Highway 742 – Goat Pond, South Fan

This site is located approximately 14 km southbound from the junction between Highway 742 and Three Sisters Parkway in Canmore, AB and adjacent to the south end of Goat Pond in the upper end of the Goat Creek valley. The site location is shown on Figures A1 and A2 in Appendix A. The site coordinates are listed in Table A1 in Appendix A.

The site inspection was performed on October 18, 2008 by Mr. Andrew Bidwell, P.Eng. of AMEC.

Background

AMEC is not aware of any previously reported problems at this site.

A general description of the physical setting and conditions around this site is presented in Section 4.2 of this report.

Site Observations

This segment of the highway is very slightly above the broad and relatively flat-lying valley floor and is in an area transitioning between the Goat Creek drainage towards the north and the northernmost portion of the valley formerly drained by the Spray River and now flooded with the Spray Lakes Reservoir.

At this site, the highway crosses the lowermost portion of a fluvial fan at the lower end of a drainage basin below Three Sisters Pass. The fan gradient is less than 5° around the highway and the area is forested. The fan gradient reduces further downslope of the highway and essentially tapers off to zero roughly 30 to 50 m downslope of the highway. The creek channel tapers out and disperses off in several directions into the treed area further downslope.

The highway crosses a small creek channel at this site, as shown on Photo 742-40. There was no surface flow within the creek channel at the time of the October 2008 inspection. No culvert, or delineator posts marking a culvert, were visible where the highway crosses the creek channel shown in Photo 742-40.

Roughly 200 m upslope from the highway, the creek channel is well confined between approximately 1.5 to 2 m high, near-vertical banks that expose gravel to cobble-sized material deposited earlier in the development of the fan (Photos 742-41, 742-42 and 742-43). Closer to the highway, the height of the active creek channel banks incised into the fan surface taper down.

Within approximately 50 m of the highway, it appears that in recent years during periods of peak runoff the creek flow has jumped the banks of the main channel and flowed into the treed areas on either side of the main channel at several locations. These flows have deposited lobes of debris that meander through the treed areas a short distance upslope of the highway. These lobes of gravel to cobble-sized debris appear to have been deposited in recent years during peak seasonal flows of an active channel that frequently shifts laterally in the area upslope of the highway. Photo 742-44 shows a typical view of one of these debris lobes. It does not appear that any of these lobes of debris reached the highway.

As shown in Photo 742-40, the segment of the creek channel immediately downstream of the highway and extending for approximately 20 m downstream from the highway appears to have been shaped and graded by an excavator within the last year or two. This would be consistent with clearing of debris deposited along the segment of the channel around the highway and possibly of debris that had flowed onto the highway.

Assessment

The apparent creek channel shifting upslope of the highway during peak flows is a natural process on debris fans such as this one, and indicates that large volumes of debris continue to be transported along the creek channel and are deposited in the area around the highway. Therefore, there is a hazard of debris being deposited onto the highway at this site, however AMEC understands that this is not the site of the reported blockage of the highway in August 2004. The "hazard zone" along the highway is estimated to be a roughly 100 m long segment of the road centered around the creek channel crossing.

As described in Section 4.3.2 of the main report, the nearest available precipitation records are from the "Kananaskis Pocaterra" and Banff town site climate stations. Both of these stations are more than 20 km from this site and are at lower elevations within different river valleys than this site. Therefore, neither of these stations should be relied upon as an accurate measure of the actual precipitation at this site in an assessment of possible past debris flows at this site nor the potential for future debris flows. Furthermore, these stations do not provide a measure of short duration, high intensity rainfall events (e.g. over a period of hours, or on some occasions within one hour) that are often triggering factors for debris flow events.

Risk Level

The recommended Risk Level for this site, based on AT's debris flow risk matrix, is as follows:

- Probability Factor of 7 because debris buildup in the channel/source area is considered to be ongoing and it appears that debris flows have occurred along the channel and short distance upstream of the highway crossing in recent years.

- Consequence Factor of 5 to reflect debris deposited onto the highway requiring at least partial closure of the highway while maintenance crews use an excavator or loader to clear the debris.

Therefore, the recommended Risk Level for this site is 35.

Recommendations

Maintenance and Short Term Measures

- This site should be re-inspected during spring runoff in 2009 in order to clarify if there is a culvert in place (perhaps with the inlet buried by rocky debris) and to check if the peak spring runoff flows spill out from the main channel and into the adjacent treed areas upslope of the highway.

- Depending on the assessment during the spring 2009 inspection, clearing of the culvert inlet (if present) may be recommended.

- This site should be added to the 2009 annual Southern Region site inspection tour in order to check if the amount and distribution of debris upstream of the highway changes during the spring 2009 runoff and to re-assess the Risk Level for the site at that time.

Possible Mitigative Measures

It is not practical to attempt to reduce the Probability Factor of debris flows along the creek channel because the source area for the debris comprises the entire creek watershed above the highway. Therefore, the most effective approach to reduce the Risk Level at this site would be to reduce the possibility of debris being deposited onto the road surface in the event of future debris flows. This could be done by:

- Raising the grade of the road surface along an approximately 50 to 100 m segment of the highway centered around the creek channel crossing and, when necessary, cleaning of accumulated debris along the main creek channel for a

short distance upslope of the road into the ongoing highway maintenance program.

- Alternatively, constructing a diversion berm a short distance upstream from the road crossing in order to attempt to divert debris flows from reaching the road. The diversion berm could be constructed by an excavator using the existing channel deposits. However, such in-channel work with a permanent change to the drainage course would likely not be approved by the environmental regulatory authorities given that there is the alternative option of raising the road grade as described above.

Meanwhile, a practical approach would be to treat any debris flows onto the highway as an immediate priority maintenance task. If the highway becomes blocked by debris, a lengthy detour via Highway 40 is possible.

Attempting to set up an automated warning system that would be triggered by debris on the highway is likely not worth the effort at this point.

Other Work

A study of historic aerial photographs of this site should allow the frequency of debris flows along this channel to be more precisely estimated and identify any changes in the watershed upstream of the highway that may make this site more prone to significant debris flows in the future. A more extensive ground traverse of the channel upstream of the highway would also be worthwhile to further assess and characterize the debris flow conditions and risk to the highway. The installation of a rainfall gauge with a datalogger to record hourly precipitation amounts would be of interest in a longer-term research effort into debris flow activity along this creek channel.

Hwy 742 – Goat Pond, South Fan

Photo 742-40 (top) – Facing upstream along the creek channel from below the highway crossing. Note how the creek channel has been shaped and graded at some point in recent years for a short distance downstream of the highway.

Photo 742-41 (middle) – Facing downstream along the creek channel, approximately 200 m upstream from the highway crossing. Note the broad, open channel area and the rocky debris along the channel. See Photo 742-40 for a view facing upstream from this location.

Photo 742-42 (bottom) – Facing upstream along the creek channel, above the highway crossing. This photo was taken at the same location as Photo 742-39.

Hwy 742 – Goat Pond, South Fan

Photo 742-43 (top) – Typical view of the banks along the main creek channel, a short distance upstream from the highway crossing.

Photo 742-44 (bottom) – Typical view of debris deposition in the treed areas adjacent to the main creek channel. It appears that during peak flows, the creek "jumps" the main channel banks and flows into the adjacent treed areas. There were several deposits like this one on the slope a short distance above the highway, but none of them appeared to have reached the highway. An approximately 100 m long segment of the highway, roughly centered around the crossing of the main channel, appears to be at risk from these debris flows.