

66-F-289M

KIRKFIELD

CAUSEWAY

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A.S.T.M.

**REPORT
OF A
SITE INVESTIGATION
KIRKFIELD CAUSEWAY**

INTRODUCTION

This investigation was requested by Mr. D. L. Valentine, P.Eng., representing the County of Victoria. The purpose of the project was to investigate the causes for the road failure on the Kirkfield Causeway.

METHOD OF DRILLING

A skid mounted diamond drill was used throughout the investigation. NX and EX casing was driven down to sampling depths and on to refusal. The casing was cleaned with high pressure water before each sampling operation.

Two boreholes were completed in this manner. One borehole was located in the centre of the failure area and the other 290' to the east on the unaffected roadway.

METHOD OF SAMPLING

As none of the material encountered was cohesive, split spoon samplers were used throughout for obtaining penetration data and to recover samples for identification. Bedrock was drilled and sampled with use of an AXT corebit and barrel.

SOIL DESCRIPTION

A compact granular road fill was found to a depth of 23'-6" and 9'-9" in boreholes 1 and 2 respectively. An area of very loose material was found from 9'-10" to 13'-0" in borehole No. 1. At the time of construction the road was built on a log mat. Approximately 7'0" of muskeg was found below the fill material. Silt and sand with some clay was then found to a depth of 40'-6" and 29'-5" in boreholes 1 and 2 respectively. A compact to dense glacial till was found to refusal depth at 32'-11" in borehole No. 2. Weathered limestone was struck at 40'-6" in borehole No. 1.

CONCLUSIONS

From the drilling results, it is apparent that this causeway was built on corduroy logs overlying muskeg. The significant feature is that the muskeg is 10 to 15 feet lower at Borehole No. 1 which is the disturbed area, than in Borehole No. 2. It would appear that over the years there has either been a gradual displacement of muskeg laterally with a necessary build-up of the road surface to keep it above water level or alternatively that this section of the causeway crossed an old creek bed or some such natural feature.

From the cross sections which you have supplied me with I notice no significant upheaval of the river bottom indicating no classical slip. Therefore it is probable that no slide has developed in the past. None the less, I notice that now there is an occurrence of muskeg above the water level which was not there on my first visit in August.

I am of the opinion that this last upheaval was probably caused by the sides of the embankment reaching a factor of safety of 1 and consequently sliding into the water and bringing the muskeg to the surface.

RECOMMENDATIONS

To remedy this situation I can see no other way than to build out into the water a berm of some 30' width running along the full length of the disturbed section with an additional 25' or more on either end. This fill material should be of large broken rock or boulders.

No corresponding instability was observed at the other side of the road. Nevertheless, I would expect from the drilling reports that this side might be unstable and an eye should be kept on it for possible deterioration.

All of which is respectfully submitted.



E. O. Butts, P.Eng.

October 6th, 1966.

Ottawa, Ontario.

EOB/ms

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BUTTS ROSS & ASSOCIATES TESTING LABORATORY

The abbreviations commonly used on the borehole logs and in the text of the report are as follows:

SAMPLE TYPES

A.S. - Auger Sample	S.S. - Split Spoon
F.S. - Foil Sample	T.O. - Thin-walled, Open
R.C. - Rock Core	T.P. - Thin-walled, Piston
S.T. - Slotted Tube	W.S. - Wash Sample

PENETRATION RESISTANCES

Dynamic Penetration Resistance - The energy required to drive a 2 inch diameter, 60 degree cone attached to the end of the drilling rods into the ground: expressed in blows per foot, as in standard penetration.

Standard Penetration Resistance - The number of blows by a 140 pound hammer dropped 30 inches required to drive a 2 inch split spoon sampler one foot into the ground.

