Lawrence River; it has a relatively deep channel and floods only a limited area of low land during periods of high rainfall. The bridge crossing ~~site itself~~ is located only some half to three-quarters of a mile from Lake St. Francis, which forms part of the St. Lawrence River.

The principal soil on this site is the sandy till containing a high proportion of limestone rock fragments with admixture of materials derived from the Precambrian rocks to the North. The area has been glaciated and formed part of the Champlain sea basin.

## SOIL CONDITIONS

### Organic Silt Stratum

As might be expected, organic silt, in some cases with sand content, constitutes the top stratum in the swamp area on the West side of the river almost as far back as Station 530 + 50. This layer, with variations in sand and clay content, but with decreasing organic content with depth, exists to 13 ft. below surface at test hole 14, to the 15 ft. depth at test hole 1, to the 16 ft. depth at test hole 2, and for the top 2 ft. or 3 ft. only at test hole 10.

The natural moisture contents ranged from 28.3% to 41% at the 7 ft. depth and increased to between 70% and 87% at the 11 ft. depth at test holes 14, and 1 and 2.

The unconfined compressive strengths ranged from a low of 104 p.s.f. to a high of 127 p.s.f. at 20% deformation; failures were uniformly plastic.

The Atterberg Limits for the sample from the 13 ft. depth at test hole 14 gave a Liquid Limit of 85.5, a Plastic Limit of 23.6 and a Plastic Index of 14.9, indicating an inorganic silty clay or clayey silt of low to medium plasticity and low compressibility. The natural moisture content was well over twice the Liquid Limit.



SOIL CONDITIONS - Cont'd

The sample from the 11 ft. depth, at the same test hole, was tested for pH factor and gave a result of 4.8, indicating a weakly acidic condition.

At test hole 8, the silt exists to a depth of about 8 ft., but the organic content is not general throughout, being localized in the form of seams of decayed wood, etc.

Silty Clay Stratum

The grey silt clay stratum shown on the profile as existing from ground surface or ice surface to the 8 ft. 6 inch or 10 ft. depth only at test holes 11 and 13 was also encountered to approximately the same depths below ice surface at test hole 12 beside the East bank, but was not encountered at test hole 10. This stratum also appeared below the organic silt at test hole 1 between the 15 and 19 ft. depths and at test hole 8 below the clayey silt, between the 8 ft. and 17 ft. depths. This stratum also appeared at the river bottom at test hole 4 between 14 and 19 ft. depth (corresponding to test hole 1) and at test hole 9 from the 14 to 17 ft. depth.



## SOIL CONDITIONS - Cont 'd

This gray silty clay has a pronounced nuggety texture. The natural moisture contents ranged from 50 to 87%, with a general average of around 64%. The unconfined compressive strength of a sample from the 12 ft. depth at test hole 3 was only 178 lbs. per square foot. Samples tested failed in shear, and quite rapidly. Due to the high moisture contents, there was considerable difficulty in recovering undisturbed samples of this stratum either from Shelby tubes or split tubes with liners. Several laboratory penetrometer tests, on samples in fair condition, gave unconfined compressive strengths ranging from 0.24 tons per square foot to almost 0.5 tons per square foot. The lowest strength results came from samples beneath the river bottom where moisture contents were generally somewhat higher than the average for this stratum.

At test hole 4 only, the sample from the 20 ft. depth appeared to be more silt than clay. The natural moisture content was only 38.7%, the sample gave instantaneous response to the shake test, and had a plasticity index of only 14.3 with a Liquid Limit of 22.2

SOIL CONDITIONS - Cont'd

Sandy Till

The basic subsoil stratum, common to all the test holes, is a gray to grey brown ( and in some cases dark grey) fine to coarse sand with grits and angular limestone fragments, generally set in a matrix of silt or clayey silt. Natural moisture contents in this stratum were recorded in several instances at around 9 to 10%.

As might be expected in a till material with quite large rock fragments, there was considerable variation in the standard penetration test results. However, the densities recorded in this stratum varied from compact to dense with standard penetration test blows averaging 37 to 39 per foot. It might be pointed out that a comparatively loose stratum was encountered at test hole 12 from 21 to 22 ft., in test hole 8 from 23 ft. to nearly the 37 ft. depth, and to a lesser extent from 23 feet to 25 feet in test hole 7.

Some minor trouble was encountered with boulders at test holes 5 and 11 at depth, and a few small boulders were encountered at one of the test hole locations immediately below the river bed. No large boulders were encountered at any of the test holes.

