Klohn Crippen Berger

May 31, 2006

Alberta Infrastructure and Transportation
Central Region
#401, 4902 – 51 Street
Red Deer, Alberta
T4N 6K8

Mr. Alain Momedi, P.Eng.
Project Engineer

Dear Mr. Momedi:

Central Region GeoHazard Assessments
Site C19 H575:04 Pavement Distress
May 2006 Site Assessment & Instrumentation Monitoring Report

Alberta Infrastructure & Transportation has initiated a process of risk management at specific geohazard sites that includes a document control system. This annual site assessment report forms Section B of the document control system for the above site.

The site was inspected on May 15, 2006 by Mr. Darren Ratcliffe, P.Eng. of Klohn Crippen Berger Ltd. Photographs from the inspection are attached. The instruments were also read as part of the inspection.

This report was prepared by Klohn Crippen Berger Ltd. for Alberta Infrastructure & Transportation Central Region under Contract No. CE045/2004.

1. BACKGROUND

Located above the Red Deer River valley, about 20 km northwest of Nacmine, SH575:04 is located at the top of an embankment fill about 30 m high with slopes of about 2H:1V within a valley. For a length of about 50 m, the pavement at the crest of the slope is indicating signs of distress in the form of longitudinal and transverse cracks with corresponding depression of the pavement. The steep slope shows no signs of cracking close to the crest and is well vegetated. The guardrail shows significant signs of downslope displacement. A water line was installed in 2004 on the side of the highway away from the slope edge.

From a review of air photos, it would appear that between 1969 and 1974 the highway was realigned through a valley leading to the Red Deer River. The realignment

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403.274.3424 t • 403.274.5349 f • www.klohn.com

comprised an embankment fill with slopes on both sides. Between 1974 and 2001, the side of the embankment between the upland and the highway was infilled, presumably for farming purposes.

Two solid stem auger holes (designated as SI04-01 and SP04-01) were drilled in October 2004 on the north side of the highway above the slide area. A standpipe piezometer and a slope inclinometer were installed to depths of 24.5 m and 21.3 m respectively. The investigations indicated that stratigraphy comprises stiff, medium to high plasticity silty clay fill about 10 m thick overlying claystones, siltstones and sandstones of the Horseshoe Canyon Formation. SPT blow counts in the fill were about 10 to 40 blows per 300 mm increasing to 50 blows per 300 mm in the underlying bedrock. Moisture contents typically varied from 20% to 30% for both the fill and the bedrock. Index testing of clay fill indicated a liquid limit of about 50% with a plasticity index of about 35%.

The site plan and cross-sections are illustrated on Figures 1 and 2. The instrumentation is described on the attached "Field Summary of Instrumentation Monitoring Form".

2. SITE ASSESSMENT

Based on the increasing width of the highway cracks and the angle of the guardrail, it is considered that the slide is actively moving at a slow rate. No signs of cracking or seepage were observed on the slope.

3. INSTRUMENTATION RESULTS

Based on a water level readings obtained, the water table is at consistent depth of about 16.6 m to 16.8 m below the crest of the highway.

The baseline reading for the slope inclinometer was recorded on November 4, 2004. The latest reading taken on May 15, 2006 indicates downslope movement on both A and B axis at about the 8 m depth (approximately the fill-native soil interface). The total resolved movement measured at the surface is about 22 mm.

The following data plots are provided for Section D of the document control system:

- Cumulative and incremental displacement in A direction on same page.
- Cumulative and incremental displacement in B direction on same page.
- Displacement – time plot showing zone of movement in A direction
- Displacement – time plot showing zone of movement in B direction
- Resolved single movement vector plots

4. INTERPRETATION

The fill placed across a valley leading towards the Red Deer River is sliding in a downslope direction on the native soil interface at a relatively slow rate. The movement is causing distress to the pavement structure and potentially to the water line recently installed on the upland side of the highway. Measured movements to date have been increasing in rate and magnitude.

Site observations would indicate a greater magnitude of movement than was measured in the slope inclinometer. A distinct dip is apparent in the pavement adjacent to the guardrail and the guardrail posts show significant displacement. The crack in the centre of the lane away from the slope is about 50 mm wide.

The infill placed between the upland and the highway embankment could be contributing to the movement by placing load on the upslope side. Due to the relatively low observed groundwater level, it is not considered that groundwater has a major contribution to the movement. The original fill is also relatively old (about 30 years) and so settlement is not considered a significant factor. However, the age of the infill behind the original fill is undetermined.

Based on the risk level criteria provided by Alberta Infrastructure & Transportation, a risk rating of 45 has been assigned to this site. This is based on a probability factor of 9 for an active slide but with high uncertainty, and a consequence factor of 5 due to the height of the slope, the likely closure of the highway and the damage to the water line.

5. RECOMMENDATIONS

It is considered that this site could deteriorate over time to a more serious slide condition with potential damage to the water line. If damage to the water line occurs, the saturation of the presently dry fill would accelerate any downslope movement. It is recommended that the slope inclinometer be read quarterly to determine the movement rate. Crack widths and guardrail displacements should also be monitored.

It is considered that remedial action is warranted and potential remediation options include:

- Flattening the fill slope and buttressing against the opposite slope;
- Reinforcing the upper fill, with the reinforcement extending back into the upland area; or
- Increasing the strength of the fill material with piles or launched soil nails.

Due to the high slope and significant volume of fill required for stabilization, it is considered that the launched soil nailing approach would likely be the most cost effective.

However, the launched soil nails are 6 m long and so are insufficient in length to extend past the failure plane. To adopt this approach, the top of the slide must be excavated by about 3 m to 4 m as shown on Figure 3. Following the installation of the soil nails, the fill would be reinstated. An approximate cost estimate for this approach is shown in Table 1 indicating a project cost of about $80,000. A soil nail spacing of about 2 m has been assumed with rows of nails 2 m apart or a total of about 80 nails over a length of about 30 m.

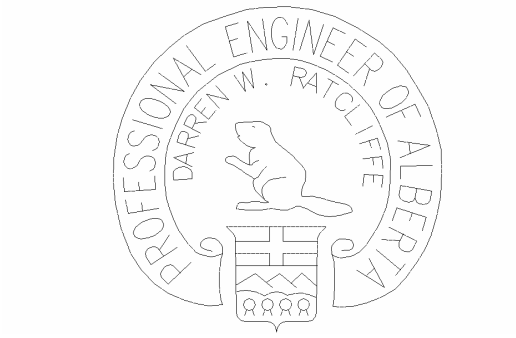
Table 1 Soil Nail Cost Estimate

Item	Quantity	Unit	Rate	Total
Mob/Demob	1	LS		$25,000
Excavation	450	m^3	$10	$4,500
Soil Nails	80	No.	$500	$40,000
Fill Placement	450	m^3	$20	$9,000
				$78,500

Please contact the undersigned if you have any questions regarding this letter.

Yours truly,

KLOHN CRIPPEN BERGER LTD.



Darren W. Ratcliffe, P.Eng.
Project Manager

APEGGA Permit to Practice No. 9196