

60-F-324C

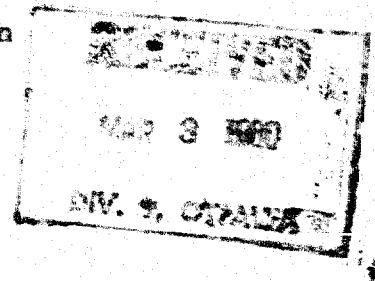
BAIE L'ORIGINAL

XXXXXXXXXXXXXXXXXXXX

14 Bayswater Avenue

Report of a Site Investigation  
at

BAIE L'ORIGINAL, ONTARIO.



Summary

60-F-324 C

The road can be preserved for some time to come by certain earthworks but the cost of this should be compared against relocating on the abandoned railway tracks. However, if some river control work is not done along the river bank the writer can foresee accelerated erosion when the Carillon Dam is completed and the river level is raised.

1. Introduction - This investigation was requested by Mr. J. Morin, P.Eng., County Engineer, Counties of Prescott and Russell. A road recently taken over from the township running around Baie l'Original is eroding and sliding into the Ottawa River. The question posed the writer was could the road be economically saved for some reasonable length of time, if so how, or is relocation necessary.
2. History of Slides - Slides in Leda Clay, of which this area is composed, are common. Large slides have already occurred at Hawkesbury and similar slides are reported up and down the Ottawa Valley. The most recently uncovered is just east of Ottawa in a river terrace well above the river. This is presumed to have occurred before the turn of the century. The causes of these slides are still sub-

ject to investigation, a most likely explanation is loss of strength through leaching of salt content. (The Leda clays were originally laid in brackish waters). Landslides and in particular flow slides in this area are being studied by the N.R.C. Soil Mechanics section.

3. The Site - At the time of this investigation the site was covered with snow and the river frozen over. Much visual evidence was therefore obscured. From the writer's experience in the Ottawa Valley and what little could be seen a clear picture of events could be interpreted.

The road skirts around the bay where erosion has already forced one relocation away from the bank, but further slips have occurred again bringing the future of the road into jeopardy.

These slips leave scars with faces almost vertical for the top 10-20' indicating deep fissuring and tension cracks but the tongue is quickly desiccated and eroded away. The river starts eating into the bank reducing stability and the cycle starts again.

The landslides generally take the usual circular form but are rarely singular in any one slip. What normally happens the initial slip activates the one behind and so on until stability is again achieved. There is on record evidence of very large flow slides originating this way. It is this sort of thing which is the real menace and so far our knowledge is too limited to accurately predict their occurrence.

4. Drilling -plates 2-4 - Three holes were drilled, two alongside the road, one against a recent slip and one in an area free of slips for the past forty years. The third hole was in the river bed opposite the first hole one hundred feet from the shore.

Hole 1 - Ten feet from slip face. In this hole a vane was pushed up to ten feet ahead of its casing to a depth of forty-three feet. Vane tests were made every foot to thirty-five feet (refusal). Following the vane test continuous thin wall samples were taken in an adjacent hole to thirty-five feet where refusal was again encountered. A split spoon sampler was driven and a layer of hard silt recovered. Thin wall sampling was continued to forty-three feet, vane to forty three.

Hole 2 - This hole was taken about one mile upstream from 1 where the river bank had been stable for some time. The subsoil being granular a vane couldn't be used so continuous split spoon samples were taken.

Hole 3 - One hundred feet off shore from one, both vane and continuous thin wall samples as in hole one.

5. Soil Descriptions

Hole 1 - A varved Leda Clay from 3' to 40' varves of silty clay, clay, clayey silt and silt. Two distinct thick layers of silt were encountered one at 15' and the other 35'. This silt desiccated rapidly when immersed in water at the laboratory. A comprehensive set of strength tests were made which gave values of cohesion of 700-1100 lbs./sq.ft. increasing with depth and an angle

of internal friction about  $8^{\circ}$ . Atterberg limits were quite scattered indicating the variation of silt content. Moisture contents were close to and in some cases exceeded the liquid limit.

Vane results gave cohesion values about twice the laboratory figures field sensitivities range between 2-10 but lab values observed of the W.R.C. are much higher. Leda Clay is definitely a sensitive clay.

Hole 2 - Samples recovered were entirely different from hole 1 generally cohesionless with some clay content. The extreme loose state and high water table between 15'-26' is amazing and the writer is surprised that the whole bank and buildings have not long ago vanished into the river. There is quite a pronounced tongue into the river at this point, the bank is also heavily vegetated and these no doubt account for the stability. The ground water is trapped in the frozen bank and will seep away slowly at the spring.

Hole 3 - Much greater sample strengths were measured in the laboratory than in hole 1. The material is otherwise similar and vane test results correspond with those taken in hole 1.

#### 6. Stability analysis

An analysis of the present bank at an assumed angle of  $1\frac{1}{2}$  to 1 was made (a) as at present (b) after the rise in water level. The writer considers that slopes steeper than  $1\frac{1}{2}$  to 1 while they can be built are unstable over the long term particularly when adjacent to water.

