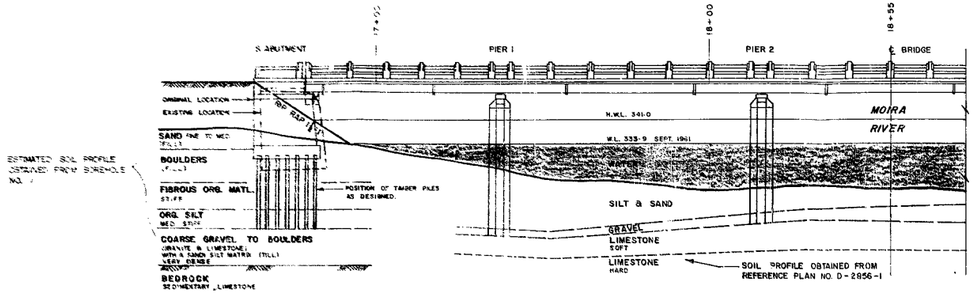
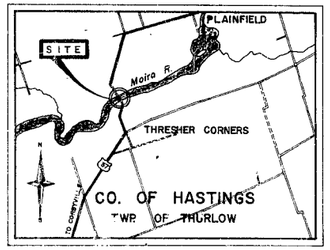
#
61-F-101
W.P.#276-60
HWY #37
MOIRA RIVER.



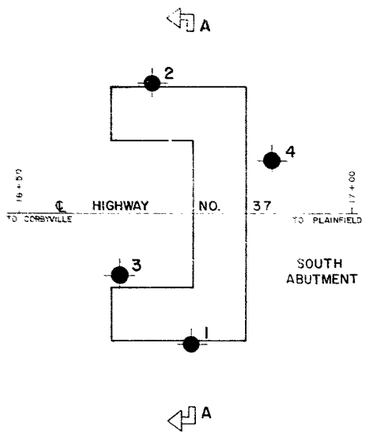
ELEVATION

SCALE: 1 inch = 20 feet



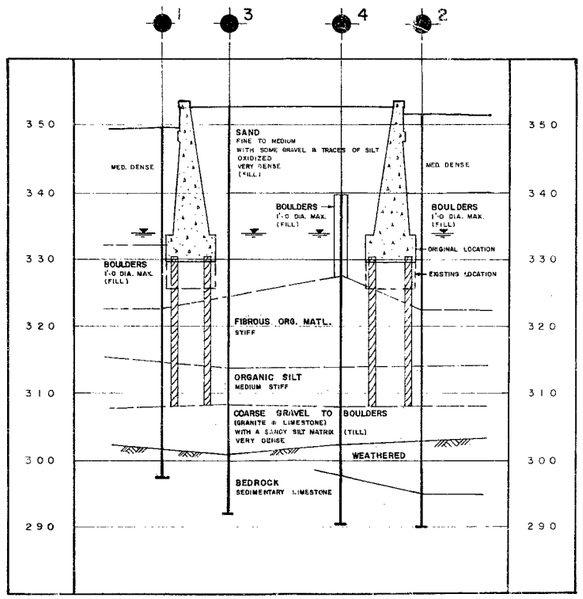
KEY PLAN

SCALE: 1 inch = 0·8 miles



PLAN

SCALE: 1 inch = 10 feet



A – A

SCALE: 1 inch = 10 feet

LEGEND

- BORE HOLE
- WATER LEVELS established at time of investigation (SEPT. 1961)

HOLE	ELEVATION	STATION	OFFSET
1	349·6	16+73	19·6' RT.
2	351·5	16+71	19·6' LT.
3	352·7	16+65	9' RT.
4	339·8	16+88	8' LT.

– NOTE –

THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BORE HOLE LOCATIONS. BETWEEN BORE HOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE AND MAY BE SUBJECT TO CONSIDERABLE ERROR.

REF. NO. D-2856-1

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH SECTION

MOIRA RIVER AND HIGHWAY NO. 37

ORIGINATED I. HOLUBEC	DISTRICT NO. 8	DATE 25 OCT. 1961
DRAWN D. MUMFORD	W.P. NO.	JOB NO. 61-F-101
CHECKED	SCALE AS SHOWN	DRAWING NO. 61-F-101A
APPROVED		

cc: Gen. Files

Mr. A. M. Toye,

Bridge Engineer.

