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| SITE NUMBER AND NAME: C035 H590 Ditch Erosion | | HIGHWAY & KM: 590:04, 20.104 | PREVIOUS INSPECTION DATE: June 24, 2021 | INSPECTION DATE: June 18, 2024 |
| LEGAL DESCRIPTION: 01-29-35-21 W4 | NAD 83 COORDINATES: UTM Northing Easting 12 5765903 365774 | | RISK ASSESSMENT: PF: 6 CF: 3 TOTAL: 18 | |
| AVERAGE ANNUAL DAILY TRAFFIC (AADT): 720 (west) (Ref No. 997156) | | | CONTRACT MAINTENANCE AREA (CMA): 517 | |

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| SUMMARY OF SITE INSTRUMENTATION: There is no instrumentation at the C035 site. LAST READING DATE: N/A | INSPECTED BY: Chris Gräpel (KCB) James Lyons (KCB) Tony Penney (AT) Rocky Wang (AT) |
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PRIMARY SITE ISSUE: Numerous erosion features located along Hwy 590, primarily in the ditches, on either side of the Red Deer River.

APPROXIMATE DIMENSIONS: The overall site length is approximately 2 km.

DATE OF ANY REMEDIAL ACTION: Fall of 2020 – The large erosion gully approximately 600 m west of the bridge was backfilled with gravel and Class 1M riprap by TEC’s HMC; Summer/Fall of 2023 – the ditch erosion east and west of the bridge was repaired (pit run gravel, in-situ material and rolled erosion control product (RECP), or pit run gravel, non-woven geotextile, and Class 1M riprap), including additional improvements at the 2020 repair area. Culvert improvements was also completed during this work.

| ITEM | CONDITION EXISTS | | DESCRIPTION AND LOCATION | NOTICABLE CHANGE FROM LAST INSPECTION | |
|-------------------|------------------|----|---|---------------------------------------|----|
| | YES | NO | | YES | NO |
| Pavement Distress | | X | N/A – none observed during 2024 inspection. | | X |
| Slope Movement | | X | N/A – none observed during 2024 inspection. | | X |
| Erosion | X | | Due to the dispersive nature of the soils in the Red Deer River valley, erosion features (gully erosion, sinkholes) exist both east and west of the bridge. | | X |
| Seepage | X | | Seepage was observed in the north (westbound) ditch approximately 1.2 km west of the bridge where a culvert and drainage pipe were installed in 2023. | | X |
| Culvert Distress | | X | N/A – none observed during 2024 inspection. | | X |

COMMENTS

General:

The colluvial soil and bedrock exposed at the C035 site (both sides of the river) are dispersive. Erosion control of dispersive soils should be approached differently than for non-dispersive soils, as per KCB’s 2017 report on the C035 site. In early-2023, KCB proposed that TEC conduct a series of field tests on the west and east sides of the river to assess erosion control measures in dispersive soils, similar to what TEC completed at the Diashowa site in the Peace River valley. Some areas of the C035 site are well vegetated, while others are not. In 2021, KCB completed a soil chemistry assessment to assess what type of vegetation could be potentially able to grow well in dispersive soils. KCB issued our report to TEC on May 17, 2021.

In late-2023, the C035 site was repaired as part of the highway improvement project (TEC Contract No. CON0021175). The prime consultant was CAP Engineering, prime consultant was Ledcor, subconsultant was Judo, and KCB was on site periodically throughout construction to monitor the geohazard repair work. The scope of the geohazard repair work included the following:

West of the Bridge:

- Erosion gullies (approximately 780 m in total) in the north and south ditches west of the bridge were backfilled with compacted pit run gravel and graded to a channel shape (ditch bottom approximately 1.5 m wide with 3H:1V side slopes).
- The 1200 mm diameter CSP culvert west of the bridge was sleeved with a 900 mm diameter smooth walled steel pipe (annulus between the two culverts was backfilled with grout). A riprap-lined channel approximately 25 m long was constructed downstream of the culvert outlet. The erosion gully was backfilled with compacted pit run gravel, lined with non-woven geotextile, and then armoured with Class 1 riprap. The outlet channel was terminated at TEC's right-of-way (ROW) boundary.
 - A short length of the north (westbound) ditch, just west of the outlet channel, was armoured where the ditch grade steepens and connects to the outlet channel. This was field-fit during construction after a rainfall event resulted in erosion gullies beginning to form.

