4.2 S2 – PRIDDIS

Background

The Priddis site is located on Highway 22:14, approximately 11 km west of the Priddis turn-off and approximately 10 km southeast of Bragg Creek, AB (as measured along Highway 22). At this site the highway is oriented east-west as it ascends westwards out of the Priddis Creek valley. The highway is located on a sidehill, with the south side upslope and the north side downslope.

The slope instability at this site consists of a moderately deep-seated (in the order of up to 10 m below road surface elevation) rotational failure (possibly with a translational component) encompassing the north shoulder of the road and extending nearly to the toe of the slope face to the north of the road. This is combined with a translational/spreading movement extending approximately 150 m downslope (north) from the toe of the highway embankment. The translational/spreading slide appears to be seated in relatively shallow, soft, wet soils in the natural slope below the highway, but is likely causing a loss of foundation support below the road embankment fill.

No details of the first occurrence of the slide were included in the site file previously reviewed by AMEC, however it would have pre-dated November 1992 because the second batch of SI's (#5 to 10) were installed at that time. It is not known if the original slide encompassed the road, although it appears likely based upon the oversteepened slope face immediately adjacent to the north shoulder of the road and the fact that a pile wall is understood to have been installed along the north shoulder of the highway above the slide area, presumably to arrest movement extending beneath the road surface.

Site assessments, installation and monitoring of slope inclinometers and piezometers has been conducted at this site since at least the early 1990's. This site has been included in the Southern Region GRMP since 2000. 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 June 18, 2007. The weather at the time of the site assessment was sunny and clear.

Please refer to Appendix S2 for a site plan illustrating the layout of the site. The highway surface, upslope ditch and the slope face below the road were inspected.

Observations

The following points summarize the observations made during the site assessment. Please also refer to Appendix S2 for a site plan and annotated photographs illustrating key observations.

- The general settlement of the road surface through the landslide area was still evident, however there was not any significant cracking or apparent recent damage to the highway through the landslide area at the time of the inspection. Photos S2-1 and S2-3 show the road surface condition. As shown in Photo S2-1, there is still cracking along the north shoulder of the road that appears to outline at least a portion of the existing pile wall.

- The appearance of the slope face in the landslide area below (north of) the highway did not appear to have changed significantly since the previous inspection, however as noted in previous inspections the thick grass and vegetation cover would have obscured any recent subtle cracking or deformation. Photo S2-2 shows a typical view of the slope.

- There was a diagonal crack across the highway surface to the east of the apparent east flank of the existing landslide, i.e. outside of the apparent landslide limits. If the orientation of this crack is projected north onto the slope below the highway, it appears to cross through an area along the treeline at the toe of the slope north of the highway where some leaning trees were noted. Taken together, these items could evidence an eastwards expansion of the existing landslide. However, the visual evidence for this is not definitive and the spring 2007 readings of SI #4 located above/east of the apparent existing east flank of the landsliding did not show any new movement in this area. However, the crack condition should be monitored in future inspections.

- The groundwater spring and adjacent area of standing water in the upslope road ditch that was noted in the 2006 inspection remains evident and does not appear to have changed significantly during the past year. This area is approximately 60 m east of the piezometers and just downgradient from the ditch block at the inlet of the culvert below the road that discharges just east of SI #4 on the north side of the road. As noted during the 2006 inspection, it is possible that this groundwater spring and standing water is from discharge from the pumping wells installed further west along the ditch (see site plan on Figure S2-1), however the actual outlets from the pumping wells could not be located.

Assessment and Risk Level

Based on the results of the current inspection, the overall assessment and Risk Level for this site has not changed in the year since the 2006 inspection. The key points are summarized as follows:

- The Spring 2007 instrument readings for this site showed that active slope movement is continuing around the toe of the slope north of the road. As shown on Figure S2-2, the SI's in BH#2 and SI#6 are showing active movement.

- It is judged that the continued slope movements to the north of the highway will eventually directly destabilize the road embankment. However, the annual inspections of this site have shown that to date the year-over-year impact on the highway from this slope movement has consisted of ongoing settlement and cracking along the downslope edge of the road. This settlement and cracking is being treated as a maintenance issue with patching and guardrail realignment typically required at least annually in recent years.

- The existing pile wall along the downslope edge of the road may be effective in stabilizing the highway to some degree with respect to the active landslide movement in the slope to the north of the highway. However:

    - It is not possible to quantify the degree to which the pile wall increases the Factor of Safety for the highway without a stability analysis with inputs based on the landslide movement detected in the instrumentation and the as-built details of the pile wall (location, pile depth, pile spacing, pile diameter etc.).