Materials & Research Division,

(Foundation Section).

November 16, 1961.

D.H.O. FOUNDATION INVESTIGATION REPORT.

W.J. 61-F-101.

Attention: Mr. S. McCombie,

re: -- Abutment Failure --
Moira River Bridge & Hwy. #37,
County of Hastings, District #8.

We are forwarding to you, our detailed report on a foundation investigation carried out recently, to determine the cause of failure at the South abutment of the Moira River Bridge.

This report includes a brief history of the structure, description of subsoil conditions, conclusions regarding possible causes of failure, as well as recommendations pertaining to remedial measures.

We believe the information contained therein, should provide an adequate basis for your future design work in connection with this problem. If, however, clarification or further data are required, please do not hesitate to contact our Office.

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Attach.
cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
J. Ford
E. A. Cash
J. E. Gruspier
T. J. Kovich
J. Roy
E. R. Saint
F. Norman
Foundations Office
Gen. Files

cc: Gen. Files

2-8-5

Mr. A. M. Toye,

Bridge Engineer.

Materials & Research Division,

(Foundation Section).

November 16, 1961.

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FOUNDATION INVESTIGATION

For

ABUTMENT FAILURE

At

Moira River Bridge & Hwy. #37,
County of Hasting, District #8,
W.J. 61-F-101.

1. INTRODUCTION:

A subsoil investigation was carried out by this Section at the Moira River Bridge to investigate the possible causes of, and remedy for, the excessive and continued settlement of the southern abutment of the bridge. The bridge is located on Hwy. 37, about 8 miles north of Belleville, and spans the Moira River.

In this report are contained the results and the discussion of the field and laboratory investigation, as well as conclusions and recommendations.

2. DESCRIPTION OF BRIDGE, SITE AND GEOLOGY:

Moira River Bridge is a five-span, 152-ft. long, continuous structure with simple supports at the abutments. The southern abutment was founded on timber piles driven 20 ft. down to limestone bedrock.

The bridge was built in 1946, and immediately after completion, settlement took place, being about 2 ft. in the first month. The rate of settlement decreased during the next 6 months but has continued at a slower rate to the present time. As of the

cont'd. /2 ...

TABLE OF CONTENTS

2. DESCRIPTION OF BRIDGE, SITE AND GEOLOGY: (cont'd.) ... last measurement, the abutment has settled 4.2 ft. and moved inward 1.2 ft. at the bottom.

At the site, the Moira River is wide and shallow, and has a small rate of flow. Its bed has been cut out in limestone bedrock and the banks and flood plains of the present river are mostly swamp deposits. The bedrock has a thin mantle of a granular till consisting of angular fragments, blocks of limestone and some pre-Cambrian rocks with a sandy silt matrix. The bedrock is a sedimentary limestone of the Black River group.

3. FIELD INVESTIGATION PROCEDURE:

In order to determine the subsoil conditions existing at the abutment location, four sampled boreholes were carried out. Samples were recovered, using a split spoon and thin-walled Shelby tubes. Samples recovered in the split spoon were used for classification purposes, only. Shelby tube samples were used for classification and various laboratory tests.

All boreholes were advanced at least 5 ft. into sound bedrock.

Water level observations were made in each borehole during the investigation.

The locations and elevations of boreholes are shown on the accompanying plan, Drawing #61-F-101A.

cont'd. /3 ...

4. LABORATORY INVESTIGATIONS:

Samples were visually examined and classified at the site as well as in the laboratory.

Tests were carried out in the laboratory on a selection of undisturbed samples to determine:-

(a) Natural Moisture Content.

(b) Liquid and Plastic Limits.

(c) Grain Size Distribution.

(d) Undrained Shear Strength.

The results of these tests are shown in the appendix of this report.

5. SUBSOIL CONDITIONS:

5.1) General:

Four boreholes were drilled around the abutment and they revealed that from a certain depth, the stratification of the subsoil is quite regular. This depth corresponds to the original ground surface and is around elevation 322' to 325'. Below this elevation, there is an approx. 10-ft. thick layer of fibrous organic material, followed by an approx. 5-ft. thick layer of organic silt overlying some 5 to 7 ft. of dense coarse gravel with boulders which, in turn, overlies limestone bedrock.

