KARLENG
Karl Engineering Consultants Ltd.

File: 2012-1002-Callout Date: Sept 1, 2014

Alberta Transportation
#301, 9621 – 96 Avenue
Bag 900, Box 29
Peace River, AB
T8S 1T4

Attention: Mr. Ed Szmata
Sr. Construction Technologist

Re: **Call-out Inspection Report** **(Currently GP-21a- Erosion of w. ditch of N. Approach)**
(Previously GP-21 Slide at previous twin culvert)
Hwy 719:02 at Henderson Creek Bridge
- Erosion distress along
Site (1) west ditch (riprap) down valley along North Approach to bridge
Site (2) east ditch (grassed) down valley along North Approach to bridge

As requested, a Callout Inspection of the site was carried out on July 31, 2014.

In attendance was (i) Alberta Transportation staff: Messrs. Ed Szmata (AT Peace River), Steve Pasquan (AT Bridge Tech, Peace River), Ken Misik (AT MCI Grand Prairie), and Rocky Wang (AT Geotech, and (ii) Mr. Karl Li of Karl Engineering Consultants Ltd. (KarlEng).

A Callout Inspection Report is provided as follows. Attached are site photos and figures to form part of the report.

1.0 SITE

On the basis of AT information and our observations, the site and distress conditions can be described as below.

A concern was raised about the erosion distress occurring along the ditches descending down the north valley slope of Henderson Creek. The descending highway stretch of was a steep grade (about 7% grade) over about 800m distance descending downvalley from upland flat farm area at valley top) to the new bridge at valley bottom. The new bridge was completed in 2010 to replace a previous twin culvert.

As indicated in Figure 1 (Site Location Plan), there were two ditches on opposite sides (west and east) of highway descending about 800m distance down the valley slope along its north approach to the new bridge. Along the west ditch, new riprap channel lining and some minor channel trimming-widening were evidently constructed along the west ditch during the 2009-2010 times of new bridge construction. It was apparent some design effort was exerted for such riprap ditch lining constructions (likely constructed as per design). Some areas of west ditch might have been widened to provide channel hydraulic section improvements. Along the opposite east ditch, the ditch was grassed and of narrower channel widths, likely of old vintage untouched ditch conditions (likely old times prior to 2010 bridge construction). In general, it was apparent that no substantial changes were made to the gradeline and channel sections along both ditches along this north downvalley approach (during the 2009-2010 time of new construction of bridge). Thus, the ditch gradeline down this north approach roadway should have remained unchanged overtime.

1.1 Site (1) west ditch (riprap) down valley along North Approach to bridge

Along this west ditch of about 800m stretch of steep grade (about 7% grade), the ditch section of slightly flat bottom channel (not quite trapezoidal) and was lined with riprap stone of Riprap Class 2-3 size. Rock checks and/or gabion

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drop structures were installed at intermediate heights along the ditch grade. According to AT information, it is understood that some portion of the riprap placement was recently (2013) repaired with riprap rocks studded in (without placement of nonwoven geotextile underlay) since repairing whole width of ditch was too expensive and not viable. With such repairs, it was understood that approx.400 sq.m. ditch area was repaired with such riprap lining repair placement at an expense of about $150,000. Such upgrade repair remains to be proven on its performance to resist future flows.

Erosional Distress from Amount of Flow Acceptable for this Ditch – The flow amount should be reviewed
On the whole, at the current stage of this callout inspection, it was observed that a mild concern of the erosion distress can be currently assessed. Especially, since substantial repair work was recently carried out by AT to beef up the erosion resistivity of the ditch linings. But future erosion distress will likely recur for the ditch to accept the same amount of flow as per recent 4 year experience since the new bridge 2010 construction. From such erosion distress so caused recently, it can be suspicious that the amount of flow may be abnormal high and excessive for this ditch to accept.

- It can be suspicious that some flows (likely belonging from some catchment area and should be outfalled to some local road ditches) may have been inadvertently converged to flow down this west ditch, despite its sturdy riprap lining constructions.
- As indicated in Figure 1. It was observed that a bundling of the culverts can be located at intersection at valley top (Hwy 719 junction with Twp 795 road) and there may be a likelihood (uncertainty) that excessive flows were converged from the culvert arrangements thereof. This needs to be further investigated.
- It is advisable that the catchment outfall from upland acceptable to this highway ditch should be reviewed with regional authorities so that this highway ditch is fairly unburdened. For this west ditch, such outfall amount should be identical to the outfall amount as in previous times prior to the new 2010 bridge construction, with no change of ditch gradeline over time.
- On site, it was observed that the Twp 795 (Resource Road) was built like a higher fill embankment that may have dammed up and diverted upland waters towards this west ditch. This may cause water cross drainage issues should be investigated as it may divert additional waters to this west ditch.
- Otherwise with excessive amount of water flow to carry, AT may have to construct a gabion mat lining step-down ditch to survive the outfall flow down such long grade steep ditch.

