GEOHAZARD ASSESSMENT PROGRAM

NORTH CENTRAL REGION – ATHABASCA

2020 CALL OUT INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
NC XX	35 km Northwest of the Junction of Hwy 2:46 and Hwy 44:04	**Hwy 2:46 Bridge File 79193 North Embankment Landslide**	2:46	38.77
Legal Description		**UTM Co-ordinates (NAD 83)**		
S.W.14-72-4-W5M		11 N 6123853 E 659514		

	Date	PF	CF	Total
Previous Inspection:				
Current Inspection:	June 19, 2020	13	5	65
Road AADT:	2560		**Year:**	2019
Inspected By:	José Pineda, Tarek Abdelaziz (Thurber) Arthur Kavulok, Gordon Wolters (AT)			
Report Attachments:	☑ Photographs	☑ Plans	☐ Maintenance Items	

Primary Site Issue:	Deep-seated landslide in the WBL embankment above the bridge culvert outlet location, resulting in the formation of multiple open tension cracks within the side slope (upper crack is about 5.6 m from edge of pavement) and highway north shoulder, and culvert distress 27 to 30 m from the outlet location.
Dimensions:	The landslide is approximately 11 to 20 m wide (parallel to the highway) and 40 m long (perpendicular to the highway).
Site History:	Embankment side slope failure and highway surface dip were first noted by AT's MCI in May 2020. The following summarizes existing information: (a) The culvert was constructed in 1966 over the Tributary to Otauwau River. The culvert records indicate a total length of 87.8 m, a span of 1724 mm and a rise of 1901 mm. (b) A 2.5 to 3 m wide 1 m deep ditch was dug by AT on the north side of the highway to convey surface runoff to a natural gully located to the east of the culvert outlet location. The mouth of the gully is in the immediate vicinity of the culvert outlet location. (c) A gully was noted above the culvert outlet location during the bridge inspections conducted in 2011, 2016 and 2018 (i.e. prior to the development of the side slope failure). This is believed to be a localized slump above the culvert outlet. Refer to Photos No. 5a, 5b. and 5c. (d) The June 3, 2020 bridge inspection report indicated that the north embankment side slope above the culvert outlet location failed and the failure area was approximately 12 m wide, 40 m long, and 3 m deep. The culvert was noted to have deformed significantly approximately 27 to 30 m from the culvert outlet locations and recommendations were provided to replace the distressed section of the pipe. Based on the 2020 report, underground telephone lines were located on the north right-of-way and three overhead power lines were located on the south right of way.

Observations:	Description	Worse?
☑ Pavement Distress	A 50 mm dip in the highway WBL shoulder above the landslide area; 15 m long, 50 mm deep open cracks within the dip	☐
☑ Slope Movement	Head scarp on the north embankment side slope with 1.3 m drop located approximately 5.6 m from the edge of pavement; four tension cracks above the head scarp as shown on Figure 1 having a width up to 200 mm and depth up to 600 mm	☐
☑ Erosion	Eroded natural gully (2.5 to 5 m wide and up to 2.5 m deep) surrounded by fallen trees/deadfall is located northeast of the culvert outlet; heavy flow from the mouth of the gully	☐
☑ Seepage	Landslide mass saturated and tension cracks filled with water	☐
☑ Bridge/Culvert Distress	The bridge inspection reports indicated that the culvert had bolts cracked near the inlet, the roof was damaged at rings 29, 30, and 31 with a reverse curvature close to the outlet. Silt accumulated at the bottom of these rings, but the inspector was unable to take measurements at these locations. The report also indicates that the culvert outlet heaved by about 300 mm.	☐
☑ Other	Two-third of the landslide area is covered with falling trees; two beaver dams were noted upstream of the culvert inlet location; scattered riprap at culvert inlet and outlet locations; water slightly ponding at outlet location	☐

Instrumentation: None

Observations and Assessment (Refer to attached Figures and Photos)**:**

The site observations indicate the presence of a deep-seated landslide on the north side of the highway. The landslide is about 40 m long (perpendicular to the highway alignment) x 13 to 20 m wide (parallel to the highway alignment) x 9 m deep and is toeing out at the culvert outlet location. The landside resulted in the development of a dip in the highway shoulder and impacted the integrity of the 2 m diameter bridge size culvert.

Previous bridge inspection records indicate that a localized toe erosion/gully was noted in the vicinity of and above the culvert outlet location. Progressive loss of toe support may have resulted in the development of the current landslide within the 14 m high embankment fill. It is possible that the culvert continued to overflow during spring seasons, resulting in progressive erosion and saturation of the toe of the embankment fill. The flow from the natural gully, located to the east of the culvert outlet, and may have also contributed to the saturation of the fill at the bottom of the embankment.

Recent bridge inspection report indicated reverse curvatures and silt accumulation on in rings 29 to 31, potentially indicting that the culvert has failed or excessively deformed.

The landslide appears to be very active and is retrogressing quickly to the highway surface. Accelerated movement of the landslide may result in partial or full closure of the highway lanes, failure of the bridge culvert, and underground telephone line(s) noted in AT June 2020 inspection report.