Above the original ground level, there is exposed rock fill in front of the abutment and rock fill covered by the sand and gravel fill material on the sides of the abutment. Behind the abutment, there is only sand and gravel fill.

cont'd. /4 ...

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

5.1) General: (cont'd.) ...

A detailed description of all these materials is given in the following paragraphs:-

5.2) Sand and Gravel Fill:

This material is a fine to medium sand containing some gravel and traces of silt. The gravel is well rounded and its maximum diameter is about 2 inches. It is oxidized throughout its depth and as a result, has a brown colour. This material forms the approach embankments of the south abutment and was found in B.H. No's. 1, 2 and 3. In B.H. No.'s. 1 and 2, it overlies the original rip-rap material around the abutment and has a medium dense relative density, while in B.H. No. 3, which was located inside of the wingwalls, it extends to the organic material and has a dense relative density.

5.3) Rock Fill:

This material was observed at the sides and in front of the abutment. It consists of rounded rocks, mainly of igneous origin, with a maximum diameter of 2 ft,, and average diameter of 1 ft. It was observed in B.H. No.'s. 1, 2 and 4, and was originally placed as rip-rap material to protect the slopes against scour. The depth of the layer varied from 11 ft. to 18 ft.

5.4) Fibrous Organic Material:

This stratum consists of a black, fibrous peaty material containing identifiable fragments of wood. The stratum marks the surface of the natural soil deposit and it extends from an average

cont'd. /5 ...

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

5.4) Fibrous Organic Material: (cont'd.) ...

elevation of 323 ft. to approximately elevation 314 ft., where it gradually changes to organic silt. The material has a stiff consistency and a relatively high in-situ shear strength, as measured with the field vane. This is due to the fact that over the past 15 years, consolidation has taken place under the weight of the abutment and approach fill.

Field vane shear strength results varied from 1,200 to 2,240 p.s.f., while the undrained laboratory tests gave much lower values. The remoulded vane test results varied from 320 to 960 p.s.f, indicating quite a high sensitivity of the material. It is believed that the discrepancy between the field and laboratory shear strength results can be partially explained by the possible disturbance of the lab. samples, which would tend to decrease the lab. results, and partially by the fibrous character of the material, which would tend to increase the vane readings. It is believed that an undrained shear strength value of about 700 - 900 p.s.f. would be representative for this layer.

5.5) Organic Silt:

This stratum extends from elev. 314.0', and decreased in organic content with depth. The silt and sand content increases with depth until it becomes a sandy silt with traces of organic material at elevation 309.0'. The consistency varies from stiff to medium stiff, decreasing with depth. The colour changes from black at the organic material interface, to grey at the bottom of the layer. The following ranges of properties were established

cont'd. /6 ...

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

5.5) Organic Silt: (cont'd.) ...

for this material:-

	Min.	Max.
Liquid Limit		
Air-dried	66%	254%
Oven-dried	48%	67%
Plastic Limit		
Air-dried	26%	104%
Oven-dried	27%	-
Natural Moisture Content	50%	214%
Density p.c.f.	72.6	104.9

The above results are a clear indication of the organic character of the material. The slight increase in plastic limit of the oven-dried sample has to be attributed to the heterogeneity of the material.

The field vane results varied from 800 to 1,920 p.s.f. with the remoulded values of 140 to 640 p.s.f. Here again, the laboratory undrained shear strength tests produced smaller values. As can be seen from the other mentioned results, the material has quite a high organic content and quite a high silt content. For this layer, a representative undrained shear strength value would be 800 p.s.f.

cont'd. /7 ...

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

5.6) Coarse Gravel to Boulders with a Sandy Silt Matrix (Till):

This stratum is about 5-1/2 ft. thick and lies immediately above the bedrock. The material is a very dense glacial till with about 75% content of boulders and coarse gravel. The boulders and gravels consist of angular limestones and rounded granitic rocks.