Sampler advanced by static weight - weight, hammer - Wh
 Sampler advanced by pressure - pressure, hydraulic - Ph
 Sampler advanced by pressure - pressure, manual - Pm

SOIL DESCRIPTION

The terminology for the descriptions of the relative density of cohesionless soils and the consistency of cohesive soils is as follows:

<u>Relative Density</u>	<u>Blows/ft.</u>	<u>Consistency</u>	<u>c, lbs./sq. ft.</u>
Very Loose	0 to 4	Very Soft	Less than 250
Loose	4 to 10	Soft	250 to 500
Compact	10 to 30	Firm	500 to 1,000
Dense	30 to 50	Stiff	1,000 to 2,000
Very Dense	over 50	Very Stiff	2,000 to 4,000
		Hard	over 4,000



Organic material



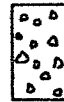
Clay



Silt



Sand



Gravel



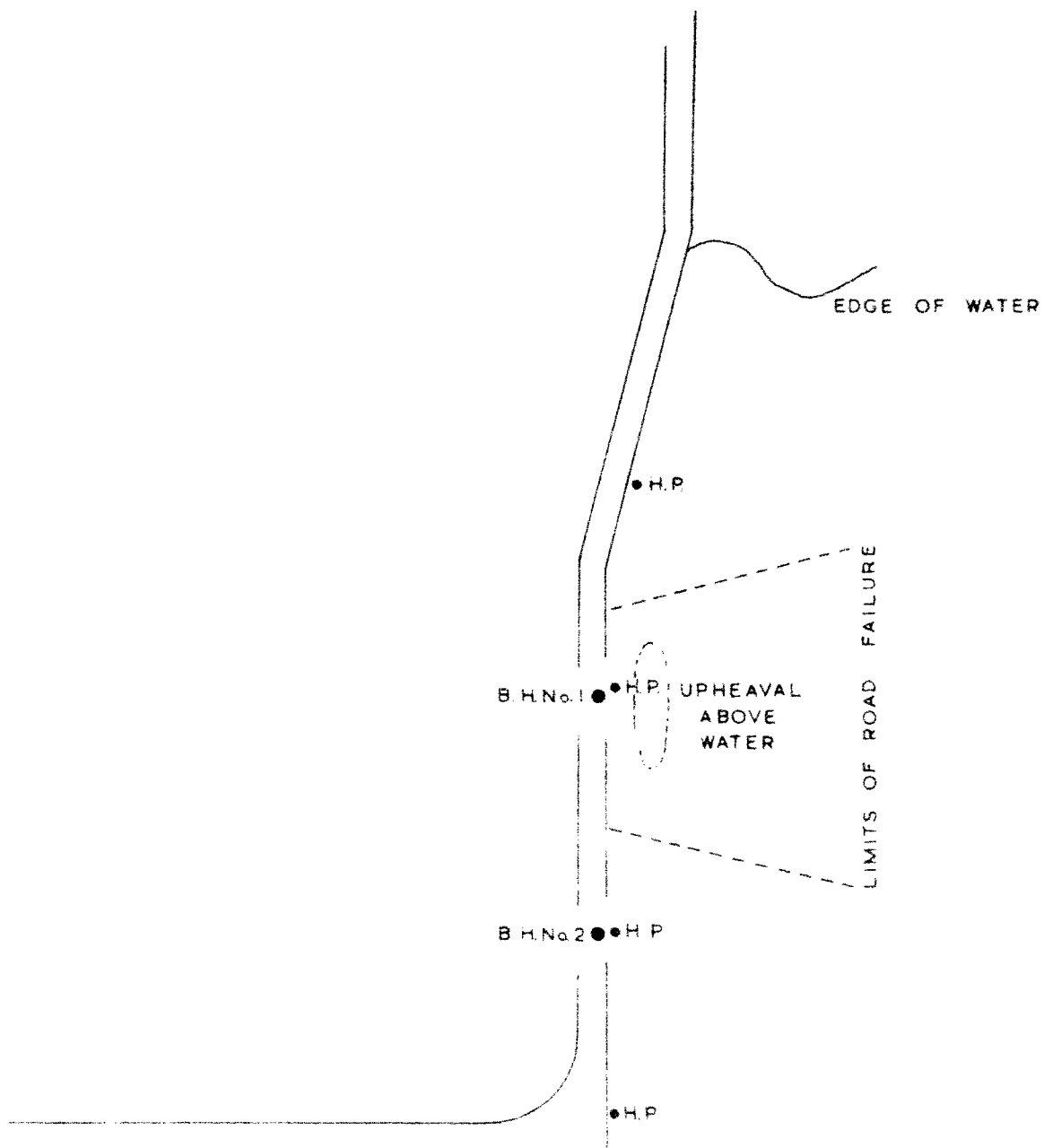
Bedrock

Trace	0 to 10 %
Some	10 to 20 %
Sandy, Silty, etc.	20 to 35 %
And	35 to 50 %

(+) or (-) sign indicates upper or lower limits within the range

SOIL TESTS & PROPERTIES

A.L. - Atterberg Limits	K - Coefficient of Permeability
C - Consolidation	MC - Moisture Content
S - Drained Triaxial	LL - Liquid Limit
V - Field Vane Test	PL - Plastic Limit
H. - Hydrometer Analysis	PI - Plastic Index
LP - Laboratory Permeability	UW - Unit Weight
FP - Field Permeability	Und. - Undisturbed Shear Strength tons/sq. ft.
Q - Undrained Triaxial	Rem - Remoulded Shear Strength tons/sq. ft.
U/C - Unconfined Compressive Strength ton/sq. ft.	Sen - Sensitivity und/rem
	G - Specific Gravity
	e - Void Ratio
	c - Undrained Shear Strength (1/2 Compressive Strength)



Scale 1" = 200'