The factors of safety as calculated using laboratory test values of  $C=1,000$  lbs/sq.ft.,  $\phi=0$  are (c) with present water level 1.14 (b) with future water level 1.23. The effect of raising the water level in stability problems is to increase the resisting moment, but other complications arise with Leda Clay. The factor of safety of 1.2 is considered too low for design of banks in Leda clay. Further analysis was made cutting down the bank by ten feet and a factor of safety of 1.6 was secured. It is therefore considered that a 7:6" cut would be sufficient. See plate 1.

#### 7. Erosion.

Of prime importance to the life of this road is the prevention of erosion. The exposed face of this Leda clay shrinks and cracks subsequent wetting by rise in water level leads to desiccation. Exposed silt seams such as found at 15' in hole 1 would disintegrate immediately. Wave action is also responsible for erosion and subsequent slips.

Two lines of soundings were taken out on the ice for 250' from the shore, one opposite hole 1 and the other opposite hole 2. The depth to the bed was measured at 50' intervals and was surprisingly uniform at 3'-4' and with normal summer water level would be just below the surface. From strength tests in hole 3 it is obvious that this is original ground and therefore it can only be concluded that clays and silts sliding into the river are quickly eroded. It is also apparent from the level bottom and higher strength that sliding will occur around and through the toe of the embankment.

The protection from erosion is to use boulders or rip rap to break up the wave force and to support the bank.

If it is decided to cut the road down as suggested the excavated material could be pushed over the bank to give some short term protection. However it would be essential to place the rip rap before erosion of the new bank profile began.

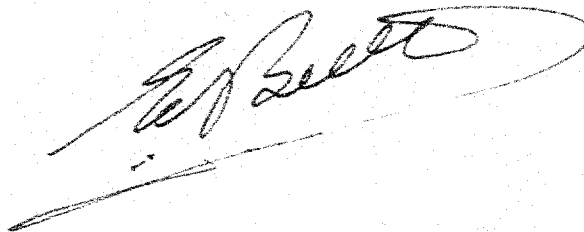
8. Conclusion

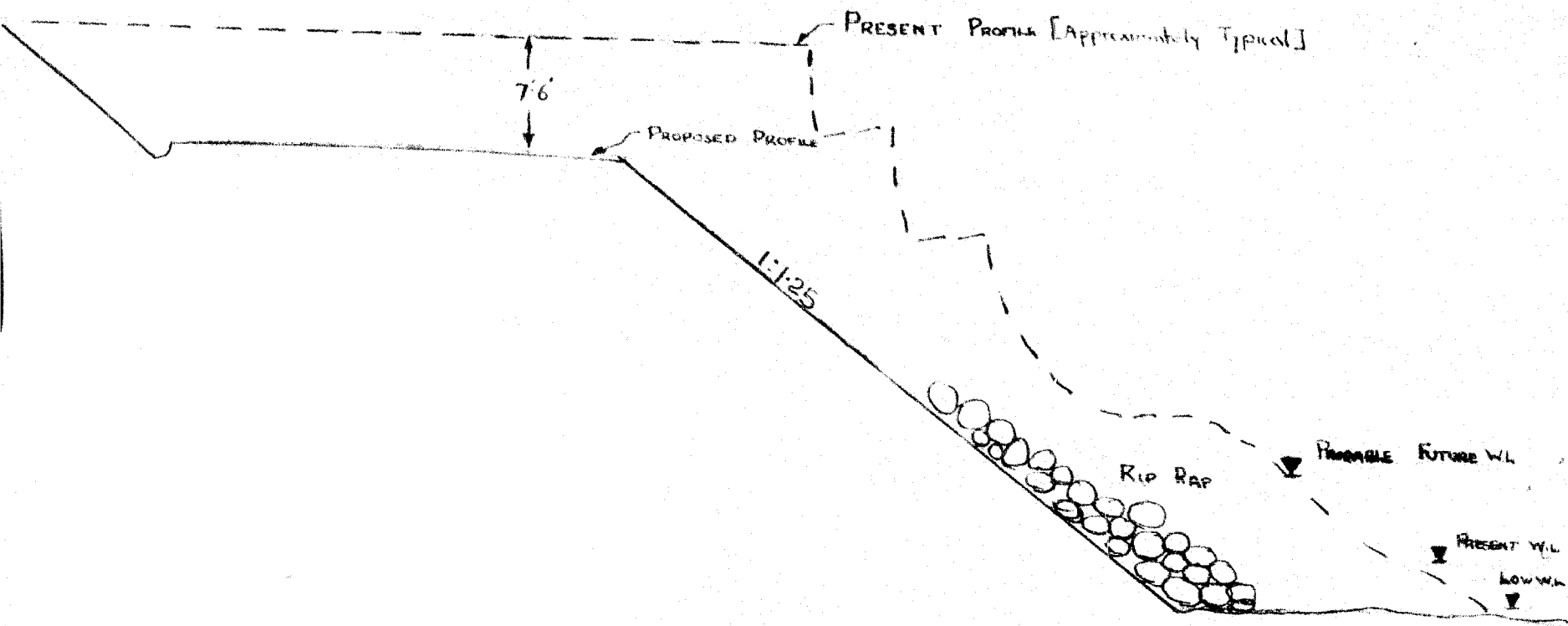
While the road can be made secure it would be more economical to relocate on the abandoned railway. However there are other things to take into account; it is essential to secure the existing road to protect the property owners.