East of the Bridge:

- Erosion gullies in the north (westbound) ditch, approximately 250 m long, was repaired using two different methods:
 - 125 m backfilled with in-situ material and armoured with RECP; and
 - 125 m backfilled with pit run gravel, lined with non-woven geotextile, and armoured with Class 1M riprap.
- The condition of the inlet of the existing CSP culvert under Hwy 590, just east of the bridge, was improved by clearing vegetation (grass, shrubs, and trees), grading the ditch to facilitate better drainage, and armouring the inlet with Class 1M riprap.

West of the bridge:

- The erosion gullies along the north and south ditches west of the bridge were backfilled with compacted pit run gravel and the repair is in good condition (Photos 1 through 7). Very little erosion was observed during the 2024 inspection.
- The pit run gravel used at the C035 repair appears more granular than the pit run gravel used at the C076 repair. The angular gravel appears to be performing better than the pit run gravel, but the increased performance may be due to the small catchment areas contributing less overall flow to the ditches.
- A small amount of seepage was observed to be flowing from the perforated drainpipe installed along the west extent of the north ditch repair (not part of KCB's scope during the 2023 repair work) (Photo 2). The drainpipe was installed in a trench along the ditch bottom upstream (west) of the new centerline 600 mm diameter CSP culvert (Photo 2) which was conveying flow from the south ditch during the 2024 inspection.
- A small amount of grass was growing in the north and south ditches (Photo 4 and 5). Generally, the vegetative cover along the repair is poor.
- Sediment is accumulating behind the straw waddles installed along the north ditch, upstream (west) of the centerline culvert (Photo 7). If the sediment is not regularly removed, flows will flow overtop the straw waddles, completely negating their ability to slow down flows through the ditch. The installation of straw waddles was not part of KCB's design and was done independently by the contractor when KCB was not on site. The straw waddles installed at the edge of riprap (Photo 8) may redirect flow away from the riprap, resulting in gully formation beside the repair.
- The riprap-lined outlet channel installed downstream of the centerline culvert appears to be performing well (Photos 9 and 10). Sediment has been deposited in the channel since the post construction inspection completed in October 2023.
- At the riprap-lined outlet channel, the non-woven geotextile was extending past where the riprap was terminated (Photo 11).

East of the bridge:

- The riprap armoured length of the north ditch is performing well (Photo 12 and 13).
- Some grass was observed to be growing on the north highway embankment slope along the repair (Photo 12 through 15).
- The length of ditch armoured with RECP is performing poorly. Sections of the RECP are already becoming undermined due to erosion of the in-situ material used to backfill the erosion gullies (Photo 14 and 15).
- Slope instability was observed on the north cutslope above the length of ditch armoured with RECP (Photo 16). There is a large crack in the slope, approximately one third up the slope, likely exacerbated by rainfall events causing surface runoff upslope of the crack.
- The armouring at the older and new culvert inlets are performing well (Photo 17 and 18). Straw waddles were installed to reduce sediment from flowing into the culverts.
- The riprap-lined outlet (overlying non-woven geotextile) of the new smooth walled steel culvert appears to be in good condition (Photo 19). The existing CSP culvert outlet is at the downstream limit of the outlet channel, is buried by riprap, and was not observed during the 2024 inspection.
- The large erosion gully on the east riverbank slope, below the bridge, was backfilled between the 2021 and 2024 inspections and is in good conditions (Photo 20).

