

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WO 94-11015 DIST 19
HWY Local Road STR SITE -

River Bank Failure - Polly Lake Local Road

DISTRIBUTION

P. Bound (3)
Planning and Design
F.A. Adams
G.J. Graham (2)
File

GEOCRES 52H-11

DATE

NOV 14 1994

memorandum



To: P. Bound
Head Geotechnical Section
Northwestern Region, Dist. 19

Date: 1994 12 08

Attn: A. Delrosario
Pavement Officer

From: Foundation Design Section
Room 315, Central Building

Re: WO 94-11015, River Bank Failure - Polly Lake Local Road
From south side of Polly Lake Road approximately 1.0 Km west of Highway
11 and 14.3 Km north of junction Hwy 11/Hwy 17, Nipigon

In response to a request from Pavement and Evaluation Officer, Mr. A. Delrosario a site inspection together with an in-house slope stability analysis was carried out by the Foundation Design Section at the above mentioned location.

The purpose of this investigation is to determine the cause of the river bank failure near Polly Lake Road and recommend remedial measures. A field investigation was previously conducted approximately 800 m north of this site under similar circumstances along Cash Creek on 1992 07 22 (WO 92-11005).

Site Description

The site is located where the Cash Creek is encroaching onto Polly Lake Road. It is approximately 15 km north of the Town of Nipigon, Booth Township, District of Thunder Bay. The topography at the site, and the surrounding area is generally flat to gently undulating. The immediate vicinity of the site is occupied by cottages.

The failure occurred in the river bank along Polly Lake Road approximately 800 m north of the Cash Creek structure. The failure is about 20 m in length with the embankment reaching approximately 7.5 m in height. Tension cracks were observed at the crest of the embankment.

Information concerning the subsoil stratigraphy was provided by the Regional Geotechnical Office.

Subsurface Conditions

The subsurface conditions are believed to be generally uniform. Based on the subsoil stratigraphy found within the area, the river bank is believed to consist of a Silty Sand. Test borings conducted at the toe of the embankment by the Regional Geotechnical Office confirmed that a Sandy Silt material extended down to 6.0 m. Gradation tests indicate a high percentage of fine Sands and Silts (See Figure 1). Underlying the above material is believed to be a granular deposit consisting of Sand with interbedded Silt layers, with the full extent of this deposit not proven.

Due to the non-cohesive nature of the embankment, the groundwater level is believed to be at the elevation of Cash Creek. However, a slight hydraulic gradient towards the creek can be anticipated. Recorded levels from the previous investigation indicated the Creek to be at elevation 93 m with a depth of 1.5 m approximately.

Discussion and Recommendations

Based on observations the instability at this site appears to be due to surficial erosion of a similar nature to the failure upstream. Instabilities are caused primarily due to undercutting of the river bank by the erosive power of the creek, further aggravated by rapid drawdown of the creek water level. As the slides occur primarily within the existing Silty Sand embankment there was no evidence of deep seated failures. It should be noted that this type of failure is of a recurring nature occurring during the spring thaw period or the period of heavy precipitation.

An effective stress analysis was applied utilizing the limited equilibrium method of stability developed by Sarma. (Sarma S.K., 1973 Stability Analysis of Embankment and Slopes, Geotechnique, Vol. 23, No. 3)

The stability analysis carried out on the existing slopes indicates that the slope area is unstable with a Factor of Safety less than unity. Refer to Figure 2 for an illustration of the embankment model and a summary of assumptions considered in the stability analysis.

Due to the non-cohesive nature of the natural embankment, subsurface drainage would not be effective. However, initial remedial measures which could slow the process of failure should be considered. These include the capture and drainage of all surface water which flows into the slide area and the filling of all open cracks to prevent the infiltration of surface water.

As illustrated in Figure 3, the stability analysis of generalized embankment conditions indicates that this type of failure can be controlled by rock protection. It is recommended that the following remedial measures can be carried out as soon as possible in order to stabilize the embankment slope in the distressed area:

1. All the failed and/or loosened material in the affected area should be removed, and replaced with the suitable rock fill material.