## SOIL CONDITIONS - Cont'd

### Bedrock

As may be seen from the profile and the borehole logs, there was considerable variation in bedrock elevation, or the level of inferred bedrock, due to virtual refusal of the casing and chopping bit at some of the test holes.

In actual fact, careful review of the depth at which diamond drilling and core recovery was carried out suggests that the top surface of the bedrock, within the confines of the river bed, lies somewhere between elevation 121.5 and 123.5. The bedrock appears to be basically a fine grained limestone, grey black in colour and generally hard with little or no reaction with dilute hydrochloric acid.

Some strata of fine grained black shale were found upon examination in some of the rock core. We could not find complete uniformity of this stratification over the site, although a comparatively thin seam of black shale was encountered at the 37 to 38 ft. depth in test holes 2, 5, 8 and 9. Variations in the cleavage plane suggests that the bedrock has been folded in the past.



SOIL CONDITIONS - Cont'd

Considerable difficulty was encountered in penetrating a very hard stratum, which is believed to be a shale layer, at around the 26 ft. depth in a number of test holes. In certain cases, no attempt was made to penetrate this very dense material by drilling after virtual refusal to the casing and chopping bit had been reached, but in others this hard layer was penetrated, usually by diamond drilling, and a further stratum of till material was encountered before final bedrock refusal was reached.

We believe that test hole number 11 (which was the first test hole put down) is an unusual case. With persistent effort, the field crew were able to drive this test hole by alternately driving a chopping bit and running an open end drill rod to the 39 ft. depth, before finally running the diamond drill core barrel. Only wash samples were recovered below the 21 ft. depth due to the very hard driving. Although we have classified the wash samples as a coarse sand and fine gravel, we believe that most of the material below the 27 ft. depth is actually a pulverized bedrock. The till material was encountered between the 25 and 27 ft. depth, overlain by a thin stratum of black shale.

During the diamond drilling operations, wash water was lost only in test hole 9 at the 35 ft. depth. There was no indication of any open seam at any other test hole.

## WATER CONDITIONS

Neither artesian water nor any water bearing seam was encountered at any of the test holes, with the possible exception of a water bearing seam at the 85 ft. depth in test hole 9.

After the till stratum had been reached with the casing, the test holes remained dry overnight after being bailed the previous day.

## CONCLUSIONS AND RECOMMENDATIONS

1. Due to the extreme variations in soil type and characteristics, it would be unwise to consider placing pier or abutment footings on any soil above the till stratum.
2. If, for reasons of economy, it should be decided to place the pier and abutment footings in the top layers of the sandy till stratum, then a load bearing value of 1.5 tons per sq. ft. should be used for the design, assuming a width of at least 8 ft. for each footing. If the footing is placed at least 5 ft. below the top surface of the sandy till, then the bearing value may be increased to 3.4 tons per sq. ft., assuming

CONCLUSIONS AND RECOMMENDATIONS - Cont'd

a footing width of not less than 5 ft. ; this value should be reduced to 2.8 tons per square foot for footings 10 feet wide or more, with values being more or less proportional for footing widths between 5 ft. and 10 ft.

We wish to point out that there is some risk of minor differential settlements, perhaps exceeding the normal maximum total settlements of 3/4" for any pier with the recommended loadings given above, due to the presence of loose pockets in the sandy till stratum, as encountered at 3 of the test holes.

2.

There is little doubt that short steel and bearing piles driven into the top surface of the bedrock will provide the most satisfactory foundation for the piers and abutments, certainly for the piers and West abutment.



CONCLUSIONS AND RECOMMENDATIONS - Cont'd

4. Timber pile foundations are not recommended for this site for several reasons, but principally due to presence of small boulders and the high density of the till. Penetration without danger of damage to the piles would be difficult to achieve. Insufficient lateral support at the pile tips could therefore be ~~a~~ problem.
5. Monotube, or similar displacement piles, are not recommended for the foundations on this site for generally similar reasons given in the preceding paragraph.
6. Due to the proximity of the site to the St. Lawrence River system and the generally sluggish nature of the stream flow, scour will not be a major problem in our opinion. This statement is further borne out by examination of the soil profile. Scour exceeding a depth of 5 ft. below river bottom is unlikely, although we recommend that sheeting be driven below this depth, if possible, if the footings are placed on the sandy till instead of on piles.

