

SITE NUMBER AND NAME: S026 Elkwater Slides		HIGHWAY & KM: 41:03, 35.169	PREVIOUS INSPECTION DATE: May 8, 2019	INSPECTION DATE: July 7, 2021
LEGAL DESCRIPTION SE-18-008-02 W4M and 16-07-008-02 W4M	NAD 83 COORDINATES: UTM Northing Easting 12 5499046 553536		RISK ASSESMENT: Site A: PF: 6 CF: 4 TOTAL: 24 (Slides) Site B: PF: 7 CF: 4 TOTAL: 28 (Pile wall)	
AVERAGE ANNUAL DAILY TRAFFIC (AADT): 680 (north), 430 (south), (Ref. No. 138060)			CONTRACTOR MAINTENANCE AREA (CMA): 23	

<p>SUMMARY OF SITE INSTRUMENTATION: Site A: Two piezometers and two slope inclinometers (SIs). The Measurand ShapeAccelArray (SAA) is inoperable, and the reading box was decommissioned in spring 2019 by KCB at the request of AT.</p> <p>Site B: One SI</p> <p>LAST READING DATE: June 2021</p>	<p>INSPECTED BY: Chris Morgan (KCB) Margot Lederman (KCB) Alex Frotten (AT) Roger Skirrow (AT)</p>
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PRIMARY SITE ISSUE: Landsliding on fill slopes and back slopes on cut and fill side hill locations in a valley. Toe erosion from the creek and high groundwater table appear to be the triggering mechanisms.

APPROXIMATE DIMENSIONS: The extent of landsliding is continuous over approximately 600 m from the south end to the north end of the site and between sites A and B, as previously identified in GRMP reports. The fill slopes vary from 5 to 10 m high, sloped at approximately 4H:1V to 5H:1V.

DATE OF ANY REMEDIAL ACTION:
Site A: Shallow drainage installed near south end of site (in 1970s or 1980s, no records available). Numerous patches over the years. The slope at Site A was regraded in fall 2016 and new overlay placed in fall 2017.

Site B: H-pile wall 60 m long constructed at Site B in 2012 (waypoints 601 and 602 mark the extents of the pile wall in Figure 1) The pile wall repair was preceded by a temporary repair consisting of slope excavation and reconstruction, and a soil nailing program.

ITEM	CONDITION EXISTS		DESCRIPTION AND LOCATION	NOTICABLE CHANGE FROM LAST INSPECTION	
	YES	NO		YES	NO
Pavement Distress	X		Overlay at Site A in fall 2017. Cracking in pavement has redeveloped at previous slide locations. The extent and width of cracking at Site B seems unchanged.		X
Slope Movement	X		Site A: Slope movement (translational) in west direction. Site B: Sliding is occurring below the pile wall, exposing the piles and causing loss of soil behind the pile wall.		X
Erosion	X		Erosion on embankment slope at culvert outlet to south of side-hill site.		X
Seepage	X		Wet areas noted on back slopes (upslope of highway) and near toe of slope near stream (downslope of highway).		X
Culvert Distress		X	Erosion at outlet of culvert		X

COMMENTS

Entire valley slope in the subject area is a landslide zone with instability features located upslope and downslope of the highway and a general trend of movement to the west, towards the creek. Numerous embankment fill slides are present to the west of road. Toe of landslide appears to be at creek level where erosion is occurring due to stream being partially blocked by slide movement. The general area of the site (Cypress Hills) was not glaciated in the last ice age.

Site A (embankment fill slides due to movement on the west side of the highway):

Ongoing movement observed at the site since 2018. Back slope slides are still active and snowplow strikes are visible on the road surface. Cracking has reflected through the recent overlay and settlement of the various slides is visible on the pavement surface. Deformation since 2018 is small-scale but ongoing, however there have been no sudden changes at the site.

Fill settlement up to 0.5 m at east edge of pavement. Up to 1.0 m of asphalt exposed at shoulder of highway. Guard rail, HTCB or fill placement is required at locations where there are steep drop offs at the edge of the pavement, due to the narrow shoulder outside of the lanes and to protect road users.

Water levels in the ditch downstream of the instability zones appears unchanged from 2018 observations to most recent inspection.

Pavement cracking extending into centre of northbound lane at waypoint 603. Area of sliding is 40 m wide at edge of pavement of the southbound lane.