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Plate No.

1

BUTTS, ROSS & ASSOCIATES LTD.
CONSULTING CIVIL ENGINEERS - OTTAWA, ONTARIO

BOREHOLE ANALYSIS
BOREHOLE NO. 1
DRILLING DATE Sept. 10, 196
TESTING DATE _____

CLIENT Victoria County
LOCATION Kirkfield Causeway

REMARKS _____

BOREHOLE ELEVATION _____

PENETRATION DATA	HAMMER	DROP
CASING		
CONE		
SAMPLER	140 lbs.	30 in.

DEPTHS MEASURED FROM GROUND LEVEL

Depth	Blows/ft	Cone Penetration Blows/foot	Description and Remarks	Sample		vane				Water Table
				Type No.	Blows/ft	MC	LL	PL	PI	
										W.L. 118"
			Compact gravel and F to C sand	SS1	17					
9'10"			Very loose gray F to C sand, some(+) gravel, some(-) silt	SS2	3					
13'			Compact gray C to F sand, some(+) gravel, trace silt	SS3	21					
					15					
					14					
			Loose gray F to C sand, some gravel, trace silt	SS4	13					
23'6"					6					
					6					
26'6"			Wood							
					5					
			Muskeg	SS5	14					

Symbols

MC = Moisture content
LL = Liquid limit
PL = Plastic limit
PI = Plasticity index
UC = Unconfined compressive strength tons/sq ft
UW = Unit weight
U = Undisturbed shear strength Tons/sq ft
rem. = Remoulded " "
sen. = Sensitivity - und rem

F = fine
C = coarse

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BUTTS, ROSS & ASSOCIATES LTD.
CONSULTING CIVIL ENGINEERS - OTTAWA, ONTARIO

BOREHOLE ANALYSIS
BOREHOLE NO. 1
DRILLING DATE Sept. 12, 1966
TESTING DATE

CLIENT Victoria County
LOCATION Kirkfield Causeway

REMARKS _____

BOREHOLE ELEVATION _____

PENETRATION DATA	HAMMER	DROP
CASING		
CONE		
SAMPLER	140 lbs.	30 in.