CONCLUSIONS AND RECOMMENDATIONS - Cont'd

4. With a tentative grade elevation of approximately 168.3 ft. at the East abutment, there is no bank stability problem on this side of the river, assuming normal excavation through the relatively soft surface clay for an abutment located at station 543 + 00 .
8. On the West bank, the 10 ft. high approach embankment will present a problem if this fill is placed directly on top of the existing swamp surface. For an embankment with a base width of 120 ft. theoretical calculations show that the new imposed load will exert a pressure exceeding the ultimate shear strength of the soil at the 12 ft. to 15 ft. depth below present surface by about 35%. In actual fact, the presence of the sandy compact to dense till so close to surface beneath such a wide embankment tends to ameliorate the critical theoretical condition. However, some failure of the embankment for a distance of at least 100 ft. back from the West abutment at station 541 + 00 can be expected in the form of a general subsidence as the fill reaches the tentative grade elevation.

CONCLUSIONS AND RECOMMENDATIONS - Cont'd

Under the circumstances, we believe that consideration should be given to removal of the organic silt and clayey silt above the sandy till between chainage 539 + 60 and 541 + 00, for a width of at least 80 ft. (the presumed width of the abutment), and replacement with a basically granular fill material.

8. Excavations for the bridge structure itself will, of course, require close sheeting if dry work is required. However, there was no indication of any potential dewatering problem if the sheeting is driven into the till stratum below the river bottom.

E. M. PETO ASSOCIATES LTD.

E. M. Peto, P. Eng.

EMP/sp



e. m. peto associates ltd.

Toronto 19, Ontario

# LIQUID LIMIT TEST

JOB No. 57147 Project Hwy. 401 - Raisin River Bridge

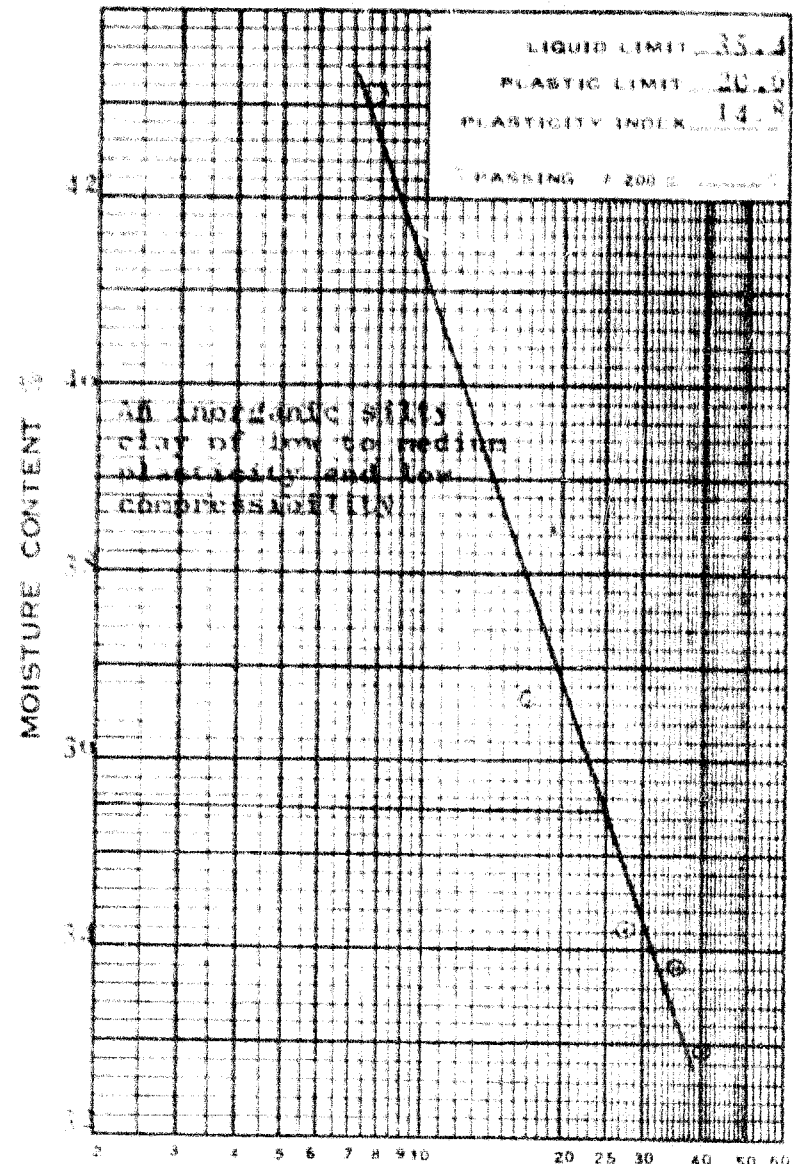
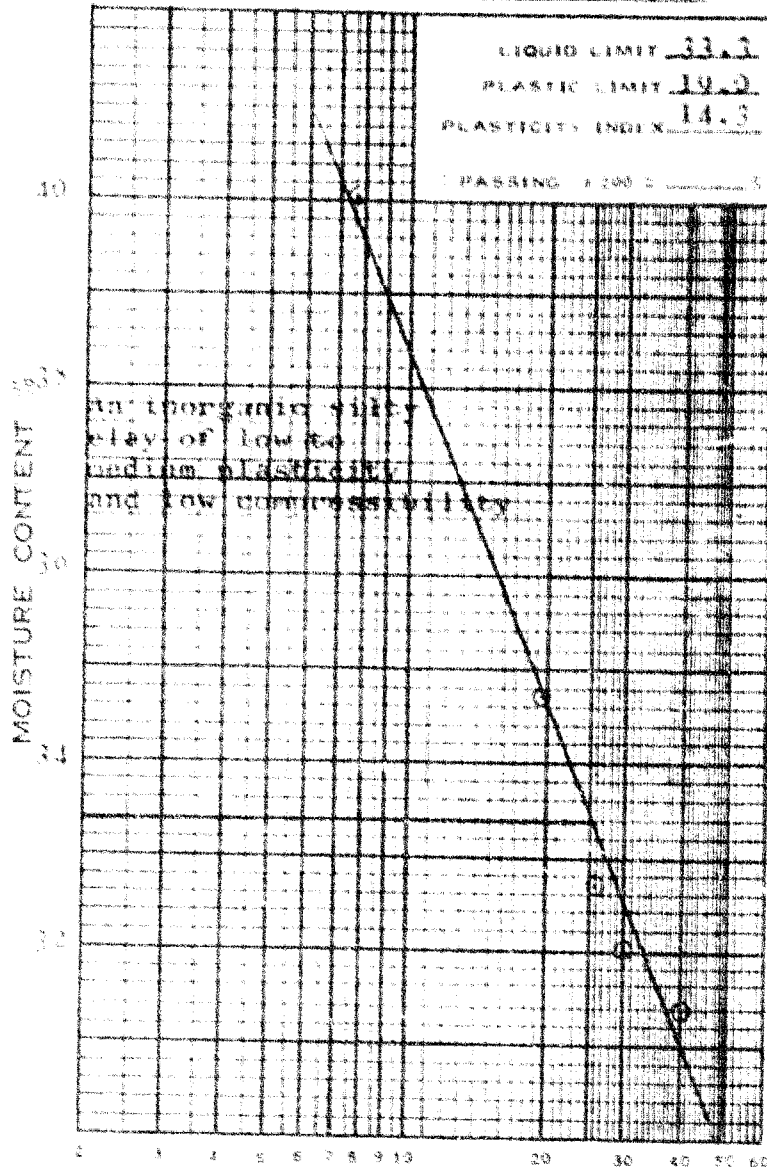
SAMPLE FROM Borehole 1 Sa. 2