Distress of Sideslope Slumping(s) – due to toe scour causal from erosion rillings
Currently, some rilling erosion was occurring along the upper edges of the riprap lining (outside the channel proper) where the eroding water(s) was scouring into the weaker subgrade soils of sideslope to find its flow path. At a few locations (at about 20m a stretch per location), the erosion scour along basal area of sideslope has caused some shallow slumpings of the sideslope to transgress onto the roadway edges.

- Such sideslope slumpings can be pragmatically repaired with the benching infill of crushed gravel for sideslope restoration and infilling the erosion rilling with compacted granular fills resistant to erosions.

Distress of Wheel Path Rutting(s) – foundation failure of subgrade soil
At 1-2 locations, some serious subsidence of pavement can be noted along 5-10m of roadway along the wheel paths likely caused from foundation soil failure(s). As discussed with AT staff, such pavement subsidence can be exerted by abnormal high traffic loads (likely illegal highway loads) infrequent in the area.

- Such pavement subsidence may be pragmatically repaired with patching to add to ACP thickening(s).

1.2 Site (2) east ditch (grassed) down valley along North Approach to bridge

The east ditch was grass covered running along opposite side along the same steep long grade (as the riprap west ditch). The ditch channel was of narrower channel widths and frequently of a V ditch at locations.

As shown in site photos, ditch erosion was incised along bottom of ditch since it was downcutting into weaker subgrade soils. The sections of eroded ditch were not numerous along the east ditch and erosion was not deeply incised despite its less resistive grass growth lining since substantial flow was not apparent for this ditch. Along about 2 sections (at 30m to 50m length per ditch section) erosion incision of occurred at toe of high backslope (20m to 30m heights) of minor slumping(s) immediately above.

- For pragmatic repairs, it can be advisable to place riprap lining along the eroded area taking the precaution not to over-subexcavate any soft bottom since it may trigger further slumpings along the marginal backslope already in distress.

The east ditch was assessed of minor concern apparently due to nominal flows.

1.3 Ditch flow convergence at top of valley (Hwy 719:02 junction with Twp 795 road)

As presented in Section 1.1, it is suspected that an abnormally high amount of flow may have been converged to flow down the west ditch (riprap lined).

It was observed on site that several culverts were installed at this highway junction with Twp Road 795 to have shuffled the upland ditch flows, apparently to converge an substantial amount towards the west ditch. This needs to be further investigated to confirm.

1.4 Historic Comparison of Ditch performance and Uncertain Distribution of Down-Valley Flow from Upland to be investigated

- Pre 2009 Twin Culvert Crossing for Hwy 719:02 crossing over Henderson Creek
- Post 2010 New Bridge Crossing for Hwy 719:02 crossing Henderson Creek

Previously in June 2002, we had the opportunity to inspect the sliding of the previous fill embankment over the previous twin culvert at this highway crossing over Henderson Creek. At such previous times, no issue of erosional distress was reported along the ditches down the north approach. To date, it is believed that the ditch gradeline has not differed (or steepened) so as to trigger in a higher erosion potential.

We are suspicious that some substantial addition of amount of water(s) may have converged to flow down this west ditch over the recent 4 years (causing erosion despite the riprap armor upgrades) since the 2010 construction of the new bridge. Since no previous erosion concern was reported for the same ditch gradeline (despite no riprap armoring) prior to 2010 bridge construction, the likelihood of increase in flow to have triggered erosion can be obvious.

Thus, it is advisable to compare the two time frame scenarios (post-bridge and pre-bridge) as to whether an increase in flow was added on the west ditch within the recent 4 years since the new 2010 bridge construction. If yes, such added flow may have been diverted from elsewhere.

2.0 ASSESSMENT and DISCUSSIONS

On the basis of above site conditions, the followings are assessed and discussed.

