

~Km 3.7 Fill Embankment

Site Observations

- As shown in Figure A5, when driving southbound at approximately Km 3.7, the highway curves to the left and passes over a lower area and drainage swale on the slope via a 5 to 6 m high fill embankment. There is a culvert installed through the fill embankment with the inlet positioned to intercept surface runoff in the upslope road ditch that flows northbound towards the embankment. The culvert discharges near the toe of the downslope embankment face. Photo 742-3 shows the relative position of the culvert inlet relative to the curve in the road and the fill embankment.
- At the time of the October 2008 site inspection, the segment of the upslope road ditch extending upstream from the culvert inlet was filled with material, as follows:
 - Boulder-sized rocks for a short distance upstream from the culvert inlet, as shown in Photo 742-4. It appears that these boulders were placed in the ditch, perhaps in an attempt to armor the ditch against excessive downcutting and with the intent that ditch flow could percolate through the large voids between the boulder-sized rocks.
 - The segment of the ditch upstream from the boulders is filled with fine grained soil and gravel that has eroded from the cut slopes above the ditch, as shown in Photo 742-5. This material appeared to have been deposited where the ditch flow was slowed by the rock fill upstream of the culvert inlet.
- The infilling of these segments of the ditch has caused the ditch flow to erode slightly into the upslope edge of the traffic surface to get around the boulders blocking the ditch, as shown in Photo 742-4. Ditch flow had also bypassed the culvert altogether by spilling onto the road surface, flowing across the road and onto the downslope embankment face. This had led to erosion in the downstream face of the embankment fill as follows:
 - An erosion gully in the embankment slope, roughly in line with the culvert alignment. The lower portion of the erosion gully is roughly aligned with the culvert outlet, and the gully has been backfilled with boulders in an apparent attempt to buttress the gully sidewalls and minimize lateral expansion of the gully.
 - A newer erosion gully a short distance northbound of the culvert (i.e. to the left, when standing over the culvert alignment and facing downslope). Photos 742-6 and 742-7 show how the head of this gully has eroded

inside of the guardrail and is encroaching into the downslope edge of the road surface. One of the guardrail posts has been undermined and exposed (as shown in Photo 742-7).

Assessment

The gully erosion on the downslope embankment face will continue if the ditch flow continues to spill onto the road surface and then drain onto the downslope face of the embankment. Continued erosion and possible lateral expansion of the head of the gully will undermine a longer segment of the guardrail and also lead to a loss of a portion of the traffic surface.

Risk Level

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

- Probability Factor of 10 to reflect the active gully erosion on the downslope embankment face with a possibility that the rate of erosion will increase in the future if the channeling of ditch flow and surface runoff from the road into the head of the gully becomes more established in the future.
- Consequence Factor of 3 based on the possibility that further encroachment of the head of the erosion gully into the road surface will affect the safety of motorists and may require a partial closure of the road (i.e. reduced trafficable width, with the upslope lane of the road remaining open).

Therefore, the current recommended Risk Level for this site is 30.

Recommendations

Maintenance and Short Term Actions

- Ditch flow into the culvert should be re-established to prevent water from flowing across the road. This could be done by removing the boulder-sized rocks in the ditch as well as cleaning out the accumulated fine grained to gravel sized soil further upstream along the ditch and also regrading the road to prevent surface runoff from flowing towards the downslope side of the road. This should be treated as an ongoing maintenance task because the upslope road ditch will need to be kept open and clear of debris (the buried telephone cable in the upslope ditch will need to either be buried at a greater depth or otherwise protected in order to accommodate this). It will also be necessary to avoid excessive erosion and downcutting of the ditch upstream of the culvert inlet (which was likely that reason that the rock fill was placed in the ditch in the first

place). The ditch could be lined with an erosion control product (e.g. a “Scour Stop” style product or equivalent) however such a product may be vulnerable to damage during future ditch cleaning with an excavator.

- Restore the full trafficable road width and re-support the exposed guardrail post by placing and compacting backfill in the head of the newer erosion gully. Wraps of geosynthetic could be incorporated into the fill in order to reinforce the resulting slope and try to minimize future surface erosion and gullying.
- Attempt to minimize future erosion along the newer erosion gully by placing rock armoring along it. This would be worthwhile as a backup measure, even after the surface flow from the roadway draining into the gully is curtailed by cleaning out the upslope road ditch and re-establishing the ditch flow into the culvert.

Medium To Long Term Actions

- Grade and shape the road surface so that surface runoff will be shed into the upslope road ditch and maintain it this way. This would provide further protection against flow in the upslope road ditch spilling across the road surface and resulting in a concentrated flow onto the downslope embankment face. This needs to be done in conjunction with ensuring that the upslope road ditch is kept open and that ditch flow is directed into the culvert.