It is the writer's considered opinion that the forthcoming rise in water level will initiate new slips and slides, possibly some quite serious. There is a great deal still unknown about slips in Leda clay and a more thorough and expensive investigation than this would be justified in the probable savings to property.

All of which is respectfully submitted

Ottawa  
28 February 1960







# E.O. BUTTS CONSULTING CIVIL ENGINEER

BOREHOLE ANALYSIS  
BOREHOLE NO. 1  
DRILLING DATE 8 FEB 60  
TESTING DATE 13 FEB 60

CLIENT UNITED COUNTIES of PRESCOTT & RUSSEL  
LOCATION BAIE L'ORIGINAL

REMARKS \_\_\_\_\_

BOREHOLE ELEVATION 31' above river level

PENETRATION DATA	HAMMER	DROP
CASING		
CONE		
SAMPLER	140 lb	30"

## DEPTHS MEASURED FROM GROUND LEVEL

Depth	Blows/ft	Cone Penetration	Description and Remarks	Sample No.	Blows/ft	Vane										Water Table	
						MC	LL	PL	PI	UC	und	rem	sen	UW	Friction	Pressure	Date & Time
5			fissured varved brown silty clay, fine white sand partings	SS1	10						101	-					
			Grey "	SS3	6						101						
			Red, grey varved clay	Tw1		52	61	23	41	52	95	4			1.4	1.5	
10			fissured grey silty clay	Tw2		90				58	77	5			1.4	1.65	
			silt lenses	Tw3		77				44	77	5			1.4	1.7	
			- - -	Tw4		68				7	9	65			1.8	1.1	
15			Grey clayey silt & silt	Tw5		42	43	17	26	3	101				1.0	1.1	
			Grey silty clay varved	Tw6		63				10	101				1.4	1.8	
			traces black organic deposits	Tw7		71				11	101						
20			Grey, red varved silty clay	Tw8		68				0.9	101				1.7	1.2	
			- - - with black organic streaks	Tw9		68	68	24	44	0.9	8	33					
			- - -	Tw10		64					8	4					
			- - -	Tw11		62				125	75	44			1.1	1.3	
25			Red, grey varved silty clay	Tw12		65				10	8	16					
			- - -	Tw13		68					75	16					
			- - -	Tw14		62	70	32	43	12	17	44			1.7	1.6	
30			- - -	Tw15		67				1.6	88	44					
			- - -	Tw16		67	42	20	37	10	12	43					
			- - -												1.4	1.3	River Level

## Symbols

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

Plate No.

2

**E.O. BUTTS**  
CONSULTING CIVIL ENGINEER

BOREHOLE ANALYSIS  
BOREHOLE NO. 1com  
DRILLING DATE \_\_\_\_\_  
TESTING DATE \_\_\_\_\_

CLIENT UNITED COUNTIES of PRESCOTT & RUSSEL  
LOCATION BHE L'ORIGINAL

REMARKS \_\_\_\_\_

BOREHOLE ELEVATION \_\_\_\_\_

PENETRATION DATA	HAMMER	DROP
CASING		
CONE		
SAMPLER		

DEPTHS MEASURED FROM GROUND LEVEL

Depth	Blows/ft	Cone Penetration	Description and Remarks	Sample		M.C.	L.L.	P.L.	P.I.	U.C.	Vane			U.W.	Triaxial		Water Table
				Type No.	Blows/ft						und	rem	sen.		Tons/sq ft	Tons/sq ft	
			Red, grey varved silty	Tw17	67					12.1	1.5				1.1	1.1	
			clay, sand partings							128.6							
35			hard silt	Tw18	46					09.135	1.0	refusal					
			seam	SS 5													
				Tw19	60										1.4	1.0	
				Tw20	62	68	20	4	1						4	1.1	
40										125.2							
										11	25						
										12	33	refusal					

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 -  $\frac{\text{und}}{\text{rem}}$

Plate No.

2A

BOREHOLE ANALYSIS  
BOREHOLE NO. 2  
DRILLING DATE 16 FEB 60  
TESTING DATE

REMARKS

PENETRATION DATA	HAMMER	DROP
CASING		
CONE		
SAMPLER	140 lb	30"

[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 -  $\frac{\text{und}}{\text{rem}}$

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BOREHOLE ANALYSIS  
BOREHOLE NO. 3  
DRILLING DATE 17 Feb 60  
TESTING DATE 18 Feb 60

PENETRATION DATA	HAMMER	DRD <sup>®</sup>
CASING		
CONE		
SAMPLER		

BOREHOLE ELEVATION 4' below river level

[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 =  $\frac{und}{rem}$

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