    - Without any as-built information on the pile wall, any stability analysis incorporating the stabilizing effects of the pile wall will have some uncertainty in it because the actual configuration of the pile wall will be unconfirmed.

- There is limited functional geotechnical instrumentation at this site and it is expected that continued landslide movement and patching of the road surface will render the remaining instruments non-functional or inaccessible in the next one to two years. As discussed in previous monitoring reports and during the 2006 and 2007 site inspections, if the remaining geotechnical instruments cease to function or become inaccessible then there is limited value in replacing the SI's because the depth of landslide movement is already known for the SI locations.

- It is understood that the existing piezometers on the upslope side of the highway were installed to monitor the effectiveness of the pumping well(s) in the same area. However, aside from the tip depths of the piezometers, no design or as-built information on the piezometers or pumping well(s) was found during the file review for this site in 2000. As discussed in the Spring 2007 monitoring report, three of the four piezometers are currently functioning and they have consistently been reading zero pressure over the last

few years. This may indicate that the pumping well(s) are effective in relieving the groundwater pressure in this area. However, the possibility of an inaudible leak in the long segments of piezometer tubing that are coiled at surface and exposed to the elements cannot be ruled out as the cause of the zero pressure readings. If this is the case, then there is effectively no monitoring of the pumping wells.

AMEC recommends the following Risk Level factors for this site:

- Probability Factor of 9 in order to reflect the ongoing slope movements measured in the instruments since the Spring 2000 readings.

- Consequence Factor of 5 given that large movements are possible and could conceivably result in at least partial closure of the road surface in the event of a major increment of landslide movement.

Therefore, the current recommended Risk Level for this site is equal to 45. This recommended Risk Level is unchanged since the 2002 assessment.

It should be noted that if it is possible to incorporate as-built information on the existing pile wall into a stability analysis for the slope at this site and clarify the Factor of Safety with respect to landslide movements that could result in a loss of a portion of the road surface, then it may be possible to reduce the Consequence Factor.

Discussion and Recommendations

AMEC has previously recommended that additional geotechnical investigation and design work be performed for this site with the objectives of:

- Installing supplementary instrumentation to replace instruments that are no longer functioning.

- Further characterizing the slope movement and to gather survey information for the area to the north of the fenceline.

This information could be used to develop a conceptual design for earthworks to stabilize the highway (extending into the forested area north of the fenceline if necessary because AIT owns the land) or possibly an additional pile wall across the landslide area.

Based on discussions on-site during the 2006 and 2007 inspections, AMEC understands that AIT's opinion is that restoring the instrumentation on the slope below the pile wall would add relatively little value versus continued visual monitoring of the road surface condition because the existing instruments have already provided some information on the stratigraphy and depth of landslide movement. Furthermore, AIT's preference is to direct future effort towards verifying that the existing pumping wells are functioning and to recover the instruments on the road surface that have been paved over during maintenance work.

The concept of upgrading the existing pile wall by adding a wailer and tie-back anchors was also discussed as a possible option to manage the landslide risk to the road.

AMEC recommends the following future work for this site:

1. Installation of new piezometers near the existing piezometers 34396, 34397, 34398, and 34399. The purpose of the new piezometers would be to replace the existing piezometers which are providing questionable data (as discussed above) and provide monitoring of the piezometric pressures around the pumping well(s). As discussed on site, the new piezometers would be installed with flush-mounted casing protectors in order to protect them and provide for a long and reliable service life. The possibility of using vibrating wire piezometers with a temporary datalogger to provide continuous monitoring in order to attempt to observe short-term reaction to the pumping well(s) switching on and off was discussed on site during the inspection.

2. The maintenance contractor should confirm that the existing pumping well(s) are functioning and effective. In the future, any pump inspection and maintenance should also be documented. It is understood that the power consumption at the pumps is currently being used as a indirect check on whether or not the pumps are functioning. The outlets from the pumps should be located and daylighted to allow for direct observation and measurement of their discharge. As part of this effort, the ditch gradient should be restored around the area of standing water noted to the east of the pump(s). If the pump outlet(s) cannot be located, it may be more effective to install new pump(s) in order to eliminate uncertainty regarding the installation details and effectiveness of the existing pump(s).

3. AIT should instruct the maintenance contractor to locate the existing instruments on the road that have been paved-over and restore access to them for future monitoring.

4. The surface conditions of the road at this location, as well as the guardrail alignment, should be carefully monitored by maintenance personnel. This would be in conjunction with the recommended instrumentation monitoring to provide as early detection of potential problems below the road as possible.

5. The semi-annual instrument monitoring should be continued. The maintenance contractor should be instructed to avoid paving over the existing instruments on the north shoulder of the road.

6. Annual assessments at this site should be continued.