Maintenance/Repair/Monitoring Recommendations:

- The site should be regularly inspected by TEC's MCI, particularly after significant precipitation events (spring freshet, or heavy and/or prolonged rainfall).
- The site inspection frequency should be reduced from annually to every two years as part of the Section B Inspections. The site should continue to be inspected to assess how the three different repair methods implemented at the site (granular fill, riprap armouring with a bedding layer and non-woven geotextile, and RECP armouring) perform to help TEC choose repair options for other sites with dispersive soils (e.g., C017-2).
- The sediment accumulating behind the straw waddles installed along the north ditch west of the bridge should be regularly removed by TEC's HMC. The straw waddles are a temporary erosion control measure and should be replaced by riprap check dams for a more permanent method of slowing down flows through the ditch.
- The RECP installed east of the bridge should be replaced by TEC's HMC. The RECP should be installed properly, with RECP placed along the ditch side slopes (with at least 0.5 m cover) and keyed in according to TEC's Erosion and Sediment Control Manual.

This report is an instrument of service of Klohn Crippen Berger Ltd. (KCB). The report has been prepared for the exclusive use of Alberta Transportation and Economic Corridors (Client) for the specific application to the Central Region Geohazard Risk Management Program (Contract No. CON0022160) and it may not be relied upon by any other party without KCB's written consent.

KCB has prepared this report in a manner consistent with the level of care, skill, and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

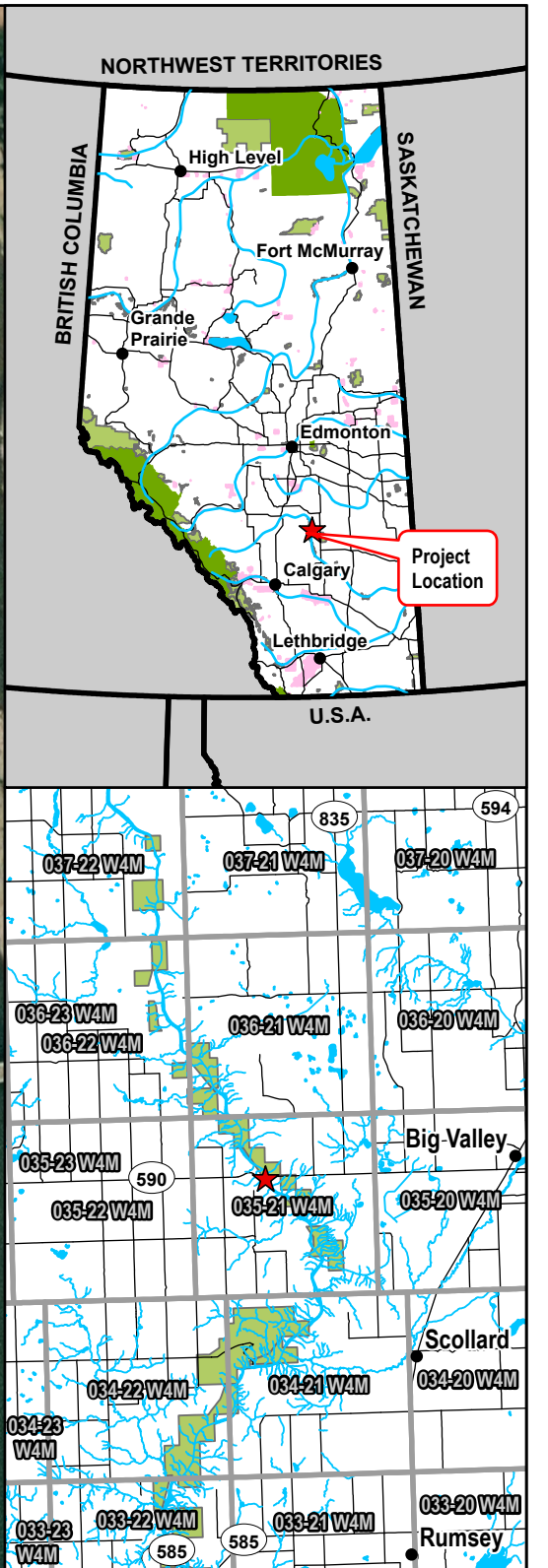
Use of or reliance upon this instrument of service by the Client is subject to the following conditions:

- (i) The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report.
- (ii) The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to precisely represent conditions at any other time.