DEPTH 20' - 21'

# FLOW LINE CHARTS

SAMPLE FROM Borehole 14 Sa. 2

DEPTH 10' - 12'



NO. OF BLOWS (LOG SCALE)

## BOREHOLE LOG

Checked By M.M.





SOIL DESCRIPTION	COLOR	Consistency	Depth Elevation	Legend	Sample No. and Container	Sample Type	No. of Blows per Ft.	WATER CONTENT, SOIL MOISTURE & REMARKS
Ice surface			0' - 6"					
Water			6' - 9'					
High'y organic silt, minor sand content.	Mixed dark brown	Vary loose	9' - 10'		1	S.S.	2	M.C. 61.8%
Very sandy organic silt, minor clay content.	Dark Grey-Brown	Very Loose	10' - 15'		2	S.T. PUSHED	-	G/u 1 <sup>st</sup> p.s.f. M.C. 77.6% pH 4.8 weekly acidic
Silty clay	Grey	Firm	15' - 19'		3	S.S.	7	M.C. 86.5%
Medium to coarse sand, some binder.	Grey-Brown	Dense	19' - 25'		4	S.S. W.S.	47	
			25' - 26"					

VIRTUAL REFUSAL

**e. m. peto associates ltd.**  
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO  
**BOREHOLE LOG**

Job Name Hwy. 401 Reisin River Bridge Job No. 5747 Borehole No. 2  
Client Dept. of Highways of Ontario Casing BX Boring Date Jan. 20th - 22nd, 1958.  
Datum D.H.O. Compiled By E. M. Peto Checked By M.M.

