ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION – GRANDE PRAIRIE DISTRICT
2020 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
GP03	NW of Grande Cache	Cutbank River S (Roseham Crk)	40:38	51.8
Legal Description		**UTM Co-ordinates (NAD 83)**		
NE16-65-5-W6		11U N 6,054,425 E 390,990		

	Date	PF	CF	Total
Previous Inspection:	May 28, 2019	9	4	36
Current Inspection:	May 26, 2020	9	4	36
Road AADT:	3,420		**Year:**	2019
Inspected By:	Don Proudfoot, Nicole Wilder (Thurber) Ed Szmata, Rishi Adhikari, Dwayne Lowen(AT)			
Report Attachments:	☑ Photographs ☑ Plans ☐ Maintenance Items			

Primary Site Issue:	This site is a sidehill embankment fill alignment that follows the Roseham Creek valley slope (a tributary to the Cutbank River). **i** Slide (minor); **ii** Roseham Creek channel erosion/degradation-(major); **iii** Groundwater seepage caused wet/soft pavement subgrade & alligator cracked pavement (medium); **iv** Tension crack along pavement, recurred in 2003, 2007 severely, 2013, 2015 (major).	
Dimensions:	**i** Slide was ~160 m x 60 m: **ii** Creek channel erosion ~700 m x 60 m. **iii** Groundwater seepage areas in pavement ~ 75 m x 5 m wide. **iv** Tension crack ~100 m length of roadway	
Date of any remediation:	**i** Slide (1996) was stabilized in a few attempts by shifting alignment (1997) towards backslope, building a toe berm, using hog fuel (lightweight fill) to replace some of the clay, and then (2000) removing the hog fuel (due to environmental reasons) and installing base/edge drains out letting into the channel and reconstruction with common fill to ~3H:1V slope; **ii** ~10 rock weir barriers ~1.5m high and some live stakes were installed along the lower portion of the creek channel (2003) to provide channel erosion protection; however, these were washed out by creek flows shortly after construction **iii** A subdrain was installed (2003) along the west highway ditch, and also possibly in the catch water ditch to depress water levels, but the stage 2 Herring Bone drains from the pavement into the ditch drains were never done. **iv** Tension crack - 100m length of highway (@ 50m north and downslope of stabilized slide i), was overlaid in ~2016.	
Maintenance:		
Observations:	**Description**	**Worse?**
This inspection was limited to the east side of the highway area since excavation of the backslope area and construction of a climbing lane is being carried out on the west side of the highway.		
☐ Pavement Distress		☐
☑ Slope Movement	Several scarps adjacent to the creek banks appeared to be in worse condition and have retrogressed further upslope towards the highway.	☑
☑ Erosion	Creek bank erosion and channel degradation (ii) have triggered frequent slumping instabilities along the channel toes which retrogress further up the highway fill embankment and steadily encroach closer to the road	☑

	surface. Erosion gullies were present on the east and west side of the highway at several locations. However, since construction began, they have since been filled in. A slump expansion is present on the north half of the site which was 6.9 m from white pavement line and another further south was 10.5 m from the edge of the pavement.	
☑ Seepage	Limited functionality of the subdrain, and possibly increased seepage from the backslope, and seem to create a wet subgrade which has caused causing pavement cracking distress in the past. Random seepage areas in the creek channel and east embankment fill also accelerate erosion head scarp slumping.	☐
☐ Bridge/Culvert Distress		☐
☐ Other		☐

Instrumentation October 8, 2020:
Inclinometers: SI-2: 5.9 mm/yr movement at 2 to 4 m depth; SI-3: no discernable movement at <3 m depth.
SI-1: Damaged in 2014 (Prev. Move. Zone at <20m depth, at 40mm/yr.).
SI-11: Assumed Destroyed, (was reading 9 mm/yr. at <4 m in 1998, and 4 mm/yr. at 26 m in 2001).
Piezometers: PN-3 = 4.9 m BGS; PN-5 at 6.9 m BGS.

Assessment:

Thurber prepared a preliminary engineering report (#15-16-316 dated April 15, 2015) as part of high water related mitigation work, which focused predominantly on remedial design alternatives to mitigate creek channel erosion/degradation. That report contains a detailed account of the site history and other information specifically targeting the creek channel, and details are not reproduced herein.