2.1 Historic Overview of Concerns on Erosion of West Ditch

- <u>Prior to 2010 Bridge construction – No erosion concern of ditch was reported</u>
  Previously (prior to 2009-2010 construction of the new bridge), no concern on ditch erosion distress was reported and noted in AT records during the operational times of the previous twin-culvert. To date, over the recent 4 years since the new 2010 bridge has been in service, it seems that reports on erosion concerns along the west ditch (of riprap lining) were evolving.

  It is hoped that expectation (no erosion to occur) may not have been differing by other stakeholders or jurisdictions. In erosion control matters and reality, we need to be pragmatic and cost effective aiming at reasonable outcomes.

- <u>Post 2010 Bridge construction – Ditch erosion concern evolving</u>
  As per AT records (Karl Li communication with Steve Pasquan of AT on background information), it is understood that the recent concerns of this west ditch included
  (i) Around 2011, warranty repair by contractor (as was enforced by AT) for west ditch erosion damages which was to have caused from under-scouring. (Apparently under contractual obligation

for the 2010 bridge construction and related work). Evidently, with the long and steep gradeline of the ditch, it was apparent that the west ditch was subjected to substantial flows and erosion forces to demand a strong lining, well designed and well-constructed.

- Thus for future considerations, it will be fair to review the amount of flow to be allowed down this ditch. It should be realized that the vast erosion forces from the amount of flow should be of concern (despite construction perfections or not).

(ii) Around March 2013, a complaint to AT was served from Alberta Environment on ditch erosion.

- Thus, for future consideration, it will be fair to consider construction of siltation ponds (refer to BMP in AT's Erosion Control Guideline) to locate at ditch termini (for siltation entrapment) on the concerns recur relating to siltation transport towards watercourses. We can assist in such matters if requested.

(iii) Around 2013, AT upgraded the west ditch with placement of more riprap (Class 2-3 of about 400 sq.m.) at an expense of about $150,000.

(iv) The "likelihood" or possibility that a draining-out of waters from a dugout water body was allowed to outfall down this west ditch. The distribution of upland catchment waters OR the likelihood of a convergence of upland water(s) to be allow to outfall down the west ditch.

- It is advisable to review the outfall of flows from catchment area that is allowed to outflow down this highway ditch.

2.2 Comments

Currently, the west riprap ditch was inspected in a fair condition with no serious erosion wreckage. It was assessed that the west ditch was recently upgraded with riprap ditch lining as well as drop structures to accommodate the normal amount of flow along the long 800m stretch of steep (7%) grade down the valley slope. However, when excessive amount of flow scour onto such steep long stretch of ditch is allowed to continue, erosion failure likely will recur.

It is understood that some professional design effort may have been exerted into the west (riprap) ditch constructions. However, with the recent 4 year of such erosion distress onto the west ditch, it can be rationalized that the real amount of ditch excessive flow may have differed with the amount of flow under design. Such excessive flow caused erosion failure despite of its riprap lining construction. Thus, it was likely that an excessive amount of water flow along this steep ditch may have exceeded the design flow for current ditch lining protection construction. This probability of excess in flow amounts should be investigated.

One avenue of review (on flow amounts) will entail investigating the arrangement of culverts (i.e. flows to converge) at top of valley at intersection of Hwy 719:02 with Twp 795 road. At this intersection where shuffling of culvert flows can be an uncertainty, it is reasonable to suspect the a portion of the outfall waters from the upland (which should have been distributed to outfall down some other quarter-section road ditches down valley) may have been converged to outflow down this west ditch. It is advised that, (for the shedding of upland catchment water to outfall down valley), the fair distribution of flows should be fairly reviewed by stakeholders, including local land users, Alberta Environment, the local municipality and Alberta Transportation.

It may also be advisable that a watershed assessment is to be carried out to verify the fair amount of water to be accepted by the highway ditches. Such review and assessment will be beneficial for proper ditch design for such excessive flow conditions experienced over the recent 4 years.

<u>In a time frame perspective</u>,
it can be noted that no concern of ditch erosion was reported to have occurred prior to the 2010 bridge completion. Prior to 2010, the ditch was performing well during the times when the highway was crossed over the previous twin-culvert. It is highly probable that some changes in the flow regime (additional amount of flow) may have been impressed onto the west ditch during the recent 4 years.