**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.U. UNCONFINED COMPRESSIVE STRENGTH  
W.L. WATER LEVEL IN CASING  
W.T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOUR	Consistency	Depth (Feet)	Sample Type	Remarks
Ice Surface			0.0		
Water			0.0		
Sandy and clayey organic silt.	Olive Grey	Very loose	1.0	S.T. PUSHED	Q/u 127 p.s.f. M.C. 41.0%
Organic silt some sand.	Mixed Brown-Grey	Very loose	1.2	S.S.	M.C. 70.0%
Matrix of clayey silt with numerous rock fragments.	Grey	Compact to Dense	1.6	S.T. PUSHED	M.C. 10.7%
As above with coarse sand (fragments to 1" size).	Grey	Compact to Dense	2.0	S.S.	
Layer of shale 25 - 26 ft.			2.5		
Coarse sand and fine gravel with binder.	Brownish Grey	Extremely Dense	3.0	W.S.	Chopped with open end A rod and chopping bit alternately from 25 to 30 ft.
Fine grained limestone with some fossils	Grey-Black	Hard	3.5		
Fine grained shale from 37 ft. to 39 ft.	Black	Hard	3.7		Core recovery 82.4% from 30 ft. to 39 ft.
HOLE TERMINATED					



# e. m. peto associates ltd.

SOIL ENGINEERING SERVICE - TORONTO, ONTARIO

## BOREHOLE LOG

Job Name Hwy. 401 Reisin River Bridge Job No. 5747

Client Dept. of Highways of Ontario Casing BX





Datum D.H.O. Compiled By L. M. Peto

Borehole No. 3

Boring Date Jan. 18th, 1958

Checked By M.M.

### 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 SHELLY TUBE SAMPLE
- W.S. WASH SAMPLE
- R.C. ROCK CORE

### 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

SOIL DESCRIPTION	COLOR	Consistency	Depth (Elevation)	Level	Sample No. and Location	Sample Type	No. of blows per ft.	WATER LEVEL AND MOISTURE & REMARKS
Ice Surface			0.0					
Water			1.2					
			3.0					
			5.0					
Sandy and clayey silt, organic content and seam of brown decayed wood.	Olive Grey	Very loose	12.0		1	S.T.	10	Q/u 187 p.s.f. M.C. 36.3%
			15.0		2	S.T.	12	Q/u 173 p.s.f. M.C. 80.3% dropping to 59.1% at 14 ft depth
Silty clay	Grey	Very soft	15.0		3	S.S.	6	M.C. 52.7%
Silty clay, slightly nuggety	Grey	Soft to Firm	22.0		4	S.S.	27	
Very silty clay, coarse sand and fine angular gravel. Some decayed wood.	Grey	Very stiff	25.0		5	S.S.	28	
Medium to coarse sand with fine angular gravel, clayey silt binder.	Grey-Black Light Brownish Grey	Compact to Dense	41.0		6	R.C.	-	Limestone fragment 2-1/4" recovered from tip of casing.





VIRTUAL REFUSAL

**e. m. peto associates ltd.**  
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO  
**BOREHOLE LOG**

Job Name Hwy. 40<sup>th</sup> Raisin River Bridge Job No. 57147  
Client Dept. of Highways of Ontario Casing BX  
Datum D.H.O. Compiled By E. M. Peto

Borehole No. 4  
Boring Date Jan. 17th - 18th, 1958.  
Checked By M.M.

**SAMPLE CONDITION**

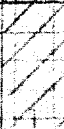


 **UNDISTURBED**  
 **FAIR**  
 **DISTURBED**  
 **LOST**

**SAMPLE TYPE**

S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
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
SOIL DESCRIPTION	COLOR	Density or Consistency	Depth (feet)	Legend	Sample No. and Condition	Sample Type	Water Level (feet)	WATER LEVEL, SOIL MOISTURE & REMARKS
Ice Surface			0.0					
			152.4					
Water			5.0					
			14.0					
Silty clay, slightly nuggety texture.	Gray	Soft	20.0		1	SS	4	M.C. 82.5% much wetter than Plastic Limit. Approx. Q/u 0.24 tons per sq. ft.
Clayey silt L.C. 33.3 P.L. 19.0 P.I. 14.3	Gray	Loose	22.0		2	SS	5	M.C. 38.7%. Instantaneous response to shake test. Unable to drive sampler below 25 ft.
		Compact	26.0					
(Casing and chopping bit refused on layer of very hard shale or limestone)								

VIRTUAL REFUSAL

**e. m. peto associates ltd.**  
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO  
**BOREHOLE LOG**

Job Name Hwy. 4 Reisin River Bridge Job No. 57<sup>th</sup> 47 Borehole No. 5  
Client Dept. of Highways of Ontario Casing BX Boring Date Jan. 16th - 17th, 1958.  
Datum D.H.O. Completed By E. M. Peto Checked By M.M.