The surficial deposit south of the Cutbank River can be expected to consist of 10 to 20 m thickness of glacio-lacustrine or colluvial deposits overlying thin to discontinuous till (extending below creek elevation). The subsurface conditions in the original slide area were reportedly described as consisting of wet lacustrine clay with silt/sand laminations and a shallow groundwater regime, with random seepage observed along the creek valley slopes. The creek is actively downcutting, migrating laterally, and creating toe slumping which regresses further up the creek channel sideslopes (the west side forms a common slope with the east highway embankment).

The base gradient of the channel varies from about 5.5 percent (over the southern 2/3 length) to about 8 percent (over the northern 1/3 length). The west creek channel sideslope/east highway embankment toe was measured in 2014 to vary from about 1H:1V to 1.7H:1V, while the east creek channel sideslopes were generally ~2.25H:1V to 3H:1V. The 2003 LiDAR indicated the overall east highway embankment sideslope varied from 2.25 to 3H:1V (excluding the repaired hog fuel area which was at about 5H:1V to 8H:1V).

The east highway embankment contains a continuous slump scarp along its lower to mid-length portion, but at 3 locations encroaches to within 6.9 to 13.8 m of the highway white line. The east highway embankment slope is inclined about the same as the east channel sideslope (2.25 to 3H:1V), which is most likely near the angle of repose. The lower portion of the west creek channel slope is much steeper than this and is considered to be in an unstable condition.

The Class 1 rock riprap weirs installed in the channel bottom were likely either overtopped, bypassed laterally, or undermined due to channel flows and bank/toe slumping, and only remnants remain. The erosion in the creek channel is a threat to the stability of the east highway embankment, and if not protected will only become more severe with time, and also be a source of sediment deposition into the creek or downslope Cutbank River. A preliminary hydrology study performed by Terrace Engineering as part of the 2015 study suggested at least Class 2, and possibly Class 3 sized riprap would be required as suitable channel protection.

No flow was observed from the outlets of the subdrain installed in 2003 along the backslope ditch, rendering its functioning capacity ineffective. It reportedly took 2 to 3 years to dry up the pavement subgrade after the subdrain installation. In past years, indications of pavement distress was observed. This may be due in part to increased heavy truck traffic loading related to the gas drilling industry, and due to wetter subgrade conditions. The previously observed alligator cracking of the pavement will most likely reflect through the overlay if the subdrain functionality is not improved.

The seepage observed from the west edge of the highway embankment at a few locations indicates a high groundwater table. Improving free drainage from the pavement base could help control pavement cracking.

Recommendations:

Investigation:
Note: AT was to check their files for any previous test hole information.

Drill 6 test holes complete with slope inclinometers and piezometers on the downslope edge of the highway with one directly below the one at the south end (as shown on Figure GP03-1-2/3) to depths of between 15 to 25 m to provide information on the soil and groundwater conditions at this location, and to confirm slope stabilization design measures. There should also be some surficial samples taken (using a backhoe or a hand auger/spade) to assess base channel soil characteristics, for liners/anchor/cut-off design. Detailed hydrological design will also be required prior to preparing a detailed design and tender document.

A complete survey (or alternatively unmanned aerial vehicle (UAV)) is required to update the topography from the 2003 LiDAR. An assessment of potential borrow and riprap sources, and erosion conditions along the creek should also be performed. Since any planned repairs will likely involve in-stream work, a QAES may be required to provide their assessment for procuring a Water Act application and permit from DFO. Notification, compliance and collaboration with Alberta Environment and Parks (AEP) will also be required for potential right-of-way, cultural heritage, birds' nest, and/or wildlife issues.

Construction:
The highway is being widened to add a climbing lane, the west backslope was cut back in the new location, but at the same inclination as the original one. The west ditch subdrain system was maintained, and the manholes will now be present in the in the west side slope of the new climbing lane.

Maintenance:
Maintain/clean the existing subdrain system (installed in 2003) to provide continued service, preferably on an annual basis.

Short Term:
In the short term, continue with instrumentation monitoring. The site should also be regularly inspected for progression of the previously mentioned tension crack in the highway, wet subgrade/increased pavement cracking, and slump regression from the creek valley sidewall.