- (iii) The report is based on information provided to KCB by the Client or by other parties on behalf of the client (Client-supplied information). KCB has not verified the correctness or accuracy of such information and makes no representations regarding its correctness or accuracy. KCB shall not be responsible to the Client for the consequences of any error or omission contained in Client-supplied information.
- (iv) KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.
- (v) This report is electronically signed and sealed and its electronic form is considered the original. A printed version of the original can be relied upon as a true copy when supplied by the author or when printed from its original electronic file.

James Lyons, P.Eng.
Civil Engineer

File: Z:\A\EDM\A05116\A02\ABT_CentralRegion_GRI\400 Drawings\GIS\02_ProFiles\2024\Section B\AT_CentralRegion_SectionB_240627\AT_CentralRegion_SectionB_240627.aprx Date: Time: Creator: EQuine



- Legend**
- Culvert
 - Guardrail
 - Riprap
 - Erosion

NOTES:
 1. HORIZONTAL DATUM: NAD83
 2. GRID ZONE: UTM ZONE 12N
 3. IMAGE SOURCE: 2024 MICROSOFT CORPORATION, MAXAR, CNES DISTRIBUTION AIRBUS DS.

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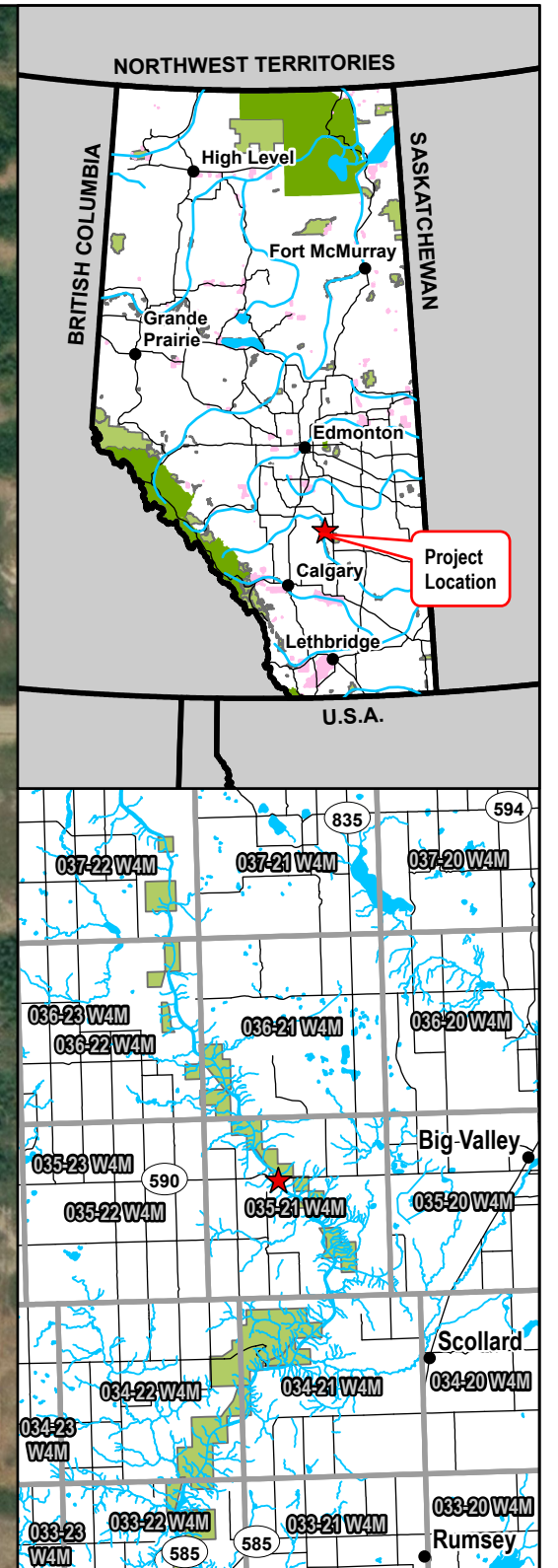
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Klohn Crippen Berger