5.7) Limestone Bedrock:

Limestone bedrock is found below elevation 298 ft., and is a sedimentary limestone of the Black River Formation. The limestone is stratified with grey and black strata. The black strata are thinner (1/2" to 2" thick), have visible fossils and are similar to a shale. The grey strata (2" to 8" thick) have a greater hardness and consist of fossiliferous limestone. Weathered bedrock of 4 ft. and 8 ft. was found in boreholes No. 2 and 4, respectively.

6. GROUND WATER OBSERVATIONS:

The ground water level was found to be at elevation 33.9 ft. in all boreholes, coinciding with the river water level, at the time of investigation.

7. DISCUSSION AND RECOMMENDATIONS:

The structure was completed in 1946, and over the past 15 years, the south abutment, which was designed to be supported on timber piles, has settled a total amount of 4.2 ft.

cont'd. /8 ...

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

A time-settlement curve completed on the basis of available settlement records, is presented in the appendix of this report. It can be seen that immediately after completion of the bridge, very large settlements took place. The curve has the shape of a typical odometer settlement curve of a very compressible soil, and it is therefore concluded that the piles have actually never acted as an end-bearing support. It is practically impossible today, to establish the real facts but two reasons are mentioned as possible explanations:-

1. Either the piles were too short and as such, never reached the bearing stratum of coarse gravel with boulders or bedrock; or -

2. the piles were overdriven and therefore shattered and broken and as such, never acted as end-bearing supports.

There is no evidence that the piles are presently contributing anything to the stability of the embankment. The present actual condition of the piles is also not known.

On the basis of the shape of the time-settlement curve, it can be concluded that the settlements are still taking place, although at a slow rate, and also that the end cannot even be predicted. There are no settlement records available between 1955 and 1961 and the curve has been assumed. It seems that in

cont'd. /9 ...

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

this period, an additional load has been added and therefore the amount of settlement has increased.

The present investigation has revealed that the subsoil immediately below the footing consists of a very compressible layer of organic material extending for about 15 feet, underlain by a layer of coarse gravel and boulders underlain, in turn, by limestone bedrock.

This stratigraphical profile is quite compatible with the recorded settlements under the assumption that the piles have not and are not fulfilling their intended function as end-bearing supports, because of some assumed but not established reason. It can therefore be concluded that any additional load would create further settlements and also, possibly, a shear failure, as very rough stability calculations indicate that the factor of safety is rather low.

It is therefore recommended that a new abutment be built, founded on steel 'H' piles driven to limestone bedrock, or to practical refusal in the coarse gravel layer. In this layer, refusal may easily be encountered because of the presence of boulders.

Support for the end span during construction, could be obtained by means of a temporary structure also supported on 'H' piles. Prior to removing the existing abutment, the approach fill should be excavated with a forward slope not steeper than 2:1. The design of the piles for the abutment must take into account the horizontal thrust caused by the weight of the approach fill.

cont'd. /10 ...

8. SUMMARY:

The south abutment of the Moira River bridge has settled a total of 4.2 ft. over the past 15 years. The abutment was designed to rest on timber piles, but on the basis of the available evidence, it appears that the piles never acted as abutment supports.

The presence of an approx. 15-foot thick layer of compressible organic soil is quite compatible with the observed settlements. There is no doubt that any additional load would cause additional settlements, possibly also, a shear failure. Rough stability calculations indicate the factor of safety to be rather low.

It is recommended that a new abutment, founded on steel 'H' end-bearing piles driven to bedrock, or practical refusal in the coarse gravel layer with boulders. Temporary supports for the end span should be also founded on 'H' piles driven to refusal.

9. MISCELLANEOUS:

The field work was carried out from September 28 to October 11, 1961, by F. E. Johnston Drilling Co., Ltd., using a diamond core drill adapted for soil testing. The work was supervised by Mr. I. Holubec for the Ontario Department of Highways.

November 1961. REPORT PREPARED BY: .....

I. Holubec,
PROJECT FOUNDATION ENGR.

REPORT APPROVED BY: .....

K. G. Selby,
SR. PROJECT FOUNDATION ENGR.

APPENDIX 1.

SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-101

W.P. -

HOLE NO.	SAMP. NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
1	T1	26'-9"-28'-3"	Fibrous organic material, medium stiff, black.	Pushed	-	-	-	-	-	No Recovery.
	T2	28'-10"-30'-4"	- " -	Pushed	214	-	-	740	72.6	Small F. Vane (30'-4"-32'-0") S.S. = 2240 p.s.f. R. S.S. = 960 p.s.f.
	T3	32'-0"-33'-6"	- " -	Pushed	172	-	-	780	75.1	
	T4	33'-6"-35'-0"	Fibrous organic material, medium stiff with traces of silt, black.	Pushed	-	-	-	-	-	
	T5	35'-0"-36'-6"	Organic material, medium stiff, with some silt, black.	Pushed	126	254 (Natural) 68.5 (Oven Dried)	65.5 67.4	805	79.6	Small Field Vane (36'-6"-38'-0") S.S. = 1920 p.s.f. R. S.S. = 640 p.s.f.
	T6	39'-6"-40'-2"	Sandy silt, medium stiff, grey.	Pushed	-	-	-	-	-	
	S7	40'-2"-41'-8"	Gravel, poorly graded, silty sand and gravel. Dense, grey.	36	-	-	-	-	-	
	RC8	42'-0"-47'-0"	Coarse gravel and boulders (granite and Limestone) with a sandy silt matrix, Very dense (Till).	Coring	-	-	-	-	-	Recovery 30%.
	RC9	47'-0"-52'-0"	Sound Limestone bedrock.	Coring	-	-	-	-	-	Recovery 98%.

SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-101

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2	S1	5.0'-6.5'	Sand, fine to medium, with some gravel and traces of silt, medium dense brown (Fill Material).	11	-	-	-	-	-	
	T2	29'-4"-30'-10"	Fibrous organic material, medium stiff, black.	Pushed	-	-	-	-	-	
	T3	30'-10"-31'-6"	- " -	Pushed	-	-	-	-	-	
	T4	31'-5"-33'-0"	- " -	Pushed	-	-	-	-	-	
	S5	33'-0"-34'-6"	- " -	11	-	-	-	-	-	
	S6	34'-6"-36'-0"	- " -	8	-	-	-	-	-	
	S7	36'-0"-37'-6"	- " -	8	-	-	-	-	-	
	T8	37'-9"-39'-0"	Organic silt, stiff, black.	Pushed	-	- (Natural)	-	-	-	Small Field Vane (39'-0"-40'-6")
	T9	40'-5"-42'-0"	Clayey silt with traces of organic material, grey.	Pushed	50.5	25.2 (Oven 27.4	71.0 Dried) 48.0	680	104.9	S.S. = 1600 p.s.f. R. S.S. = 480 p.s.f.
	RC10	43'-4"-48'-10"	Coarse gravel to boulders (Granite & Limestone) with a sandy silt matrix (Till).	Coring	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-101

W.P. -

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2	RC11	48'-10"-51'-6"	Weathered Limestone.	Coring	-	-	-	-	-	
	RC12	51'-6"-54'-0"	- " -	Coring	-	-	-	-	-	Drilling from 43'-4"-55'-0"-11'-8"
	RC13	54'-0"-55'-0"	- " -	-	-	-	-	-	-	Recovery from above 6'-8" = 57%.
	RC14	55'-0"-56'-6"	- " -	-	-	-	-	-	-	Recovery 50%.
	RC15	56'-6"-61'-6"	Sound Limestone bedrock.	-	-	-	-	-	-	Recovery 100%.
3	S1	5.0'-6.5'	Sand, fine to medium, with some gravel and traces of silt. dense, brown (Fill Material).	32	-	-	-	-	-	
	S2	10.0'-11.5'	- " -	56	-	-	-	-	-	
	S3	15.0'-16.5'	- " - med. dense, brown (Fill Material).	15	-	-	-	-	-	
	S4	20.0'-21.5'	- " - Very dense brown (Fill Material).	108	-	-	-	-	-	
	S5	25.0'-26.5'	Clayey silt with some sand, loose, grey (Fill Material).	3	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-101