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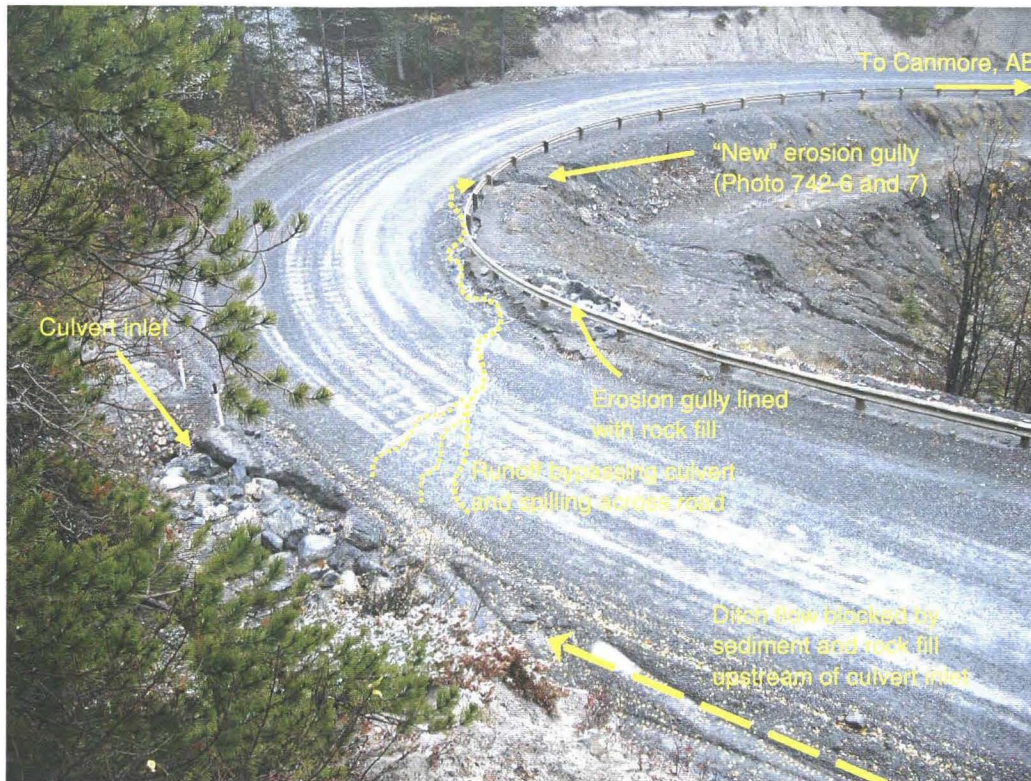


Photo 742-3 (top) – Facing northbound along the highway and across the Km 3.7 Fill Embankment site.

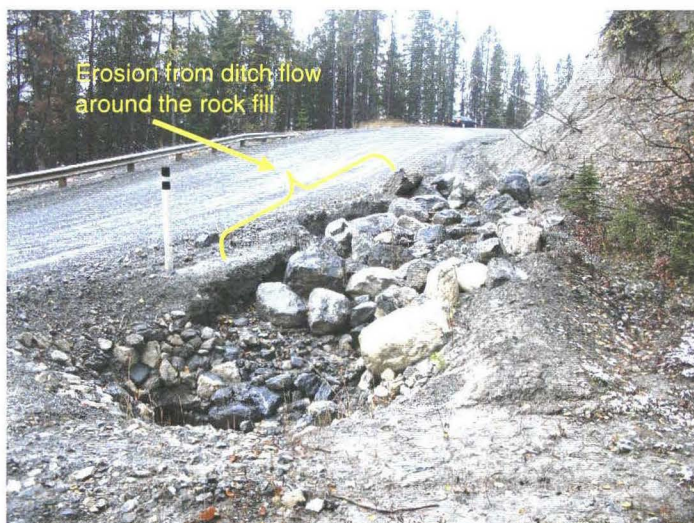


Photo 742-4 (bottom) – Facing southbound across the culvert inlet area. Note the rock fill in the ditch for a short distance upstream of the culvert inlet. Note how the ditch flow has eroded slightly into the road surface adjacent to the rock fill.

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Photo 742-5 (top) – Adjacent to ~Km 3.75 Cut Slope site, facing northbound along the upslope road ditch, towards the culvert inlet at ~Km 3.7. Note the accumulation of sediment in the ditch upstream of the culvert inlet. This had reduced the ditch capacity and led to ditch flow spilling across the road surface as shown in Photo 742-3.



Photo 742-6 (bottom) – Head of “new” erosion gully in the downstream embankment slope, encroaching below the guardrail and into the road surface. See Photo 742-3 for the location of this gully relative to the rest of the site.

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Photo 742-7 (top) – Another view of the head of “new” erosion gully in the downstream embankment slope, encroaching below the guardrail and into the road surface. See Photo 742-3 for the location of this gully relative to the rest of the site.

The older erosion gully that had been armored with rock fill above the culvert alignment is visible in the left background of this photo.