Medium to Long Term:

Some alternative open liner repair options were discussed in the 2015 preliminary design report. Prior to and as part of any of these remedial options, the existing subdrains that outlet along the highway embankment/creek valley toe should be preserved/restored if still functioning, or replaced, and additional subdrains could also be added where appropriate. Also, for any of the liner options, the channel base should be built up by 2 m vertically as follows to buttress the eroded slope embankment:

a) Remove/clean the channel of all existing debris (trees, geotextile, riprap, and loose/wet material).
b) Rebuild/reshape the channel base subgrade and sideslopes with engineered fill forming a finished surface having a 2 m wide bottom width and 2.5H:1V sideslopes that extend up the sides a vertical height of 1.5 m. A free draining granular fill layer enveloped in non-woven geotextile will likely need to be incorporated between the riverbed and the overlying fill.

The alternative liner options and preliminary costs (including the above measures) are:

1) Class 3 Riprap, 1.2 m thick **Cost ~9 Million**
2) Class 3 riprap Rock Barrier Weir Structures, spacing 28 m along channel with 2H:1V & 3H:1V upstream and downstream slopes, add a downstream apron, 1.5 m high **Cost ~$5.2 Million**

It was discussed with AT during the 2016 geohazard meeting, that instead of lining the entire base of the channel, it might be more cost effective to armour only the highway side of the channel.

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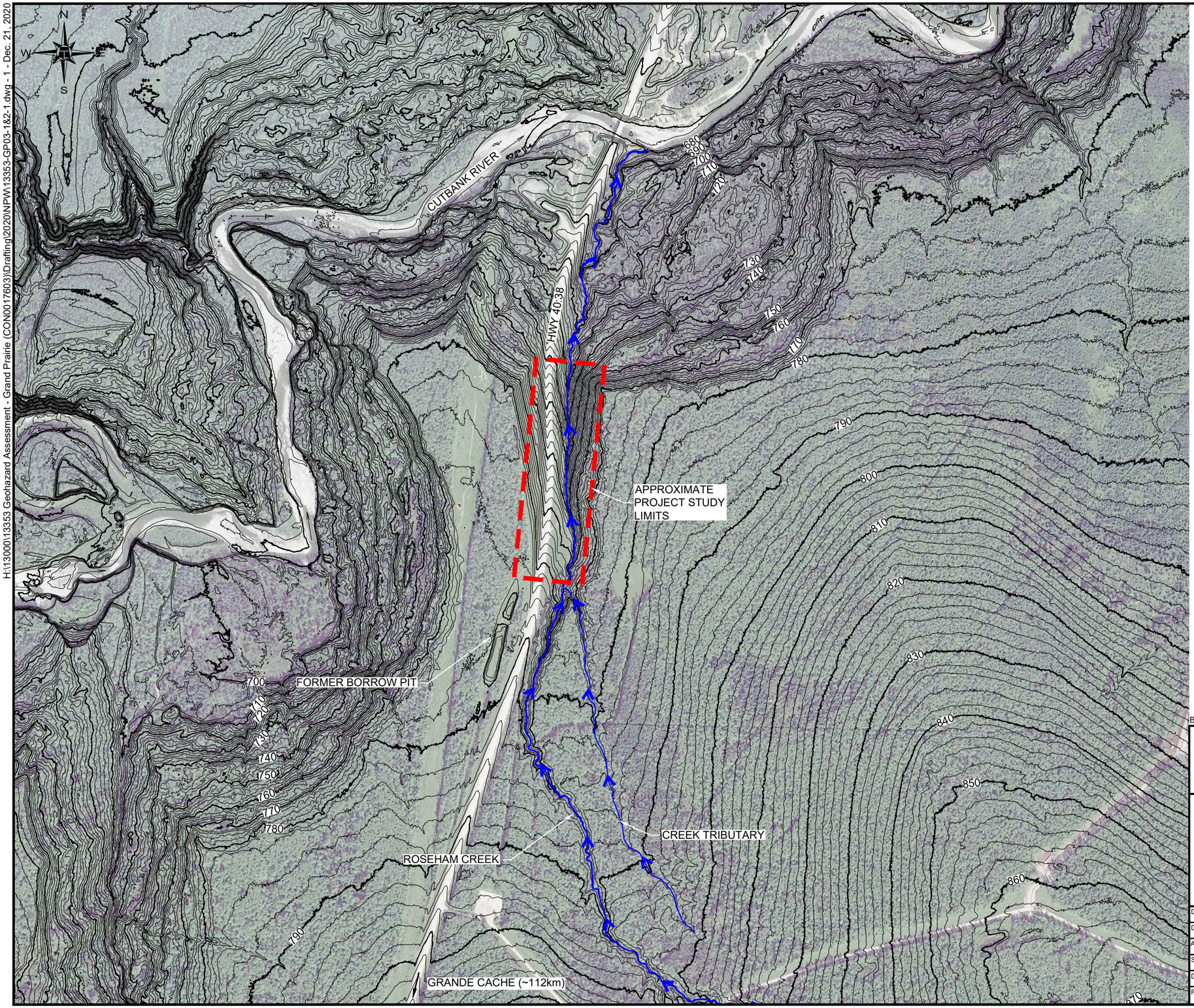