**SAMPLE CONDITION**

 **UNDISTURBED**  
 **FAIR**  
 **DISTURBED**  
 **LGST**

**SAMPLE TYPE**

S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
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W.L. WATER LEVEL IN CASING  
W.T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample Type	No. of Blows per ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
Ice Surface			0 0 152.4				
Water			5 0 10 0 15 0				
Very silty fine to medium sand, some organic matter.	Dark Brownish Grey	Compact	20 0	1	SS	16	M.C. 30.5%
Medium to coarse sand, grits and small angular stones, some binder.	Dark Grey	Compact to Dense	25 0	2	SS	30	
Layer of hard shale.	Black		30 0	3	W.S.		Unab'e to drive split spoon more than 3"
Silty medium to coarse sand and fine angular gravel.	Grey-Brown	Compact to Dense	35 0	4	SS	38	Slight reaction with dilute hydrochloric acid
As above. Gravel to 1" fine grained dolomitic limestone.	Grey-Black	Hard	38 0	5	R.C.		Creavage slightly inclined from horizontal
As above with some fossils							
very fine grained shale from 37 to 38 ft.	Black	Hard					

HOLE TERMINATED



## BOREHOLE LOG

Checked By M.M.

### ABBREVIATIONS











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

### 9. UNCONFINED COMPRESSIVE STRENGTH

W T GROUND WATER TABLE IN

W. T. GROUND WATER TABLE IN SOIL

R. C. ROCK CORE





SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
Ice Surface			0' 0"					
			1' 0"					
			2' 0"					
			3' 0"					
			4' 0"					
			5' 0"					
			6' 0"					
			7' 0"					
			8' 0"					
			9' 0"					
			10' 0"					
			11' 0"					
			12' 0"					
			13' 0"					
			14' 0"					
			15' 0"					
Sandy and clayey silts, many grits and angular pebbles, organic traces	Grey	Compact to Dense	16' 0"		1 <input checked="" type="checkbox"/>	SS	27	Saturated
Fine to coarse sand, angular gravel and binder	Grey	Compact to Dense	17' 0"		2 <input checked="" type="checkbox"/>	SS	29	Very moist.
As above (Rock fragments up to 1-1/2")	Grey	Compact	18' 0"		3 <input checked="" type="checkbox"/>	SS	24	
As above	Grey	Dense	19' 0"		4 <input checked="" type="checkbox"/>	SS	43	Very moist.
			20' 0"		5 <input checked="" type="checkbox"/>	W.S.	-	Drilled open end A rod 25 ft. to 25'6". Refusal
Pulverized shale	Black	Hard	21' 0"					
Fine grained limestone, some inclusions of iron pyrites interbedded throughout with fossiliferous limestone	Greyish Black	Hard	22' 0"					No reaction with hydrochloric acid. Cleavage approximately 45° from horizontal. 93.7% core recovery.
			23' 0"					
			24' 0"					
			25' 0"					
			26' 0"					
			27' 0"					
			28' 0"					
			29' 0"					
			30' 0"					
			31' 0"					
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			249' 0"					
			250' 0"					
			251' 0					

**e. m. peto associates ltd.**  
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO  
BOREHOLE LOG

Job Name Hwy. 401 Raisin River Bridge Job No. 57147  
Client Dept of Highways of Ontario Casing BX  
Datum D.H.O. Compiled By E. M. Peto

Borehole No. 7  
Boring Date Jan. 14th - 15th, 1958.  
Checked By M.M.

**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.C. 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	Disturb. Condition	Sample Type	No. of Blows per Ft.	WATER LEVEL, SOIL MOISTURE, & REMARKS
Ice Surface			0' 0"					
			162.4					
Water			5' 0"					
			10' 0"					
			15' 0"					
			15' 0"					
Medium to coarse sand many angular rock fragments some binder As above rock fragments up to 1-1/4"	Grey	Compact to Dense			1	S.S.	30	Quite moist.
	Grey	Compact to Dense			2	S.S.	27	Quite moist.
			20' 0"					
Silty coarse sand with considerable angular fine gravel. As above.	Grey-Black	Compact			3	S.S.	19	
	Grey-Black	Dense			4	S.S.	53	Quite moist
			25' 0"					Compact only from 23 ft. to 25 ft.
Silty fine to coarse sand and gravel to 1-1/2"	Grey	Dense			5	S.S.	57	
	Grey	Very dense			6	S.S.	80	
Medium to coarse sand.	Grey-Black	Extremely Dense			7	W.S.	-	Casing refused at 27 ft. Drilled with open end A rod from 27 ft. to 31 ft.
Fragmented shale.	Black	Extremely Dense	31' 0"		8	W.S.	-	





