4.5 S5 – CHIN COULEE

Background

The Chin Coulee site is located on Highway 36:02, approximately 20 km south of Taber, AB and on the north approach slope to the highway bridge across the Chin Coulee Reservoir.

The slope instability at this site consists of deep-seated landsliding in the north valley slope along with relatively shallower movements in the fill embankment immediately below the highway. Based on a review of historical airphotos of this site it is believed that the highway fill embankment may have infilled a drainage gully in the valley slope.

The overall landslide mass has an elevation difference of approximately 50 m from the reservoir level to the headscarp adjacent to the highway. The width of the landslide is approximately 350 m at the reservoir shoreline. The length of the landslide is approximately 200 m. The overall angle of the landslide is approximately 13°. The overall landslide is inferred to be deep seated with a failure surface at a depth of about 30 to 40 m near the highway (scarp) and 17 m near the reservoir (toe). Therefore, the overall toe of the landslide is likely below the reservoir level. The failure surface is thought to be along weak zones in the bedrock and overlying till. The exact position of the overall landslide crest relative to the highway is not clear, and it is judged that this landslide mechanism could potentially encompass the entire highway.

The SI GA98-3 that was installed in the shallower movement area in the fill embankment immediately downslope of the highway has previously sheared off at a depth of approximately 15 m below ground surface. The road fill embankment slope in this area has an inclination of approximately 20°.

The landslide has shown large scale movements on two known occasions since the 1950's, with some possible ongoing shallower movements contained within the overall landslide mass. The ongoing movements are impacting the south/downslope shoulder of the highway. There remains a risk of reactivation of the larger landslide mass, which could have a more significant impact on the road.

This site has been inspected and monitored by AIT and consultant personnel since 1979. The landslide most recently experienced significant movement in 1997. Additional instruments have been installed since that time and regular assessments and monitoring are ongoing. In 2002 the National Research Council (NRC) commenced InSAR satellite-based ground movement monitoring of this site, however it is understood that this monitoring is no longer active.

A functional planning study for this segment of the highway was completed by AMEC in December 2004. The functional planning study considered the possibility of realigning the highway through the landslide area and also the possibility of adding a climbing lane. The functional planning study concluded that a climbing lane was not warranted and that upslope relocation of the road would be deferred indefinitely. The functional planning study also concluded that the highway should be relocated approximately 30 m upslope in the future if

deep-seated landsliding damaged the road. The functional planning study recommended additional geotechnical investigation and analyses for detailed design of any upslope shift of the road in order to optimize the amount of upslope shifting and provide a greater level of assurance as to the amount of benefit. The previous geotechnical investigation and analysis in 1998 only included preliminary analyses on the increase in Factor of Safety for various amounts of upslope shifting of the road that were based on limited borehole drilling and limited testing of bedrock samples.

Please refer to Section A of the site binder for a more detailed discussion of the site background.

Site Assessment

The site assessment was performed on May 31, 2006. The weather at the time of the site assessment was sunny with a light breeze.

Please refer to Appendix S5 for a site plan illustrating the layout of the site. The assessment covered the highway surface through the landslide area, the upslope ditch, and the downslope slope face.

Observations

The following points summarize the observations made during the site assessment. Please also refer to Appendix S5 for a site plan and annotated photographs illustrating key observations.

- The headscarp position of the shallow slumping immediately downslope of the road did not appear to have changed significantly since the 2005 inspection, however there were some areas on the east and west flanks of the slumping where the tension cracking may have worsened somewhat since the 2005 inspection. Photo S5-5 shows this area.

- The guardrail along the downslope edge of the road continues to be undermined by the shallow slumping. Two of the guardrail support posts are exposed, however the overall amount of undermining does not appear to have increased significantly since the previous assessment.

- As shown in Photos S5-3 and S5-4, there were no visible signs of cracking or landslide movement in the road surface adjacent to the shallow slumping/undermined guardrail.

- There were no significant visible changes in the overall slope face below the road since the 2005 inspection.

The Spring 2006 readings of the slope inclinometers at this site showed that the active slope instability along the downslope edge of the road had not expanded to the west of the visible scarp. The inclinometer in the upslope road ditch also showed no deep-seated valley slope landslide movement encompassing the existing road alignment, consistent with previous years.

Assessment and Risk Level

Based on the observations from the current inspection, the assessment of the geotechnical risk at this site is unchanged. In summary:

- The active, shallow slumping immediately downslope of the guardrail has already undermined a portion of the guardrail and has the potential to undermine additional segments of the guardrail and possibly the downslope edge of the road as well. It is not considered likely that significant portions of the road would be taken out of service by a sudden retrogression of the shallow slumping, however this cannot be entirely ruled out.

- The potential for reactivation of the overall deep-seated landslide at this site also exists, and could result in loss of a large portion of the road alignment. This risk has been managed by the planning and preliminary design (during the Functional Planning Study) for an upslope shift of the road alignment if required due to landslide movement.

On the basis that two separate modes of failure could affect the highway at this site, two recommended Risk Levels are provided:

- For the shallow modes of failure, the Probability Factor is taken as 10 since the rate of movement is moderate and ongoing. A Consequence Factor of 2 is assigned to this slide type on the basis that only a portion of the road would be lost. Based on the above, the Risk Level for the relatively shallow movements at this site is calculated as 20. These values are unchanged from the 2005 assessment.

- For a deep-seated mode of failure, the Probability Factor is taken as 5 since the movement appears to be inactive, but with some uncertainty. A Consequence Factor of 5 is assigned to this slide type on the basis that a large portion of the road would likely be lost during a reactivation of the deep-seated failure mode. Based on the above, the Risk Level for the deep-seated movements at this site is calculated as 25.

Recommendations

AMEC recommends the following future work for this site:

The annual assessments and semi-annual instrumentation monitoring should be continued.

As noted in previous reports, the geotechnical risk management strategy for this site is to continue monitoring the instruments and implement the existing design for the upslope realignment of the existing highway only if it becomes required due to reactivation of slope movement encompassing the road alignment.

The slope face along the south shoulder of the road should be repaired in order to restore support to the guardrail posts. The use of geogrid reinforced backfill was recommended after previous annual inspections. The use of soil nails should also be

considered if AIT's trial of this method at the Abraham Lake site in the summer of 2006 is successful.