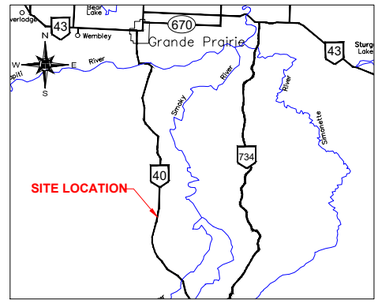

KEY PLAN
SCALE: 1:2 000 000

NOTES:

1. SEE DRAWINGS 13353-GP03-1&2-2 AND 13353-GP03-1&2-3 FOR DETAILS.
2. CONTOUR LINES ARE AT 2m INTERVAL.

0 100 200 300 400 500 600 700 m
SCALE 1:12500

BASE PLAN PROVIDED BY ALBERTA TRANSPORTATION; LIDAR FLOWN IN 2003

Alberta

PEACE REGION (GRANDE PRAIRIE)
(GP03) HWY 40:38 CUTBANK RIVER SOUTH

2020 SITE INSPECTION

DWG No. 13353-GP03-1&2-1

DRAWN BY	ML
DESIGNED BY	NPW
APPROVED BY	DWP
SCALE	1:12500
DATE	DECEMBER 2020
FILE No.	13353

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BACKSLOPE HAS BEEN STRIPPED TO ALLOW EXCAVATION TO CONSTRUCT A SOUTHBOUND CLIMBING LANE

21° BACKSLOPE

EROSION

SEEPAGE FROM ROAD SLOPE (TYP)

MH (NO FLOW)

MH (NO FLOW)

SP

SP

DIP IN HWY

SI-3
PN-3

HWY 40:38

SI-1

5

4

0.8m SCARP, CLAY TILL EXPOSED

10.5m FROM ROAD EDGE

WORSE

SI11

NEW SLOUGHING

18°

PN-5

SI-2

FORMER HOG FUEL REMOVAL AREA

6

ACTIVE

CONFLUENCE OF CREEKS; SOUTH LIMIT OF PROJECT

GRABEN BLOCK FAILURE

SP
WORSE

SP

SP

SP

VERY ACTIVE

SO

SO

SO

SO

DRY

ACTIVE EROSION & SLUMPING

ACTIVE EROSION & SLUMPING

CREEK TRIBUTARY

ROSEHAM CREEK

500mm SCARP

SUBDRAINS WERE DRY

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LEGEND

- EXISTING SLOPE INCLINOMETER / PIEZOMETERS
- PROPOSED TEST HOLES
- MH — MANHOLE
- SP — SPRING/SEEPAGE
- SO — SUBDRAIN OUTLET
- 2014 TOP OF BANK SLUMPING
- 2014 TOP OF IMMEDIATE CREEK BANK
- DIRECTION AND NUMBER OF PHOTO
- SLIDE SCARPS (MAY 2020)
- PREVIOUS SLIDE SCARPS

NOTES:

1. ALL SITE OBSERVATIONS ON MAY 26, 2020.
2. FEATURES SURVEYED BY HANDHELD GPS AND ARE APPROXIMATE.
3. CONTOUR LINES ARE AT 2m INTERVAL.
4. ROAD OVERLAYED IN 2016.