2. The recommended configuration for embankment treatment is illustrated in Figure 4. It has been designed not only to control surficial failures, but also to improve overall slope stability.
3. The rockfill should be keyed into the existing slope in accordance with current MTO standards and practice.
4. After completion of the rehabilitation, the earth slope above the rock fill should be protected in accordance with OPSD 218.01

If room permits at the crest of the slope, back to the shoulder of the road, a flattening of the slope to 2.5H:1V of the nature embankment would be adequate to prevent failure. However, erosion protection from the Creek, utilizing armour stone or appropriate rock fill at the toe to a minimum height of 0.5 m above water level would still be required.

We believe that this memo meets with your present requirements. If you have any questions, please contact this office.



A handwritten signature in black ink, appearing to read "M. Michalek", written over the printed name.

M. Michalek, P. Eng.
Project Foundation Engineer

For:

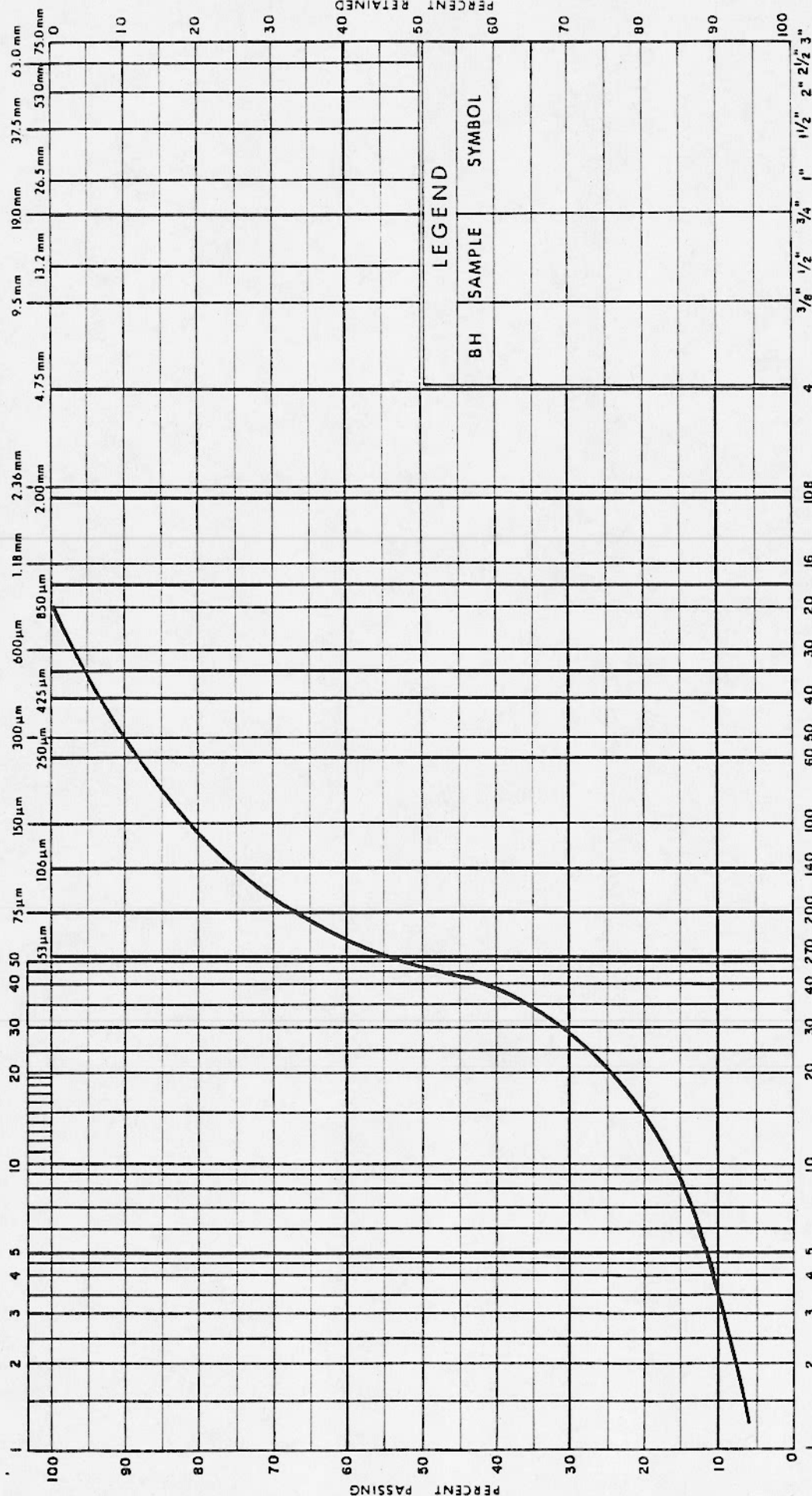
T. Kim, P. Eng.
Senior Foundation Engineer

