

### **4.3 S3 – COCHRANE**

#### **Background**

The Cochrane site is located on Highway 22:16, south of Cochrane, AB and approximately 1 km south of the bridge across the Bow River. Slope instability was noted adjacent to the road in 1991, and a series of SI's were installed in the early to mid-1990's. Instrumentation monitoring and annual inspections of this site have been performed by AIT and consultant personnel since the mid-1990's.

The slope instability at this site appears to be relatively shallow and is affecting an area in the order of 50 m by 50 m downslope (northeast) of the highway. At this location the highway is adjacent to the uppermost portion of a steep slope above the Bow River and the sliding is likely largely natural movements. Slope movements of up to 20 mm per year have been recorded in the slope inclinometers since installation in 1994 with relatively active movements occurring in 2005 and 2006. The timing and rates of the slope movements are judged to be sensitive to surface water running from the highway ditch to the slide area.

Two additional SI's and a piezometer were installed at this site by AMEC in March 2007. These additional instruments were installed as a follow-up to previous recommendations to proactively replace one of the existing SI's prior to its anticipated shearing-off due to accumulated landslide movement and to establish an instrumented cross-section extending through a cracking and settlement area on the road surface and a possibly related active slumping further downslope of the road.

#### **Site Assessment**

The site assessment was performed on June 18, 2007. The weather at the time of the site assessment was partly cloudy with rain showers in the area.

Please refer to Appendix S3 for a site plan illustrating the layout of the site. The highway surface and the slope face below the road were inspected.

#### **Observations**

The following points summarize the key observations made during the site assessment. Please also refer to Appendix S3 for a site plan and annotated photographs illustrating key observations.

- Cracking and settlement was visible along an approximately 30 m long segment of the road along the northeast shoulder, as shown in Photos S3-1, S3-2 and S3-4. At the time of the inspection, there was approximately 25 to 50 mm of downdrop on the shoulder side of the white line. The location and pattern of the cracking is the same as noted in the 2005 and 2006 inspections and it appears to delineate the headscarp of a rotational landslide that has retrogressed into the central portion of the northbound lane. It appears that the currently visible cracking and settlement has formed through a patch/overlay that was applied to this area after the 2006 inspection.

- As noted in the 2006 inspection, the cracking on the road surface can be traced southwards onto the slope below the road to a scarp/lateral separation in the ditch berm. The relative position of this damage to the ditch berm and the cracking on the road is visible on Photos S3-2 and S3-4. The scarp across the ditch berm was up to 0.75 m high at the time of the inspection and the ditch liner was exposed by the lateral separation at the scarp.
- Otherwise, no significant changes to the site appearance since the June 2006 inspection.

The Spring 2007 readings of the instruments at this site show continued movement in the uppermost 2 to 3 m of each slope inclinometer. This is consistent with the instrument data from the 2000 readings onwards.

#### **Assessment and Risk Level**

The cracking and settlement of the road surface continues to develop through recent annual patching and overlays. The pattern of the cracking on the road surface and instrument data from this site are consistent with a shallow slump failure retrogressing into the northbound lane of the road. It is not clear if the visible slumping along the fenceline below the road is linked to the apparent slumping retrogressing into the northbound lane, however the future data from the additional instrumentation that was installed in the spring of 2007 should provide clarification on this.

Therefore, AMEC recommends the following Risk Level factors for this site:

- Probability Factor of 9 in order to reflect the ongoing slope movement observed in the area around and downslope of SI 2007-1. This is the same value that was recommended after the 2005 and 2006 inspections.
- Consequence Factor of 3 in order to reflect the magnitude of the cracking and settlement that has occurred along the downslope edge of the pavement during the past few years. Otherwise, no significant impacts to the highway are anticipated in the short term.

Therefore, the current recommended Risk Level for this site is equal to 27. This is the same value recommended after the 2005 and 2006 site assessments.

## **Recommendations**

AMEC recommends the following for this site:

### **Short Term (e.g. by end of 2007)**

- Road surface patching and overlays as required to mitigate the settlement and cracking along the shoulder and in the northbound lane.
- The previously-recommended repairs to the downslope berm along the ditch should be implemented. The visual observations from the 2005 inspection showed that ditch flow overtopped the berm and flowed down onto the slope and into the unstable area around and downslope of SI #3A / 2007-1 during the significant rainfall events in June 2005. The downslope berm height between SI #2 and SI #5 should be restored and if possible the carrying capacity of the lined ditch increased in order to avoid future overtopping of the ditch berm during peak rainfall events.

### **Medium To Long Term (e.g. early 2008 onwards)**

- Develop a list of repair options for the settlement and cracking of the road surface for AIT's consideration and possible construction in 2008. The spring 2007 site survey and borehole logs can be used for this work. As discussed on site, the most practical and effective repair options could include a pile wall along with upgraded drainage measures to intercept and redirect subsurface and ditch flow drainage away from the slumping area below the road.
- The semi-annual monitoring of the SI's should be continued.
- Annual assessments at this site should be continued.