~Km 4.1 to ~Km 4.5 Cut Slopes, Ditches and Drainage Courses

Site Observations

The following hazards were noted along this segment of the highway.

- Numerous locations where the upslope road ditch appears to be undersized relative to height and inclination of the adjacent cut slope and/or ditch flow. At the time of the site inspection, there were no cobble-sized or larger rocks from the cut slopes on the road surface. However, there were a couple of locations of concern, including:

    - Roughly 20 m northbound from a pull-out at ~Km 4.1, where two 45° inclination cut slopes on either side of a drainage draw expose rocky silt till that has up to boulder-sized rocks included. Photo 742-9 shows one of these cut slopes. The ditch along the toe of these cut slopes is very small to negligible. As shown in Photo 742-10, eroded material and slope wash from the cut slopes has accumulated along the toe of the slopes and then been washed clean of fine grained soil by surface runoff flowing along the upslope edge of the road.

    - Around Km 4.2, ditch flow along the very small to negligible upslope road ditch has spilled across the road, as shown on Photos 742-11 and 742-13. This flow has started to erode a gully into the fill slope below the highway, as shown in Photo 742-12. As of October 2008, the guardrail adjacent to the gully was set back roughly 1 m from the head of the gully so there was no imminent hazard to the road.

- Immediately southbound of Km 4.1:

    - Water and soil washed along the ditch has infilled a natural drainage draw in the slope above the road. The thickness of the accumulated sediment is not clear, and could be in the order of 1 m. Several of the trees in the infilled area were dead. Photo 742-14 shows the infilled area upslope of the road. There did not appear to be a culvert installed at this location and there are no delineator posts marking a culvert. However, if there is a culvert present the inlet would very likely be buried by the accumulated sediment.

    - It did not appear that the sediment accumulation in the drainage draw had been causing ditch flow to overtop the road at this location. As shown in Photo 742-14, the ditch flow appears to continue past the infilled area without problem. It also appeared unlikely that ditch flow could flow across the road in this area because the road surface is very slightly

banked inwards to shed runoff towards the upslope side of the road. Furthermore, the risk to the road from gully erosion in the fill slope below the road as a result of concentrations of road surface runoff discharging onto the slope below the road is also mitigated by the guardrail being inset roughly 1 m or more from the crest of the fill slope, as shown in Photo 742-16.

- At approximately Km 4.15:
    - A natural drainage draw at this location has also been infilled by water and soil washed along the ditch, similar to that at Km 4.1. Photo 742-17 shows this area.

Assessment

The infilling of the drainage draws at approximately Km 4.1 and 4.15 with sediment and water from the ditch flow did not appear to be posing a significant risk to the highway at the time of the October 2008 site inspection. The dead trees in the infilled area at Km 4.1 may eventually become a hazard to the road if they start to fall over.

With respect to the ditches along this segment of the highway:

- The rockfall catch ditch design chart, attached as Figure C1 in Appendix C, suggests ditches in the order of 4 m wide and 1.3 m deep for rock cut slopes in the same range of height and inclination as the soil cut slopes along this segment of the highway. Even if the suggested ditch width and depth are factored down because the cut slopes in this area are in rocky till soil, rather than exposed bedrock, the existing ditches are still judged to be undersized with respect to containing debris from the cut slopes. Therefore, there is a potential for large rocks that erode out from the cut slope to slide and roll down the cut slopes and onto the road. No such rocks were noted on the road at the time of the October 2008 site inspection, but this hazard cannot be ruled out.

- The undersized ditches have also caused the ditch flow to spill across the road around Km 4.2, which has led to the erosion of a gully into the fill slope below the road in that area (as shown in Photos 742-11 to 742-13). The risk to the road from this gully erosion is mitigated, for the short term, by the guardrail being inset roughly 1 m from the current position of the head of the gully.

Risk Level

The recommended Risk Level relative to the ditch flow spilling across the road and leading to the erosion of a gully in the fill slope below the road around Km 4.2 like that in Photo 742-12, based on AT's general geohazard risk matrix, is as follows:

- Probability Factor of 9 to reflect how the ditch flow spills across the road under the current conditions at the site.

- Consequence Factor of 2 if the head of the erosion gully shown in Photo 742-12 retrogresses below the guardrail in the next one to two years, i.e. it would affect the use of the roadway but without requiring closure.