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH SAMPLE SYMBOL

Ministry of
Transportation

FIG No 1

GRAIN SIZE DISTRIBUTION

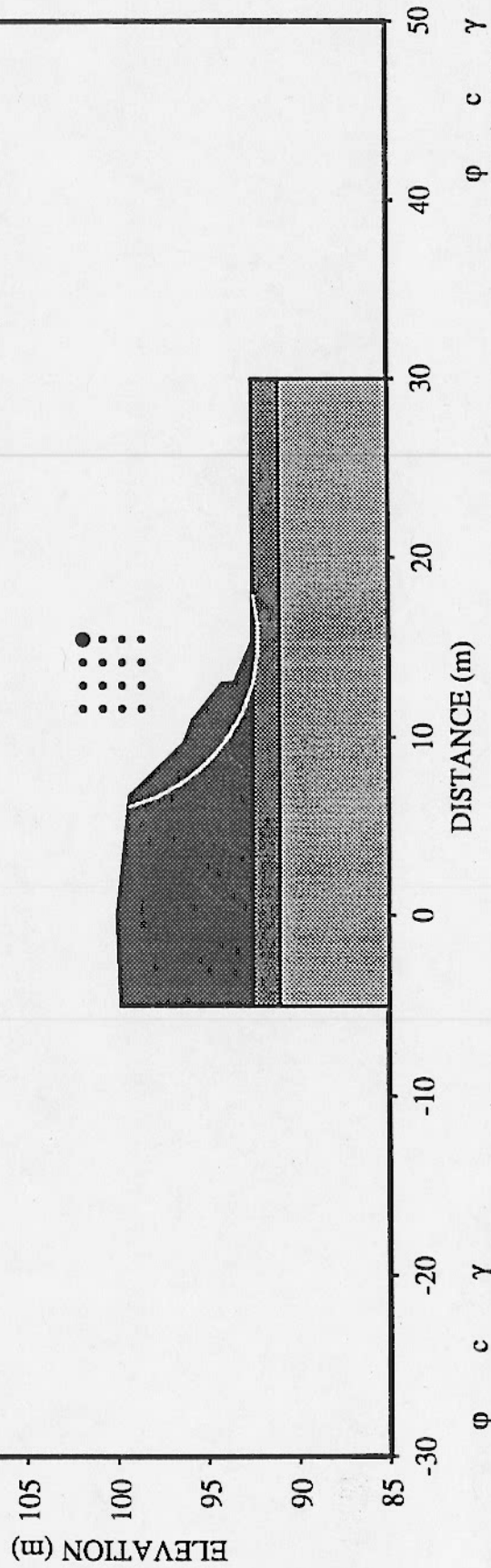
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SANDY SILT