The embankment slope below the highway between waypoints 604 and 607 is experiencing a series of semi-continuous slope failures:

- Pavement cracking extending into southbound lane (to within 1 m of centreline) at waypoint 605. Area of sliding is 18 m wide at edge of pavement of the southbound lane.
- Pavement cracking extending to 0.5 m past edge of pavement into southbound lane at waypoint 606. Area of sliding is 5 m wide at edge of pavement of the southbound lane.
- Pavement cracking extending to 1.0 m past centreline into northbound lane at waypoint 607. Area of sliding is 25 m to 30 m wide at edge of pavement of the southbound lane.

Site B (H-pile wall)

The pile wall at Site B has been exposed by soil sliding downslope of the wall. KCB monitors the wall during spring and fall instrument readings. There have been no significant changes when compared to 2019 observations. A small amount of ground cracking was observed between the highway and pile wall.

Pavement cracking upslope of the pile wall was noted at the southern end of the wall, where the wall ends. Transverse pavement cracking south of pile wall appears to have worsened and was approximately 20 mm wide in 2021.

Cracking and slope movement is also present north of the northern extent of the pile wall, outflanking the pile wall. The guardrail at the north edge of the pile wall has a noticeable dip.

Slope movements below pile wall have exposed the piles over a length of 30 m at the north limit of the wall. The piles were measured as leaning between 0.2° and 0.6° from vertical in 2018. The upper 2 to 3 m of pile wall is exposed and unsupported. Below the exposed section of H-piles is a 2 m high section where sloughed material from between and behind the pile wall has eroded out and covered the piles. Voids are up to 0.5 m deep behind the pile wall, and erosion is ongoing. Sloughing is due to seepage and infiltration.

Well-developed toe roll near creek level beyond the edge of the trees below pile wall. Wet conditions present at toe of slope. Seepage and surface water runoff has resulted in exposed soils being eroded and deposited at toe of slope.

Candidate repair options for this site are:

Site A – Carry out additional ground investigation, including boreholes and installation of additional geotechnical instrumentation, to assess the depth of movement in recently active areas for repair design options evaluation. Potential repair options include additional pile walls in slide areas, with drainage trenches installed at the toe of the landslide zone to lower the groundwater table and improve slope stability.

Site B - Candidate repairs include extending the existing H-pile wall to the north and the addition of timber lagging between H-piles to minimize material loss from between the piles (this work could be completed by the HMC). Drill boreholes and install two additional two slope inclinometers adjacent to the pile-wall.

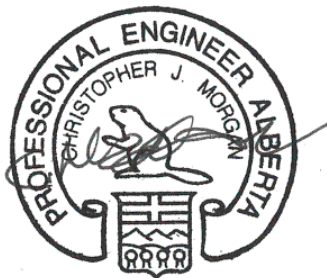
Ditch drainage through the whole S026 area should be improved to minimize infiltration into the slide zones. The highway surface should continue be regraded in areas where it has deflected and cracked, to improve the smoothness of the highway through this site. Highway regrading should include milling the existing asphalt, and not placing more material which adds weight to the failure zones.