Fundamentally, it may be likely that an excessive amount of flow was converged onto this west ditch to invoke erosion failures. It is advisable to review the fair amount of outflow from upland that should be allotted down this west ditch. The review outcome may require a reduction of flow to be accepted by the west ditch. Otherwise, an

upgrade of ditch lining and channel design should be carried out to accept the flows which is to be reviewed as proper for this highway ditch to accept.

The erosion distress along the west ditch downvalley along north approach is not considered a geohazard site at its current conditions. Risk assessment ranking on geohazard is not assessed.

3.0 RECOMMENDATIONS

On the basis of above assessment, it is recommended that

1) Another callout inspection should be carried out after one year duration. Then, we will assess and review the changes of ditch condition from the perspective of a highway engineer and geotechnical engineer and erosion control professional. We will need to be pragmatic and reasonable with erosion control practices and its relevant outcomes.
2) A review of the flow amount allotment should be carried out to assess that the allowable legitimate flows down this west ditch so that the flow amount is not excessive to overburden and "wreck" the existent riprap lining investment. This will include review of the culvert arrangement at top of valley (especially at highway junction with Twp road). If required, an assessment of "upland water shed flow down valley" should be carried out to assess the rightful and legitimate amount to be accepted by the highway ditches. Thereafter, the ditch channel lining adequacy can be assessed properly.
3) Closely observe the performance of this west ditch for coming 1-2 years, especially during times of spring snow melt and lengthy wet rainy weathers. This will allow a real field assessment of upland water flow patterns downvalley.
4) The disposition and high fill (damming) of Twp 795 Resources Road can be suspicious in probable blocking off cross drainage (north-south). This may be a minor issue but should be investigated as appropriate.
5) For the erosion damages along east ditch, the repairs can be pragmatically carried out with placement of riprap lining with careful (no over subexcavation) preparation of ditch subgrade. Over sub-excavation along ditches will endanger and further the existent slumpings of high backslope (already in margin stability condition).
6) It will be unwise to expend further resource without confirming the amount of flow to be accepted for this west ditch. For such purposes, we need to further observe the riprap ditch performance which was only recently upgraded.

4.0 CLOSURE

We appreciate the opportunity to provide the above information. Should you require further information, please contact the undersigned.

Karl Li, P.Eng.
Senior Geotechnical Engineer

cc.
Roger Skirrow, AT Geotech Br.
Rocky Wang, AT Geotech Br.