POLLY EXISTING

Minimum factor of safety 1.03 at $X_c = 15.5$ $Y_c = 101.8$ tangent at 92.2

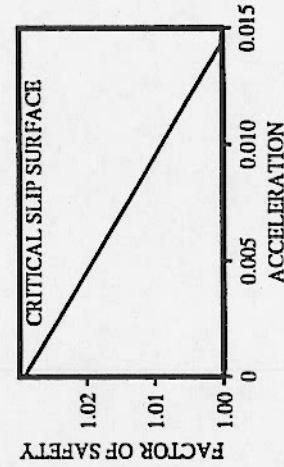


ϕ	c	γ
35.0	0.0	18.9
		Silty Sand

Sandy Silt	ϕ	c	γ
	35.0	0.0	18.9
Silt with Sand	32.5	0.0	18.5

CRITICAL ACCELERATIONS

0.178	0.124	0.059	0.014
0.170	0.107	0.042	0.022
0.164	0.095	0.040	0.039
0.164	0.098	0.058	0.042



FACTORS OF SAFETY

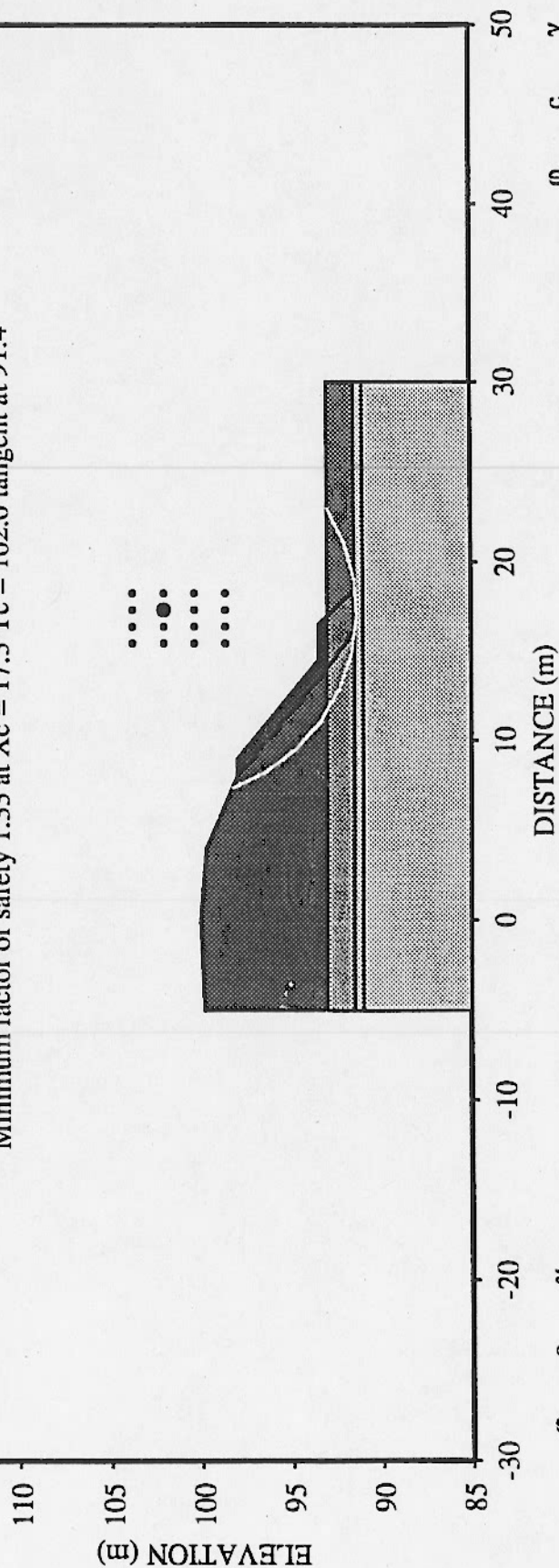
1.474	1.282	1.126	1.029
1.428	1.234	1.084	1.045
1.391	1.198	1.079	1.082
1.384	1.202	1.120	1.091