0 20 40 60 80 m
SCALE 1:1500

BASE PLAN PROVIDED BY ALBERTA TRANSPORTATION; LIDAR FLOWN IN 2003

Alberta

PEACE REGION (GRANDE PRAIRIE) (GP03) HWY 40:38 CUTBANK RIVER SOUTH

2020 SITE INSPECTION (SOUTH HALF)

DWG No. 13353-GP03-1&2-2

DRAWN BY	ML
DESIGNED BY	NPW
APPROVED BY	DWP
SCALE	1:1500
DATE	DECEMBER 2020
FILE No.	13353

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H:\13000\13353 Geohazard Assessment - Grand Prairie (CON0017603)\Drafting\2020\NPW\13353-GP03-1&2-2~3.DWG - 3 - Dec. 22, 2020

BACKSLOPE HAS BEEN STRIPPED TO ALLOW EXCAVATION TO CONSTRUCT A SOUTHBOUND CLIMBING LANE

HIGH TENSION CABLE BARRIER WAS REMOVED IN 2020

2-200mm Ø CSPs (MANHOLE DRAIN OUTLETS)
1-150mmØ CORRUGATED HDPE OUTLET

6.9m FROM WHITE LINE

MH (NO FLOW)

7.5m FROM WHITE LINE

HWY 40:38

MH (NO FLOW)

OVERLAY PLACED IN 2016

13.8m TO WHITE PAVEMENT LINE

EROSION

APPEARS THAT GRAVEL WAS PLACED WHERE EROSION WAS PRESENT

FRESH SLUMPING

SCARP

TOP OF SLUMPS

22°

1.3m SCARP

0.9m SCARP

0.8m SCARP, 12.3m FROM WHITE LINE

SP

SP

MORE MOVEMENT

0.6m HIGH SCARP

NORTH LIMIT OF PROJECT

RETROGRESSION

ROSEHAM CREEK

N
W
E
S

LEGEND

- PROPOSED TEST HOLES
- MH⊗ MANHOLE
- SP✪ SPRING/SEEPAGE
- SO⌑ SUBDRAIN OUTLET
- 2014 TOP OF BANK SLUMPING
- 2014 TOP OF IMMEDIATE CREEK BANK
- HIGH TENSION CABLE BARRIER
- ① DIRECTION AND NUMBER OF PHOTO
- GABION DITCH CHECK
- SLIDE SCARPS (MAY 2020)
- PREVIOUS SLIDE SCARPS

NOTES:

1. ALL SITE OBSERVATIONS ON MAY 26, 2020.
2. FEATURES SURVEYED BY HANDHELD GPS AND ARE APPROXIMATE.
3. CONTOUR LINES ARE AT 2m INTERVAL.
4. ROAD OVERLAYED IN 2016.

0 20 40 60 80 m

SCALE 1:1500

BASE PLAN PROVIDED BY ALBERTA TRANSPORTATION; LIDAR FLOWN IN 2003

Alberta

PEACE REGION (GRANDE PRAIRIE)
(GP03) HWY 40:38 CUTBANK RIVER SOUTH

2020 SITE INSPECTION (NORTH HALF)

DWG No. 13353-GP03-1&2-3

DRAWN BY	ML
DESIGNED BY	NPW
APPROVED BY	DWP
SCALE	1:1500
DATE	DECEMBER 2020
FILE No.	13353

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	**Photo 1.** Looking north at active scarp inside slope of southern portion of the site.
	**Photo 2.** Looking south at active scarp on side slope of southern portion of the site.

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	**Photo 3.** Looking northwest along the top of the embankment fill where fresh slumping has retrogressed close to the highway.
	**Photo 4.** Looking south at long scarp in sideslope at middle of the site.

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	**Photo 5.** Looking north at where there was previously some erosion rilling observed at the north end of the site but has been filled in.
	**Photo 6.** Looking south towards middle of the site where tilted trees are present.

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	**Photo 7.** Looking northwest up at the sideslope slumping that extends close to the highway near the north end of the site.
	**Photo 8.** Looking south at the northmost scarp on the north side.