HOE TERMINATED

**e. m. peto associates ltd.**  
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO  
**BOREHOLE LOG**

Job Name Hwy. 401 Raisin River Bridge Job No. 5747  
Client Dept. of Highways Of Ontario Casing BX  
Datum D.H.O. Compiled By E. M. Peto

Borehole No. 8  
Boring Date Jun. 13th 1958  
Checked By M.M.

**SAMPLE CONDITION**










-  UNDISTURBED
-  FAIR
-  DISTURBED
-  LOST

**SAMPLE TYPE**

- S.S. 2" STANDARD SPLIT TUBE SAMPLE
- S.L. SPLIT SAMREL 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.C. UNCONFINED COMPRESSIVE STRENGTH
- W.L. WATER LEVEL IN CASING
- W.T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOR	Consistency	Depth (feet)	Legend	Sample No.	Sample Type	Moisture (%)	WATER LEVELS, SOIL MOISTURE & REMARKS
Ice surface.			0' 0"					
			15' 4"					
			5' 0"					
			10' 0"					
			14' 0"					
Very silty clay, many grits and angular pebbles.	Grey	Stiff	20' 0"		1	S.S.	18	Saturated. Fair response to shake test.
Fine to coarse sand, many grits and angular rock fragments, some binder.	Grey	Compact to Dense	20' 0"		2	S.S.	34	
	Grey	Compact to Dense	20' 0"		3	S	27	quite moist. Stratum of loose to compact coarse to fine sand from 23 ft. to 25 ft.
Medium to coarse sand	Grey-Black	Loose to Compact	20' 0"		4	S.S.	11	
Fine to coarse sand, many grits and stones, considerable binder.	Grey	Dense	20' 0"		5	S.S.	52	
Pulverized shale	Black	Soft	20' 0"		6	S.S.	10	
						R.C.		Chopped to 33 ft.
Fine grained shale with thin bands of limestone	Black	Hard	33' 0"					
Dolomitic limestone	Grey-Black	Hard	35' 0"					
with some fossils 34-1/2 to 36-1/2 ft.	Black							
Fine grained shale	Black							No reaction with weak hydrochloric acid.
36-1/2 to 37-1/2 ft.								73% core recovery. Core very badly broken up. Drift hole did not stand up well.
Medium grained limestone	Grey-Black	Very hard	42' 0"					
Some very thin black layers of fossiliferous limestone	Black		42' 0"					

HOLE TERMINATED



**e. m. peto associates ltd.**  
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO  
**BOREHOLE LOG**

Job Name Hwy. 401 Raisin River Bridge Job No. 57747

Borehole No. 9





Client Dept. of Highways of Ontario Casing B.X.

Boring Date Jan. 12th - 12th, '958

Datum D.H.O. Compiled By E. M. Peto

Checked By M.M.

**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 SHELLY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

**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

SOIL DESCRIPTION	COLOR	Consistency	Depth (ft.)	Remarks	Sample Type	Number of Samples	Notes
Ice Surface			0				
Water			5				
			12				
			14				
Silty clay, nuggety	Grey	Very soft	17		1	3	M.C. 64.7% Much wetter than Plastic Limit M.C. 39.2%
Sandy and silty clay, many grits and angular rock fragments.	Dark Grey	Firm to Stiff	20		2	12	
As above	Dark Grey	Very stiff	25		3	32	
Medium to coarse sand, angular rock fragments	Grey	Dense	26		4	45	
Coarse sand and fine gravel in matrix of light grey silt.	Grey	Dense	27		5	52	Moist
As above.	Grey	Very dense	28		6	98	Encountering odd small boulder.
As above	Grey	Dense	30		7	34	For 6 Boulder at 30'6". C hopped to 32 ft. Ran rod to 33 ft. Shale cleavage from 33 ft to 33'3".
2" of black shale above fine grained limestone, some fossils.	Grey-Black	Hard	35				Lost wash water at 35 ft.
7" of black shale at bottom of core.							87.5% core recovery.
Limestone	Grey-Black	Hard	40				
			42				

HOLE TERMINATED

## BOREHOLE LOG

Checked By M.M.

R.C. ROCK CORE

[illegible]

# BOREHOLE LOG

Borehole No. 11

Boring Date Dec. 22nd - 23rd, 1957

Checked By M. M.