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| PROJECT CENTRAL REGION GEOHAZARD RISK MANAGEMENT PROGRAM | | |
| TITLE Site Plan C035 - Ditch Erosion Hwy 590:04, km 20.104 | | |
| SCALE 1:3,000 | PROJECT No. A05116A02 | FIG No. 1 |



File: Z:\A\EDM\A05116\A02\ABT_CentralRegion_GRI\400 Drawings\GIS\02_ProFiles\2024\Section B\AT_CentralRegion_SectionB_240627\AT_CentralRegion_SectionB_240627.aprx Date: Time: Creator: EQuine



- Legend**
- Sinkhole
 - Guardrail
 - Culvert
 - Riprap
 - Erosion

NOTES:
 1. HORIZONTAL DATUM: NAD83
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| TITLE Site Plan C035 - Ditch Erosion Hwy 590:04, km 20.104 | | |
| SCALE 1:3,000 | PROJECT No. A05116A02 | FIG No. 2 |



West of Red Deer River Bridge:

Photo 1 West extent of the where the north (westbound) ditch was repaired in late-2023. Photo taken June 19, 2024, facing west.



Photo 2 Downstream (east) of a new 600 mm diameter CSP culvert and perforated drainpipe outlet. Photo taken on June 19, 2024, facing west.



Photo 3 Downstream (east) portion of the north (westbound) ditch repair. Photo taken June 19, 2024, facing west.



Photo 4 Upstream (west) extent of the south ditch repair. Photo taken June 19, 2024, facing east-southeast.



Photo 5 Portion of the south (eastbound) ditch repair. Photo taken June 19, 2024, facing west.



Photo 6 West extent of the north (westbound) ditch repair just west of the Red Deer River bridge crossing. Photo taken June 19, 2024, facing east.



Photo 7 Sediment captured by a straw wattle installed perpendicular to the ditch.
Photo taken June 19, 2024, facing southeast.



Photo 8 Riprap armoring in the ditch bottom, where the grade of the ditch steepens just west of the culvert outlet underlying Hwy 590. Straw wattles installed along the edge of riprap could direct flows away from riprap and lead to erosion gully formation.
Photo taken June 19, 2024, facing east.



Photo 9 Riprap-lined outlet channel downstream of the culvert underlying Hwy 590. Sediment has been deposited along the channel since late-2023 construction. Photo taken June 19, 2024, facing north.



Photo 10 Riprap-lined outlet channel downstream of the culvert underlying Hwy 590. Sediment has been deposited along the channel since late-2023 construction. Photo taken June 19, 2024, facing southwest.



Photo 11 Downstream limit of the riprap-lined channel. The non-woven geotextile extends past where the Class 1 riprap was placed. Photo taken June 19, 2024, facing north.



East of Red Deer River Bridge:

**Photo 12 Riprap armouring in the north (westbound) ditch constructed in late-2023.
Photo taken June 19, 2024, facing east.**



Photo 13 Riprap armouring in the north (westbound) ditch. Photo taken June 19, 2024, facing west.



Photo 14 Length of north (westbound) ditch armoured with rolled erosion control product (RECP). Photo taken June 19, 2024, facing east.



Photo 15 Length of north (westbound) ditch armoured with RECP in late-2023. The RECP is being undermined along the ditch bottom (indicated by red arrow). Photo taken June 19, 2024, facing east.



Photo 16 Area of instability along the north (westbound) cut slope above where the ditch was armoured with RECP (ground crack indicated by red arrow). Photo taken June 19, 2024, facing northeast.



Photo 17 Riprap armoured culvert inlet in the north (westbound) ditch just east of the Red Deer River bridge crossing. Photo taken June 19, 2024, facing southwest.



Photo 18 Riprap armouring of new centerline culvert installed below Hwy 590 in 2023, east of the existing culvert (shown in Photo 17). Photo taken June 19, 2024, facing southwest.



Photo 19 Culvert outlet of new centerline culvert installed in late-2023. Photo taken June 19, 2024, facing southwest.



Photo 20 Large erosion gully on the east riverbank below the bridge was backfilled between the 2021 and 2024 inspections. Left and right photos taken June 24, 2021, and June 19, 2024, respectively.