W.P. -

HOLE NO.	SAMP. NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
3	T6	30.0'-31.6'	Fibrous organic material, stiff, black.	Pushed	122	(Natural) 154.0	104.0	-	-	Large Field Vane (32.0'-33'-6") S.S. = 1600 p.s.f. R. S.S. = 240 p.s.f.
	T8	40.0'-41.6'	Organic silt, stiff, black.	Pushed	-	-	-	-	-	Large Field Vane (42.0'-43-6') S.S. = 800 p.s.f. R. S.S. = 140 p.s.f.
	RC9	44.0'-49.0'	Coarse gravel to boulders (Granite & Limestone) with a sandy silt matrix (till) very dense, grey.							Recovery = 27%.
	RC10	49.0'-51.6'	Coarse gravel to boulders (Granite & Limestone) with a sandy silt matrix (till) very dense, grey.	Core	-	-	-	-	-	Recovery = 70%.
	RC11	51.5'-55.5'	Limestone bedrock.	Core	-	-	-	-	-	Recovery = 100%.
	RC12	55.5'-60.5'	- " -	Core	-	-	-	-	-	Recovery = 100%.
4	T1	12'-3"-13'-9"	Fibrous organic material, stiff, black.	Pushed	-	-	-	-	-	
	T2	14'-5"-15'-11"	- " -	Pushed	-	-	-	p.p.= 600	-	Small Field Vane (16.0'-17.5') S.S. = 1280 p.s.f. R. S.S. = 440 p.s.f.
	T3	18'-8"-20'-2"	- " -	Pushed	-	-	-	p.p.= 800	-	Small Field Vane (20'-2"-21'-8")

SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-101

W.P. -

HOLE NO.	SAMP. NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
4	T3									S.S. = 1200 p.s.f. R. S.S. = 320 p.s.f.
	T4	23'-8"-25'-2"	Fibrous organic material, stiff, black.	Pushed	-	-	-	p.p.= 600	-	
	T5	25'-8"-27'-2"	- " -	Pushed	-	-	-	390	p.p.= 600	Small Field Vane (27'-2"-28'-8")
	T6	29'-8"-31'-2"	Organic silt, soft grey.	Pushed	-	-	-	657	p.p.= 400	S.S. = 1440 p.s.f. R. S.S. = 320 p.s.f.
	RC7	33'-0"-37'-4"	Coarse gravel to boulders (granite & Limestone) with a sandy silt matrix Very dense.	Coring	-	-	-	-	-	Recovery = 54%.
	RC8	37'-4"-41'-4"	Weathered Limestone.	Coring	-	-	-	-	-	Recovery = 67%.
	RC9	41'-4"-46'-6"	Sound Limestone bedrock.	Coring	-	-	-	-	-	Recovery = 100%.
	RC10	46'-6"-49'-3"	Sound Limestone bedrock.	Coring	-	-	-	-	-	Recovery = 75%.
			RC denotes Rock core sample. T " shelby tube " S " split spoon "							

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. -

JOB 61-F-101

DATUM 349.6

BORING DATE Sept.29/61.

BORE HOLE NO. 1

STATION 16+76 (19.6' Rt. of ℄

COMPILED BY I.H.

CHECKED BY I.H.&K.S.

2" DIA. SPLIT TUBE

2" SHELBY TUBE

2" SPLIT TUBE

2" DIA. CONE

2" SHELBY

CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Qu)

VANE TEST (C) AND SENSITIVITY (S)

NATURAL MOISTURE AND LIQUIDITY INDEX

LIQUID LIMIT

PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	↓ Groundlevel	349.6	0
	Sand, fine to med., with some gravel and traces of silt, oxidized, med. dense, brown. (Fill Material).		10
	W.L. ▽	333.9	
	Boulders, Average diam. 1ft. (Fill Material).	332.1	20
	Fibrous organic material, medium stiff, black.	322.6	30
	Organic silt, medium stiff and grey.	314.6	40
	Coarse gravel & boulders (granite & limestone) with a sandy silt matrix. Very dense (IIII)	308.0	
	Limestone bedrock.	302.6	50
	End of borehole.	297.6	60

STRENGTH AND PENETRATION RESISTANCE

P.S.F. 250 500 750 1000

BLOWS/FT. 25 50 75 100

CONSISTENCY

MOIST. CONTENT - % DRY W. 0 50 100 150 200

SAMPLE	NATURAL UNIT WT. P.C.F.
T1	-
T2	72.6
T3	75.1
T4	79.6
S7	-
RC8	-
RC9	-

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. -

JOB 61-F-101

DATUM 351.5

BORING DATE Oct. 3/61.