**SAMPLE TYPE**

## ABBREVIATIONS

 UNDISTURBED

 FAIR

☒ DISTURBED

**LOST**

### 5.5. 2<sup>nd</sup> STANDARD SPLIT TUBE SAMPLE

5.2. SPLIT BARREL WITH LINERS

S. T. THIN-WALLED SHELBY TUBE SAMPLE

W.S. WASH SAMPLE

R. C. ROCK CORE

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

Q/6 UNCONFINED COMPRESSIVE STRENGTH

W. L. WATER LEVEL IN CASING

W. T. GROUND WATER TABLE IN SOIL

[illegible]



## BOREHOLE LOG

Checked By M.M.

## ABBREVIATIONS

B.C. ROC

SOIL DESCRIPTION	COLOR	Dens Consistency	Geph. Elevation	Land	Sample No. and Condition	sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
Ice Surface			0'					Hole remained dry with casing to 14 ft. depth overnight.
Water			4' 2"					
Clay with thin layers of grey brown clay and some decayed wood.	Grey	Soft			1 X S.S.	S.S.	5	Approx. Q/u 0.5 t.s.f. M.C. 73.5%. Much wetter than Plastic Limit.
Clay with light grey layers at 1" intervals	Grey	Soft	10' 8"		2 X S.S.	S.S.	2	M.C. 58%
Sandy gravel with clay and silt binder, layers of silt.	Dark Grey	Loose			3 X S.S.	S.S.	6	
Coarse sand and gravel to 1-1/4", some binder	Dark Grey	Compact	15' 0"		4 X S.S.	S.S.	25	
Coarse sand with pebble gravel.	Very dark grey	Compact to Dense			5 X S.S.	S.S.	35	
Pea gravel and coarse sand, minor clay content	Dark grey	Compact	20' 0"		6 X S.S.	S.S.	22*	Odd subrounded 2" stone.
As above with more medium gravel.	Dark Grey	Compact to Dense			7 X S.S.	S.S.	32*	Loose from 21 ft. to 22 ft.
Coarse sand and fine to medium gravel, some binder.	Dark Grey	Compact	25' 1"		9 X S.S.	S.S.	22	
Medium sand and fine gravel, considerable clay binder.	Dark Grey	Dense			9 X S.S.	S.S.	40	
Medium and coarse sand, gravel and stones to 1-1/2", clay binder.	Dark Grey	Dense	29' 0"		10 X S.S.	S.S.	42	
								* trap valve in sampler.
					VIRTUAL REFUSAL.			

## BOREHOLE LOG

Checked By M. M.

R. C. ROCK CORE

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
Ground Surface			0' 0"					
			1' 6"					
			5' 0"					
Very silty clay, and luggety texture	Grey- Brown	Stiff			1	S.S.	18	M.C. 40.3%
			10' 0"					
Clayey silt with sand content, numerous angular rock fragments.	Mixed Brown-Grey	Compact			2	S.S.	14	Saturated
			15' 0"					
Medium to Coarse sand with angular rock fragments, some binder.	Grey- Black	Dense			3	S.S.	34	
			20' 0"					
As above.	Grey	Extremely Dense			4	S.S.	134	
			23' 0"					
				VIRTUAL REFUSAL				

## BOREHOLE LOG

Checked By M. M.

W.T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
Ground Surface	-	-	0' 8" 153.6					
Organic silt. Clay and silty fine sand	Black Grey-Brown	Very loose Loose	5' 9"	 	1 X	S.T. PUSHED		Super saturated 50% recovery from tube.
Sandy organic silt	-	-	10' 3"					M.C. 28.5%
Silty and sandy clay - Pockets of organic silt	Light Brown Grey-Brown	Very soft	13' 9"	 	2	S.T. PUSHED		Q/u 104 p.s.f. L.L. 35.5 M.C. 87.5% P.L. 20.6 P.I. 14.9
Sandy silt with considerable angular gravel	Gray	Dense	16' 0"		3 X	G.S.	39	Very moist.
Pulverized shale	Grey-Black		17' 0"		4 X	w.s.	-	
					VIRTUAL REFUSAL			



## BOREHOLE LOG

Checked By M.M.

W.T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Liquid Limit Plasticity Chart	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
Ground Surface	-	-	0.0 135.8					
Silty and sandy clay, some organic matter.	-	Fine						
-	-	-	4.0					
Silty fine sand with many rock fragments.	Brown Grey-black	Dense			I X SS	43	Moist	
-	-	-	10.0		VIRTUAL REFUSAL			
-	-	-						