For comparison, the recommended Risk Level relative to the hazard of debris from the cut slopes rolling or sliding onto the road surface because the existing ditch is too small to contain it, based on AT's rockfall risk matrix, is as follows:

- Probability Factor of 9 to reflect the possibility of a few large rocks being eroded out of the slope each year.

- Consequence Factor of 2 to reflect the possibility of large rocks released from the cut slope to slide and roll downslope and onto the road surface without being contained by the existing ditches.

Therefore, the recommended Risk Level for this site is 18.

Recommendations

Maintenance and Short Term Actions

- The maintenance contractor should clean out the accumulated sediment from the upslope road ditch and regrade the existing ditches to restore their available capacity. In the future, the ditches should continue to be cleaned out as necessary to maintain them as close as practical to maximum capacity. The buried telephone cable along the upslope ditch will need to be buried at a greater depth or otherwise protected in order to accommodate this.

- In addition to the ditch cleaning, the surface runoff flow path around Km 4.2 that takes ditch flow into the head of the erosion gully adjacent to the guardrail should also be graded out. The road surface should be graded as necessary in the future to minimize the chances of the ditch overflowing in the future and eroding drainage channels across the road.

- It is not recommended that the accumulated sediment in the drainage draws at Km 4.1 and 4.15 be removed. This material does not appear to create a significant hazard to the road and if it is removed, the low-lying areas on the slope face will eventually fill with sediment over time again.

Medium to Long Term Actions

- Culverts should be installed at the drainage draws at Km 4.1 and 4.15 in order to drain ditch flow and standing water from the sediment-infilled areas adjacent to the road.

- This site should be added to the Southern Region annual inspection tour in 2009 in order to check the condition of the erosion gully at Km 4.2 and review the site conditions in general. It may be necessary to revise the recommended Risk Levels in the future.

~Km 4.1 to ~Km 4.5

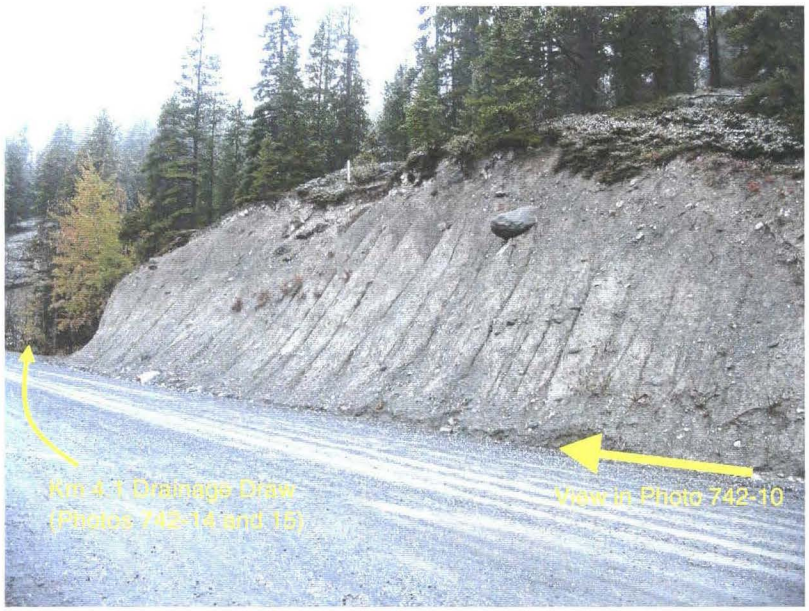

Photo 742-9 (top) – Cut slope immediately northbound of the Km 4.1 Drainage Draw.

Photo 742-10 (bottom) – Facing southbound/uphill along the ditch immediately northbound of the Km 4.1 Drainage Draw. The slope wash/ eroded material along the toe of the cut slope has filled the very small ditch. The ditch flow has washed the fine grained soil from the material and left behind the gravel-sized and larger rocks behind.

~Km 4.1 to ~Km 4.5

Photo 742-11 (top) – At approximately Km 4.2, showing the ditch flow spilling across the road. Please refer to Photo 742-12 for a view of the head of the erosion gully being formed where this surface runoff flows below the guardrail and onto the fill slope below the road.

Photo 742-12 (middle) – Erosion gully developing in the fill slope below the road around Km 4.2, where the ditch flow coming across the road flows below the guardrail. Note how the guardrail is set back roughly 1 m from the crest of the fill slope, thus mitigating the hazard to the road from the gully erosion in the short term.