Fig 2

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POLLY - TREATED

Minimum factor of safety 1.33 at $X_c = 17.3$ $Y_c = 102.0$ tangent at 91.4

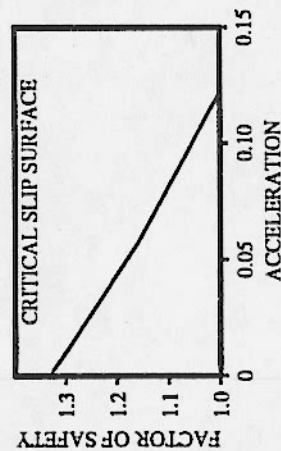


ϕ	c	γ
45.0	0.0	18.1
35.0	0.0	18.9
0.0	0.1	10.0

Soil Type	ϕ	c	γ
Rock Fill	45.0	0.0	18.1
Silty Sand	35.0	0.0	18.9
Sandy Silt	35.0	0.0	18.9
Silt with Sand	32.5	0.0	18.5

CRITICAL ACCELERATIONS

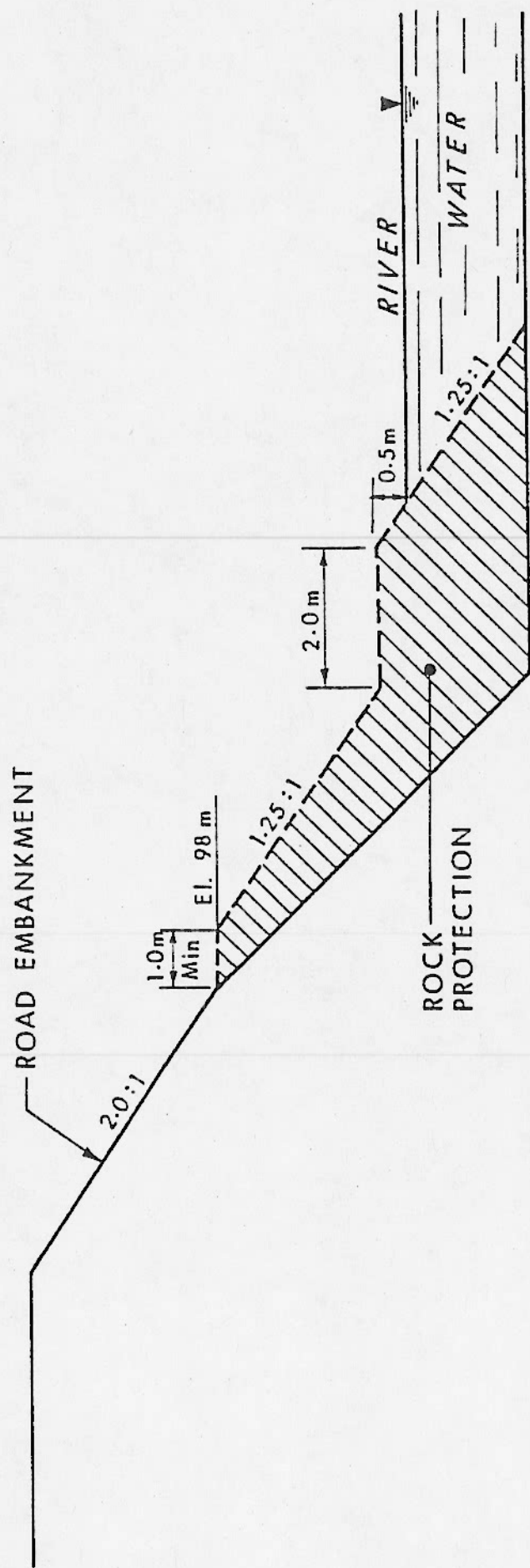
0.178	0.143	0.128	0.154
0.180	0.138	0.122	0.164
0.185	0.142	0.122	0.211
0.205	0.169	0.156	0.285



FACTORS OF SAFETY

1.468	1.385	1.353	1.440
1.458	1.365	1.333	1.472
1.454	1.363	1.334	1.700
1.474	1.432	1.487	2.237

Fig. 3



NTS

TREATMENT GEOMETRY GENERALIZED SLOPE CONDITIONS

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Fig. 4