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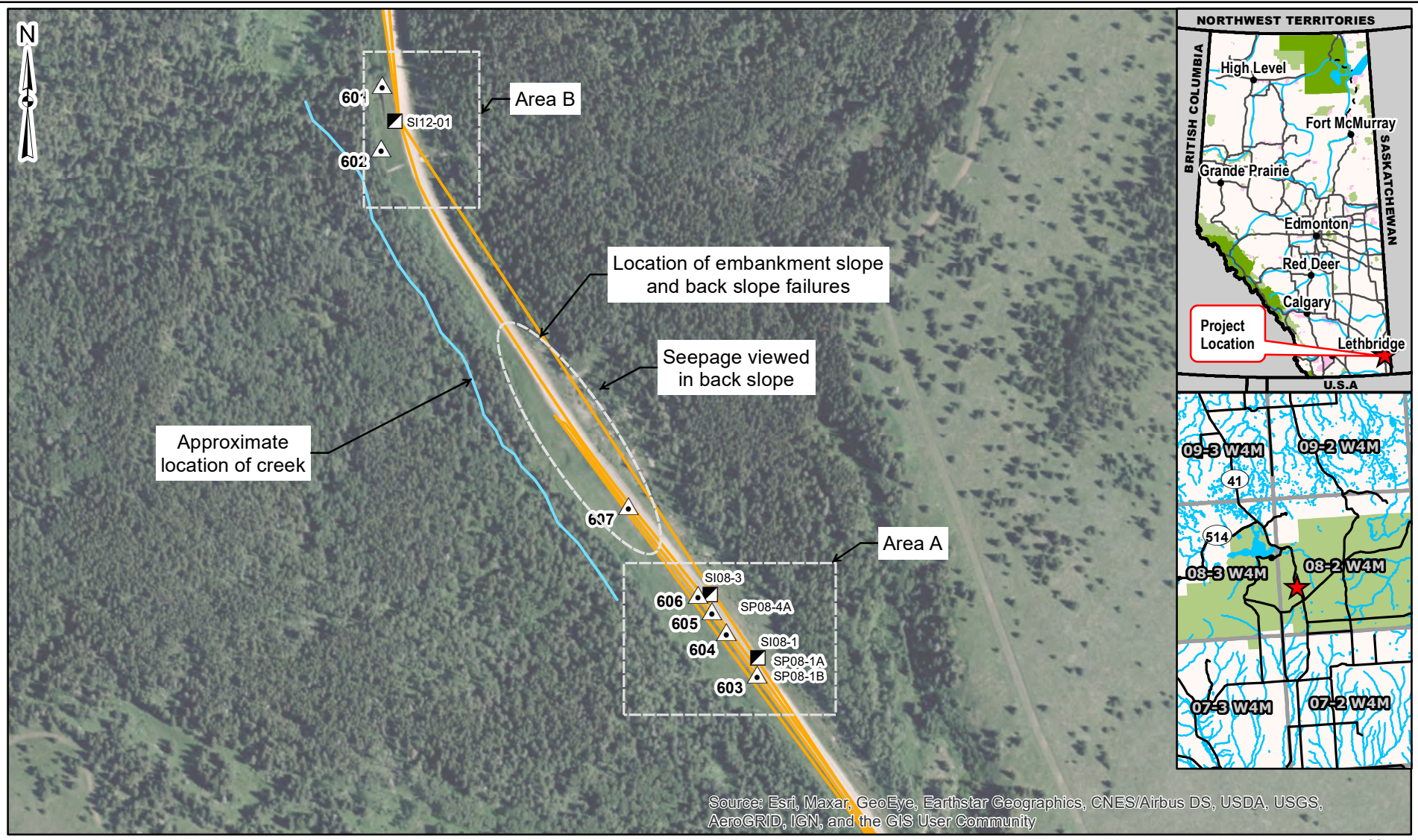
- (i) The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report.
- (ii) The observations, findings, and conclusions in this report are based on observed factual data and conditions that existed at the time of the work, and should not be relied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



2021-11-24






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Senior Geotechnical Engineer

Time: 11:15:42 AM
 Date: October 12, 2021
 File: Z:\MCG\Alberta\A05116A03\NET Southern Region GRMP\400 Drawings\2021\Section B figures\MXD\S026_211012.mxd Date: October 12, 2021 Time: 11:15:42 AM Creator: tharrison



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

-  GPS Waypoint (May 3, 2018)
-  Slope Inclinometer
-  Standpipe Piezometer
-  GPS Track (2021)
-  Flow Direction

NOTES:
 1. HORIZONTAL DATUM: NAD83
 2. GRID ZONE: UTM Zone 12N
 3. IMAGE SOURCE: World Imagery, ArcGIS Online. Southern Alberta 2015 Imagery

CLIENT




PROJECT SOUTHERN REGION GEOHAZARD RISK MANAGEMENT PROGRAM		
TITLE Site Plan S026 - Elkwater Slides Hwy 41.03; km 35.169		
SCALE 1:5,000	PROJECT No. A05116A03	FIG No. 1

Photo 1 **Site A: Cracking has redeveloped through the pavement overlay. Photo was taken facing south on July 7, 2021.**



Photo 2 **Site A: Pavement cracking. Photo was taken facing southeast on July 7, 2021.**



Photo 3 **Site A: Backslope instability is visible for the full length of the site. Photo was taken facing east on July 7, 2021.**



Photo 4 **Site B: Pile wall is located downslope to the west of the highway. Soil sliding downslope of the wall has exposed 2 to 3 m of steel pile over a length of approximately 30 m. Photo was taken facing northwest on July 7, 2021.**



Photo 5 Site B: Soil sliding downslope of the wall has exposed 2 to 3 m of steel pile over a length of approximately 30 m. Photo was taken facing north on July 7, 2021.



Photo 6 Site B: Erosion of material between piles has contributed to voids up to 0.5 m behind the wall. Photo taken facing north on July 7, 2021.



Photo 7 **Site B: Sloughing at the north limit of the pile wall (red circle). Photo was taken facing downslope on July 7, 2021.**



Photo 8 **Site B: Dip in guard rail north of the pile wall. Photo taken facing north on July 7, 2021.**