DEPTHS MEASURED FROM GROUND LEVEL

Depth	Cone Penetration				Description and Remarks	Sample		M.C.	L.L.	P.L.	P.I.	U.C.	Vane			U.W.	Water Table	
	Blows/ft	Blows/ft	Blows/ft	Blows/ft		Type No.	Blows/ft						und	rem	sen		Date	Time
33'2"						SS6	9											
					Compact gray silt		20											
					occ 1" layers of													
					clayey silt													
37'						SS7	19											
					Compact silty F to		17											
					C sand													
40'6"																		
					Cored 5' (40'6" to 46'6")													
					Recovered 5'1"													
					Partings 1" to 6"													
					Average 3"													
46'6"																		
					Weathered limestone													
					occ shale partings													
					2" seam at 41'3"													

Symbols

M.C. = Moisture content

L.L. = Liquid limit

P.L. = Plastic limit

P.I. = Plasticity index

U.C. = Unconfined compressive strength tons sq/ft

U.W. = Unit weight

und. = Undisturbed shear strength Tons/sq ft

rem. = Remoulded

sen. = Sensitivity - und rem

occ = occasional

F = fine

C = coarse

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Plate No.

CLIENT Victoria County
LOCATION Kirkfield County

REMARKS _____

BOREHOLE ELEVATION_____

PENETRATION DATA	HAMMER	DROP
CASING		
CONE		
SAMPLER	140 lbs	30 in.

DEPTHS MEASURED FROM GROUND LEVEL

[illegible]

Symbols

MC = Moisture content
 LL = Liquid limit
 PL = Plastic limit
 PI = Plasticity index
 U/C = Unconfined compressive strength (tons/sq.ft)
 U.W = Unit weight
 und = Undisturbed shear strength (Tons/sq.ft)
 rem = Remoulded " " "
 sen = Sensitivity - $\frac{und}{rem}$

DEF

He is fine

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Plate No.

3

PENETRATION DATA	HAMMER	DROP
CASING		
CONE		
SAMPLER		

BOREHOLE ELEVATION_____

[illegible]

M.C. = Moisture content
 L.L. = Liquid limit
 P.L. = Plastic limit
 P.I. = Plasticity index
 U.C. = Unconfined compressive strength tons sq/ft
 U.W. = Unit weight
 und. = Undisturbed shear strength Tons/sq ft
 rem. = Remoulded " " "
 sen. = Sensitivity - $\frac{\text{und}}{\text{rem}}$

F = fine
 C = coarse
 occ = occasional

1

Hwy. 401 & Keele St.,
Downsview, Ontario.

Materials and Testing Division

October 12, 1966

Mr. D. L. Valentine, P. Eng.,
County Engineer,
Court House,
Lindsay, Ontario.

Re: Maintenance Problems - County Road No. 9 - Causeway Section

Dear Sir:

With reference to your letter of October 11, 1966, and the attached report prepared by the consultant, Butts, Ross & Associates Ltd., we would like to make the following comments:

In our opinion the results of the investigation are insufficient to allow a more specific statement as to what caused the failure. Here, we would like to add that based on the cross sections you sent us, and your description of the event, there is no doubt in our minds that a failure has indeed occurred. As to whether a "classical" failure took place would depend on the consultant's definition of classical.

One or two boreholes in the water within the failed area would have, in our opinion, provided more useful data than the one (No. 2) outside the failure area, and an attempt could have been made to evaluate the subsoil profile perpendicular to the road's centre-line.

The only information presently available on the material within the area of ground upheaval, is that some muskeg has appeared above the water level.

Although we would not agree with the consultant's arguments and conclusions, we would partly concur with his recommendation as to the remedial measures. However, we still maintain that it would be more than just desirable to know more about the material on which the berm is to be placed.

cont'd. /2 ...

Mr. D. L. Valentine, P. Eng.,
County Engineer,
Court House,
Lindsay, Ontario.

October 12, 1966


It is our opinion that berming would be required in order to prevent further sudden subsidence, or what could be called failure. From the cross sections it can be seen that the ground heaved for a distance of up to 100 ft. from the centre-line. It would, therefore, appear that the consultant's recommendation for a 30-ft. wide berm is inadequate. A berm of some 80 - 90 ft. seems to be more appropriate. However, we would suggest that the berm be started some 30 ft. from the road's centre-line, thus forming an island. In our opinion, any material placed within the 30 ft. from the centre-line, would only aggravate the situation.