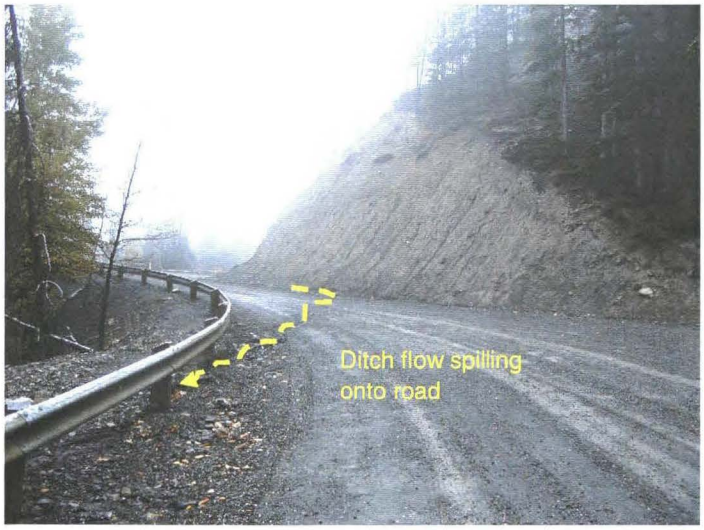

Photo 742-13 (bottom) – Facing southbound from approximately Km 4.2, with the ditch flow coming across the road surface as shown. A typical cut slope in the order of 8 to 9 m high and up to 45° inclination is visible in the background.

~Km 4.1 to ~Km 4.5

~Km 4.1 Cut Slope
(see Photos 742-9 and 10)

Photo 742-14 (top) – Drainage draw above the road at ~Km 4.1, infilled with sediment and water from the ditch flow. There does not appear to be a culvert installed at this location. The ditch flow appears to continue past this location, as marked. Note the dead tress in the infilled area.

Photo 742-15 (bottom) – Another view of the infilled drainage draw at ~Km 4.1.

~Km 4.1 to ~Km 4.5

Photo 742-16 (top) – Opposite the drainage draw at Km 4.1, showing the guardrail inset more than 1 m from the crest of the fill slope below the road.

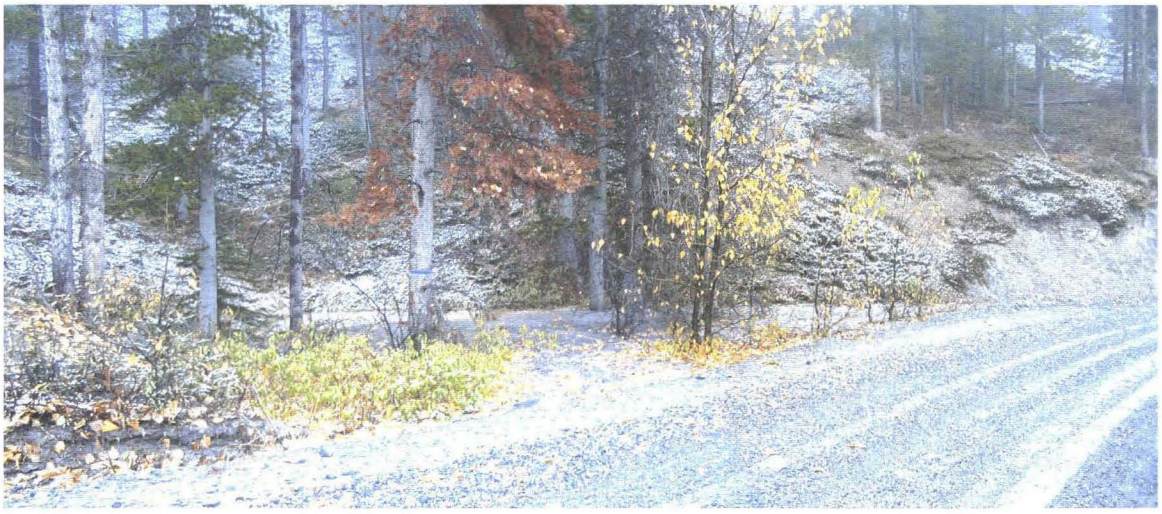

Photo 742-17 (bottom) – Drainage draw upslope of the road at approximately Km 4.15, infilled with sediment and water from the ditch flow similar to the draw at ~Km 4.1.