Attachment: - Site Photos,- Figure 1

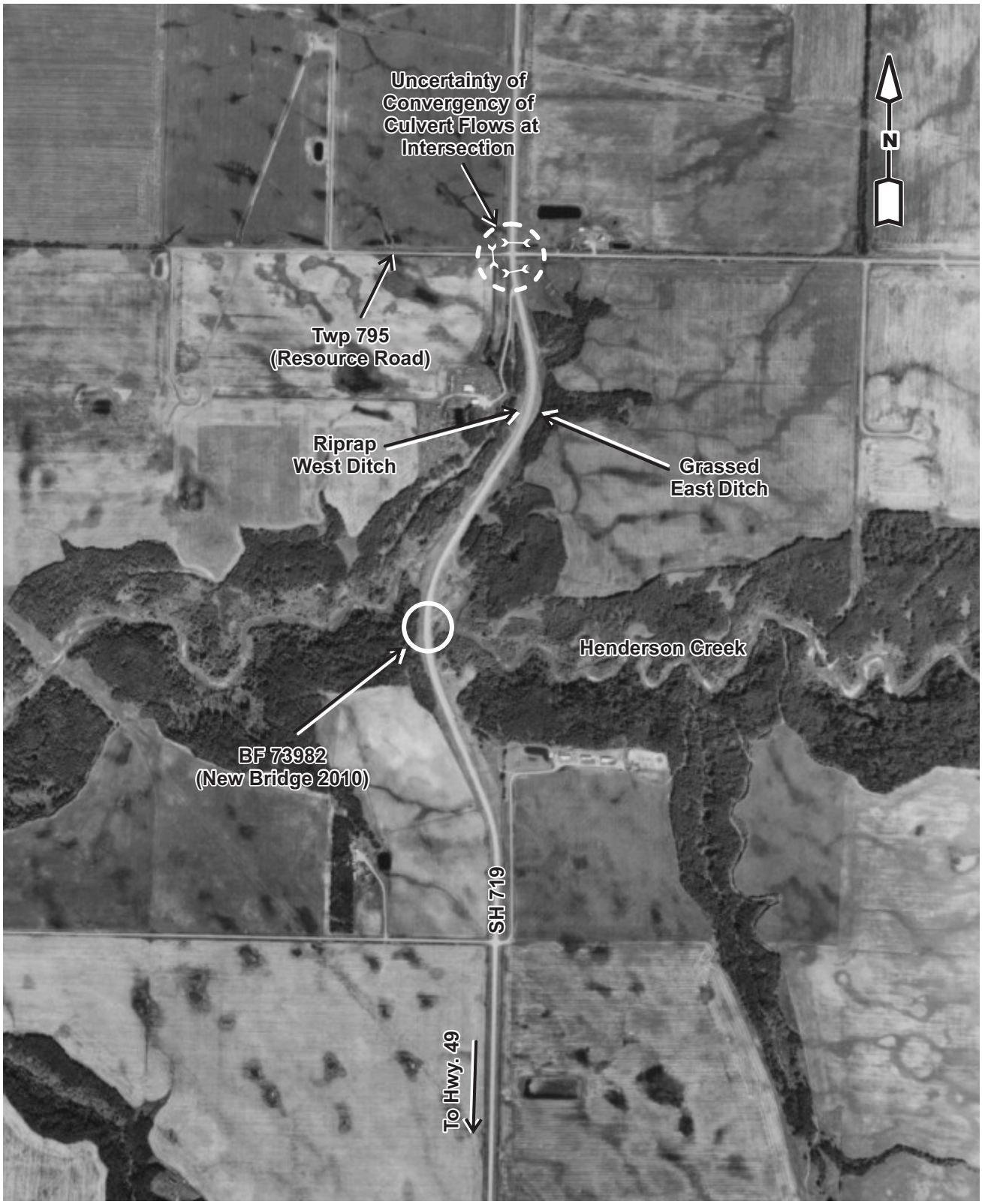

Figure 1
Aerial Photo
Site Location Plan

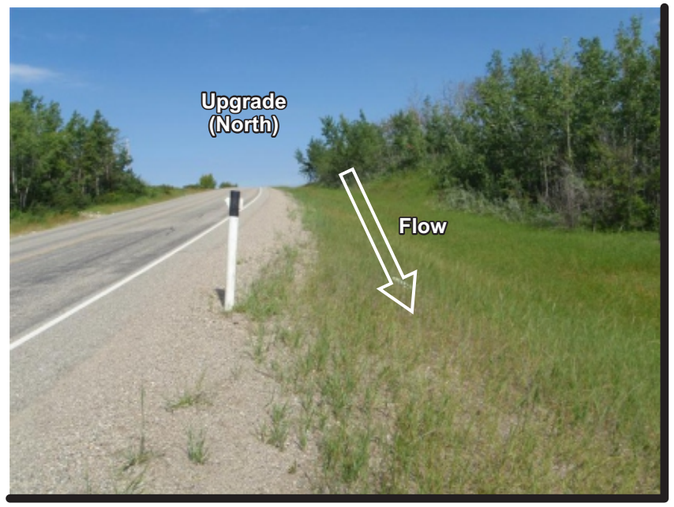

Photo 1

Looking north upgrade towards upland – Highway start its descend of north valley slope

- Ditch not sustaining erosion distress and apparently less flow transmitting along this east ditch
- East (grassed) ditch going down the north slope
- Width bottom grassed ditch is of trapezoidal width at top portion of valley slope