BORE HOLE NO. 2

STATION 16+70(19.6'Lt of ℄)

COMPILED BY I.H.

CHECKED BY I.H.&K.S.

2" DIA. SPLIT TUBE

2" SHELBY TUBE

2" SPLIT TUBE

2" DIA. CONE

2" SHELBY

CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Qu)

VANE TEST (C) AND SENSITIVITY (S)

NATURAL MOISTURE AND LIQUIDITY INDEX

LIQUID LIMIT

PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Groundlevel	351.5	0
	Sand, fine to med., with some gravel and traces of silt, oxidized, Med. dense brown. (Fill Material).	341.5	10
	Boulders, average diam. 1ft., (Fill Material) W.L. ▽	333.9	20
		325.5	30
	Fibrous organic material, med. stiff, black.	313.0	40
	Organic silt, med. stiff, grey.	308.0	
	Coarse gravel to boulders (granite & limestone) with a sandy silt matrix (Till) Very dense.	302.5	50
	8 ft. of weathered limestone		
	Limestone bedrock.	290.0	60
	End of borehole.		70

STRENGTH AND PENETRATION RESISTANCE

P.S.F. 250 500 750 1000

BLOWS/FT. 25 50 75 100

CONSISTENCY

MOIST. CONTENT - % DRY WT. 0 50 100 150 200

SAMPLE

NATURAL UNIT WT P.C.F.

S1 -

T9 104.9

RC10 -

RC11 -

RC15 -

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. - BORE HOLE NO. 3

JOB 61-F-101 STATION 16/65 (9' Rt of ℄)

DATUM 352.7 COMPILED BY I.H.

BORING DATE Oct. 5/61. CHECKED BY I.H.&K.S.

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Qu) O
VANE TEST (C) AND SENSITIVITY (S) +
NATURAL MOISTURE AND LIQUIDITY INDEX X
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Groundlevel	352.7	0
	(Upper 1 ft bituminous road surface) Sand, fine to medium, with some gravel and traces of silt, oxidized Very dense, brown. (Fill material). w.l. ▽	333.9	10
			20
		324.7	30
	Fibrous organic material, medium stiff, black.	313.7	40
	Organic silt, medium stiff, grey.	308.7	
	Coarse gravel to boulders (granite & limestone) with a sandy silt matrix (till) Very dense, grey.	301.1	50
	Limestone Bedrock.	292.1	60
	End of borehole.		

STRENGTH AND PENETRATION RESISTANCE P.S.F.
BLOWS/FT 25 50 75 100

CONSISTENCY
MOIST. CONTENT - % (DRY W.) 0 50 100 150 200

SAMPLE

S1
S2
S3
S4
S5
T6
S7
T8
RC9
RC10
RC11
RC12

NATURAL UNIT WT. P.C.F.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. - BORE HOLE NO. 4

JOB 61-F-101 STATION 16+38 (8' Lt of ℄)

DATUM 339.8 COMPILED BY I.H.

BORING DATE Oct. 11/61. CHECKED BY I.H.&K.S.

LEGEND

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

1/2 UNCONFINED COMPRESSION (Qu) ○
VANE TEST(C) AND SENSITIVITY(S) +
NATURAL MOISTURE AND LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Groundlevel	339.8	0
	Boulders, average diam. 1 ft. w.l. ▽ (Fill Material)	333.9	
		327.8	10
	Fibrous organic material, medium stiff, black.		20
		312.8	
	Organic silt, medium stiff, grey.	307.8	30
	Coarse gravel to boulders (granite & limestone) with a sandy silt matrix (Till) V. dense.	302.5	40
	4 ft. of weathered limestone.		
	Limestone bedrock.	290.8	50
	End of borehole.		60