Apparently, muskeg became exposed above the water level. We would recommend a sandy gravel or sand as material for the berm. The use of large rocks or boulders could result in puncturing of the muskeg and sinkage of the rock to great depth. We wouldn't like to dispute that probably this would have the most desirable effect, but in view of the very likely tremendous quantities and consequently prohibitive cost, we feel that this should be avoided.

In view of the presence of muskeg under the road bed, it is very likely that some settlements will still be occurring and that even if further large and sudden movements are prevented, certain road maintenance will be required. It seems to us that it would indeed be warranted to give consideration to a road realignment.

If we can be of any further assistance, please do not hesitate to contact this Office.

Yours very truly,



A. G. Stermac,
Principal Foundation Engineer

AGS/Kder?

cc: Foundations Office ✓
Gen. Files

Hwy. 401 & Keele St.,
Downsview, Ontario.

Materials and Testing Division

August 18, 1966

Mr. D. L. Valentine, P.Eng.,
County Engineer,
Court House,
Lindsay, Ontario.

Re: Maintenance Problems -
County Road No. 9 -
Causeway Section

Dear Mr. Valentine:

Thank you for your letter of August 8, 1966, and the cross-sections of the above mentioned section of the road sent under separate cover.

The last incident that happened a while ago when the road surface suddenly dropped 3 feet and a small island formed in the canal, pretty well resolved the dilemma as to whether it is a shear failure or not. However, we would be inclined to define the problem as a combination of a shear failure and a slow subsidence or creep that was occurring earlier. Nevertheless, it is now quite evident that in order to prevent further sudden movements, berming of the road will have to be undertaken. The shape and length of the berm will have to be of the same order as the small island that was formed.

In order to proceed with these stabilization measures in a rational manner, I would suggest that a few boreholes be put down within the active area, and the subsoil and its properties be defined. It will be necessary to remove some of the material of the formed island, anyway, in order to build the required berm.

By building a counterbalancing berm, it is believed that any sudden movements of the road embankment will be eliminated. However, further slow settlements can still be expected and a certain amount of road maintenance will probably be required.

cont'd. /2 ...

Mr. D. L. Valentine, P.Eng., - 2 -
County Engineer,
Court House, Lindsay, Ont.

August 18, 1966

We would like to point out the benefit that can now be derived from the cross sections taken before and after the mentioned failure.

It should also be mentioned that the portion of the fill placed by the County forces after subsidence, although necessary, did further aggravate the precarious stability. This part of the fill is hardly balanced by the material which formed the island.

If we can be of any assistance, apart from doing the field investigation, please feel free to contact this Office.

Yours very truly,

A. G. Stermac

A. G. Stermac,
Principal Foundation Engineer

AGS/MleF

cc: Foundations Office ✓

Gen. Files

D. L. VALENTINE, B.S.A., B.A.Sc., P.Eng.

COUNTY ENGINEER AND
COUNTY ROAD SUPERINTENDENT



F-12A

COURT HOUSE
LINDSAY, ONT.

August 8th. 1966.

Mr. A. G. Stermac,
Principal Foundation Engineer,
Materials and Testing Division,
Department of Highways, Ont.,
Hwy. 401 & Keele St.,
Downsview, Ont.

Re: Maintenance Problems -
County Road No. 9 -
Causeway Section

Dear Sir:

The section of road in question
dropped about 3 feet overnight about a week
and a half ago, and a small island formed
between the road and the canal.

It therefore seems obvious that
sideways clippage is occurring. We are
negotiating to have soil borings taken, but
the cost of maintenance is getting a little
ridiculous.

I have sections of the area before
and after the drop occurred, and am sending
prints under separate cover.

Yours very truly,

D. L. Valentine
D. L. Valentine, P.Eng.,
County Engineer.

DLV/we

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