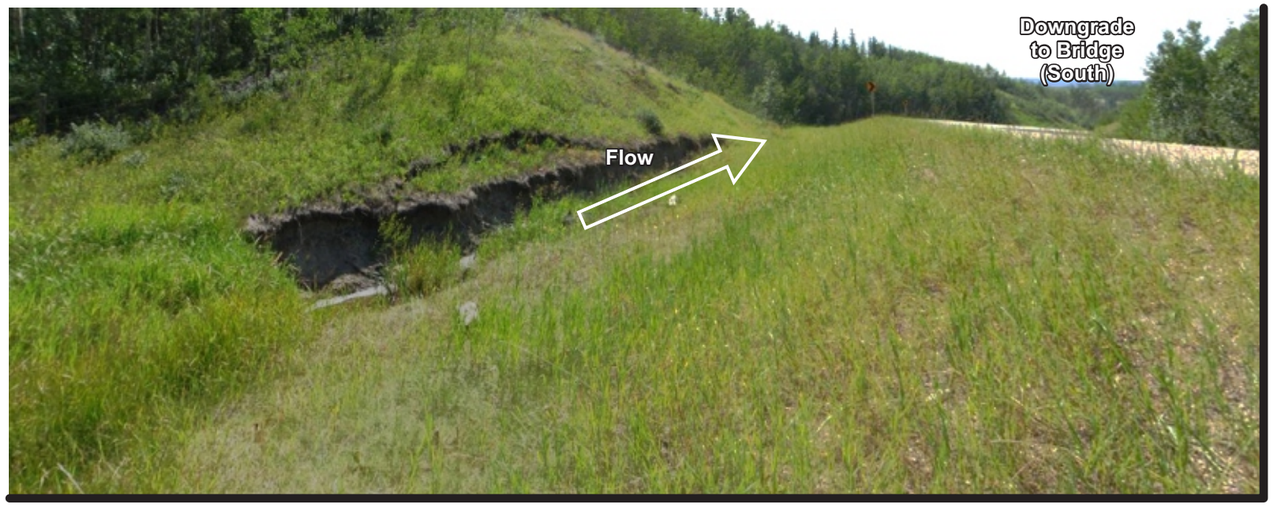

Photo 1a

Looking south downgrade at east (grassed) ditch – upper portion of north valley approach

- Erosion of this grass lining ditch has started already despite a wider ditch section and a gentler grade (at some distance downgrade from top of valley)

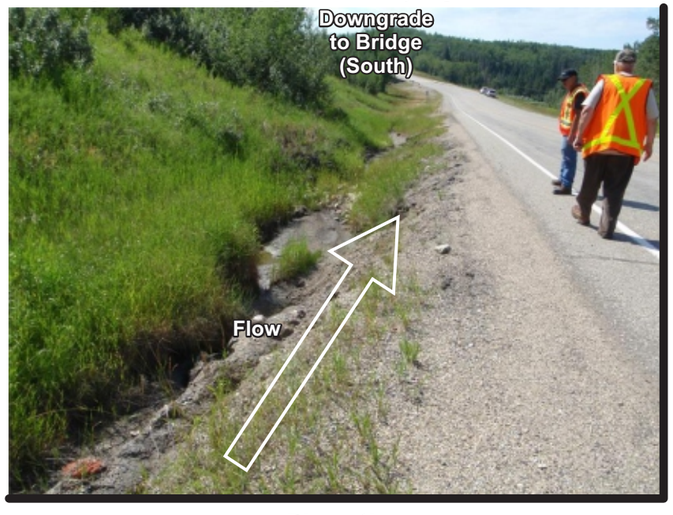

Photo 1b

Looking south downgrade at east (grassed) ditch – descending down north valley approach

- Narrower V ditch and higher cut slope above
- Erosion rilling is occurring (at some distance downgrade from top of valley)

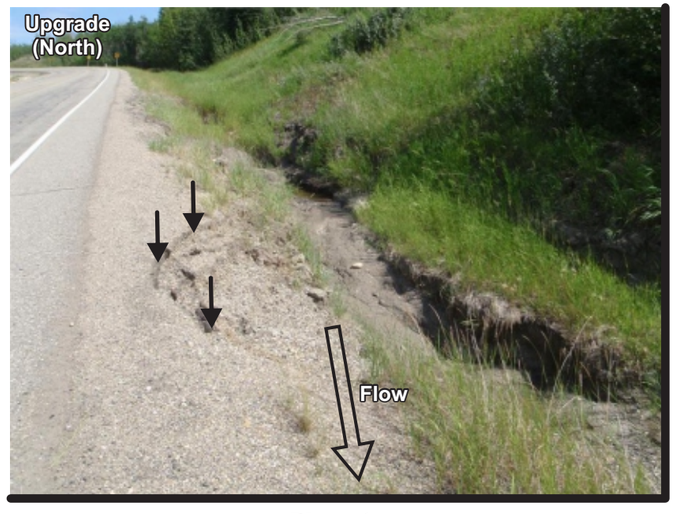

Photo 1c

Looking north upgrade at east (grassed) ditch erosion – descending down north valley approach

- Another upgrade view (reverse of Photo#1b)
- Rilling erosion of ditch (at some distance downgrade from top of valley)