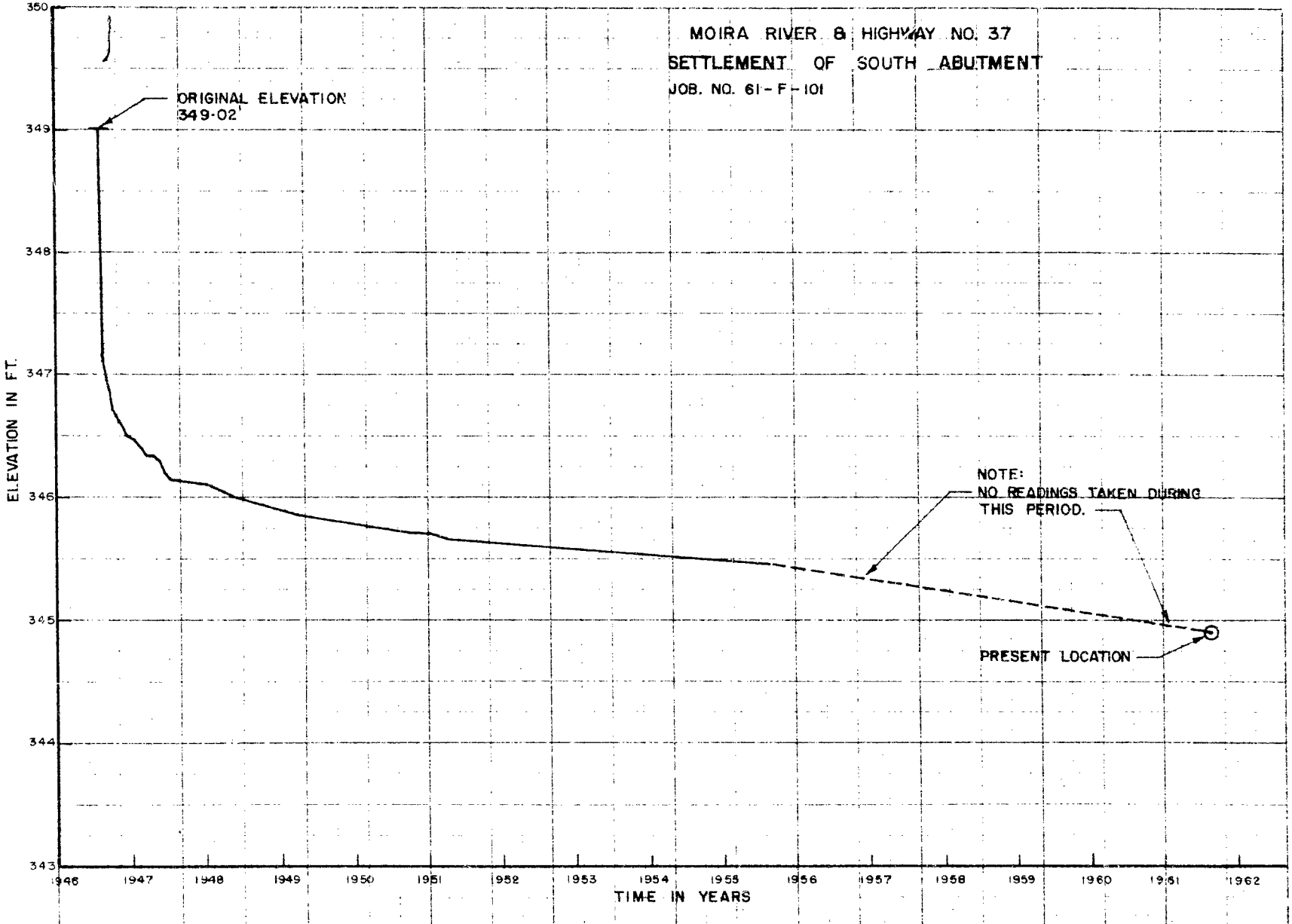
STRENGTH AND PENETRATION RESISTANCE
P.S.F. 250 500 750 1000
BLOWS/FT. 25 50 75 100

CONSISTENCY
MOIST CONTENT % DRY WT.

SAMPLE

NATURAL UNIT WT. P.C.F.

T1
T2
T3
T4
T5
T6
RC7
RC8
RC9
RC10


MOIRA RIVER & HIGHWAY NO. 37
SETTLEMENT OF SOUTH ABUTMENT
JOB. NO. 61-F-101
ORIGINAL ELEVATION
349-02'
NOTE:
NO READINGS TAKEN DURING
THIS PERIOD.
PRESENT LOCATION
ELEVATION IN FT.
350
349
348
347
346
345
344
343
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
TIME IN YEARS