Note: Photos taken on End of July, 2014

Photo 1d

Looking north upgrade at east (grassed) ditch erosion - Another view

- Sloughing of sideslopes as a result of ditch erosion
- Sloughing of sideslope due to incising erosion rilling of a V ditch
- Sideslope can be pragmatically repaired with benching infill with erosion resistant granular materials

Photo 1e

Looking north upgrade at east (grassed) ditch erosion - Another view

- Sloughing of sideslopes as a result of ditch erosion
- Sloughing of sideslope due to incising erosion rilling of a V ditch
- Sideslope can be pragmatically repaired with benching infill with erosion resistant granular materials

Photo 2

West ditch– Looking north upgrade – a general view of riprap lining ditch

- Channel constructed with riprap (M-1 stone)lining and rock and gabion checks to accept flow
- Ditch of trapezoidal width to increase hydraulic radius to minimise flow erosion energy
- Heavy Industrial Traffic (illegal weights) may have caused rutting subsidence settlement (foundation failure) of pavement structure at locations. A very likely scenario

Note: Photos taken on End of July, 2014

Photo 2a

West ditch with riprap lining and rock and gabion checks – erosion+sideslope sloughing

- Heavy Industrial Traffic (illegal weights) may have caused rutting subsidence settlement (foundation failure) of pavement structure at locations. A very likely scenario.
- Some rilling erosion occurring alongside edge of riprap lining
- Some sloughing of sideslope transgressed up the edge of roadway
- Substantial flow apparently transmitting along this ditch
- Riprip stone mostly of M-1 size; gabion drop structure in fair conditions
- Flow path has shifted out of its intended channel lining channel and flow occuring along weak soil along edge of rock lining

Photo 3

Upland ditch flow convergence can be source of overloading flows to erode onto a ditch (west ditch of Hwy. 719)

- Ditch flow convergence at Intersection at north valley top of Henderson Creek may be problematic culprit to converge high flow amount onto the west ditch
- Culvert layout at Intersection of Hwy 719:02 and Twp 795 Road needs to be reviewed on outflow/onflow distribution from down valley from uplands
- West ditch of Hwy 719:02 likely accepting high flows converged from along Twp 795 road (both from east side and from west side).
- A need to review the convergence of ditch flows down this west ditch of Hwy 719

Photo 3a

Twp 795 Resource road (east/west)

- Apparently the damming up waters by Twp 795 Resource road embankment may have converged upland waters to flow into Hwy 719 west ditch
- Need to check any cross drainage culvert constructed along Twp 795 R. road for equalizing flows on its both sides (north to south)

Photo3b

Looking north (at access to farm house) – an access culvert to channel flow onto west ditch

- Culvert apparently under full flow distress to scour flow onto west ditch
- A need to review actual flows accepted onto this west ditch via this culvert

Photo 3c

Another view of west ditch

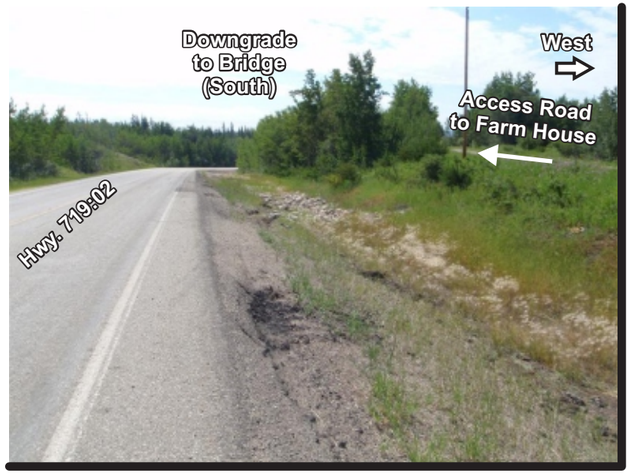

Photo 3d

West ditch at top verge of valley and edge of uplands

- Ditch sideslope sloughing apparent under some erosion scour likely from snow windrow melt erosion effect
- Sideslope distress can be repaired with bench in filling with gravelly erosion resistant material to restore sideslope

Note: Photos taken on End of July, 2014

Photo 4

A new bridge (an early 2000 construction)

- New creek channel restored (previous a twin culvert construction) under the new bridge
- Headslope and downflow drains in good conditions

Photo 4a

A new bridge (an early 2000 construction)

- New creek channel restored (previous a twin culvert construction) under the new bridge
- Headslope and downflow drains in good conditions

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A new bridge (an early 2000 construction)

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