Recommendations:

Short-Term Measures

In the short term, the MCI should periodically monitor the highway for additional movement or cracking. Speed reduction and landslide warning signs should be placed along the highway at this location. If the dip becomes severe, minimal ACP patch should be placed on the highway surface to provide a smooth surface to motorists. This is to avoid excessive loading of the crest of the slope at the landslide location.

The underground telephone utility owner should be notified of the existing hazard and temporary above ground lines may need to be placed until the landslide is repaired.

There are no additional short-term measures that can be implemented to effectively reduce the landslide movement rate at this site. Any of the following measures should be implemented in the near future, since failure can be abrupt, to maintain the integrity of the highway and the bridge culvert.

Intermediate Term Measure:

It is understood that the existing pipe will be replaced in 2028. Hence, the most feasible intermediate term solution to maintain the integrity of the highway and the current pipe is to (a) excavate and replace the landslide mass with gravel, and (b) replace the damaged 30 m long section of the pipe below embankment fill. The existing gully will need to be re-shaped and armoured during this work to reduce the likelihood of future erosion issues within the embankment. Armoring the culvert inlet and outlet locations should also be completed during the repair.

The option will require tree clearing; Right-of-Way acquisition (if the ROW is not at the culvert outlet location); environmental approvals to armour the creek bed and banks and to clear trees; diversion of creek flow; and negotiations with utility owner. It is anticipated that one lane closure will be required to complete this work. The landslide mass should also be excavated and replaced in small panels to reduce the likelihood of short-term failures.

The estimated cost to complete this option is in the order of 1.2 Million Dollars (excluding Engineering).

Long-Term Measure:

This measure consists of: (a) replace landslide mass with gravel and armour existing gully as noted above, (b) abandon and grout existing culvert, and (c) install a new 110 m long SWSP below the highway. The new pipe will be located to the west of the current pipe and installed using a suitable trenchless installation method (e.g. pipe jacking or pilot tube micro-tunneling). Due to the big size of the culvert, the most suitable trenchless installation methodology will need to be confirmed by contacting local contractors specializing in the installation of bridge size culverts. A hydrotechnical study should be completed in the future to assess the size of the replacement pipe.

The option will require tree clearing; Right-of-Way acquisition; environmental approvals to clear trees and undertake in-stream work; construction of new creek channels, diversion of creek flow; and negotiations with utility owners.

The estimated cost to complete this option is in the order of 2.0 Million Dollars (excluding Engineering).

Prior to the design of any of the above noted measures, a geotechnical investigation, consisting of drilling test holes complete with slope inclinometers and piezometers should be undertaken to determine groundwater conditions and the depth and rate of movement within the landslide mass.

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STEEP BANK (~10m HIGH AND INCLINED ~60°)

STEADY FLOW

WATER PONDS A BIT AT CULVERT OUTLET

EROSION AROUND OUTLET EXPOSED CULVERT ROOF

GULLY (2.5-5.0m WIDE x 2.5m DEEP)

DITCH WATER FLOWING IN 2020

OUTLET

2H : 1V

SATURATED LANDSLIDE MASS

FALLING TREES LIMITING

WHITE LINES

3H : 1V

13m

11m

HWY 2:46

CENTER LINE OF HWY

CRACK E (200mm WIDE x UP TO 1300mm DROP)

CRACK D (200mm WIDE x 500mm DROP)

CRACK C (200mm WIDE x 400-600mm DROP)

CRACK B (100mm WIDE x 200mm DROP)

CRACK A (100-200mm WIDE x 300mm DROP)

5.16m

DIP ON HWY SHOULDER - 50mm DROP

SEE DETAIL

CRACK - 30mm WIDE, NO DROP

TILTED POSTS

DITCH (2 TO 3m WIDE, 1m DEEP)

CSP CULVERT (88m LONG)

3H : 1V

2H : 1V

STEADY FLOW INTO INLET

INLET

FLOW BREACHED THE BEAVER DAM AND ERODED THE WEST CREEK BANK

BEAVER DAMS

DAM CLEARED

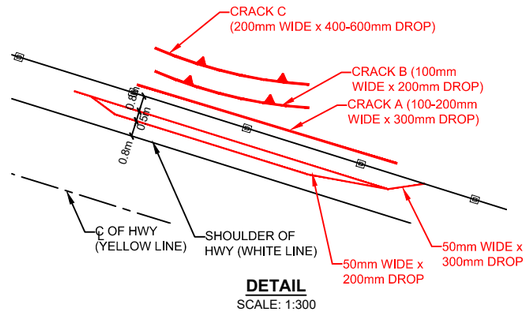
N

W E

S

LEGEND

- ACTIVE SCARP CRACK (APPROXIMATE)
- CREEK
- DITCH WATER FLOW
- HIGH TENSION CABLE BARRIER (HTCB)
- TREE LINE (APPROXIMATE)
- ① PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION



DETAIL
SCALE: 1:300

0 5 10 15 20 30m

SCALE 1:600

Alberta

NORTH CENTRAL REGION (ATHABASCA AREA) 2020 GEOHAZARD ASSESSMENT

HWY 2:46 km 38.77
BRIDGE FILE NO. 79193
NORTH EMBANKMENT LANDSLIDE
JUNE 19, 2020 CALLOUT PLAN

FIGURE 1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:600
DATE	JULY 2020
FILE No.	13357

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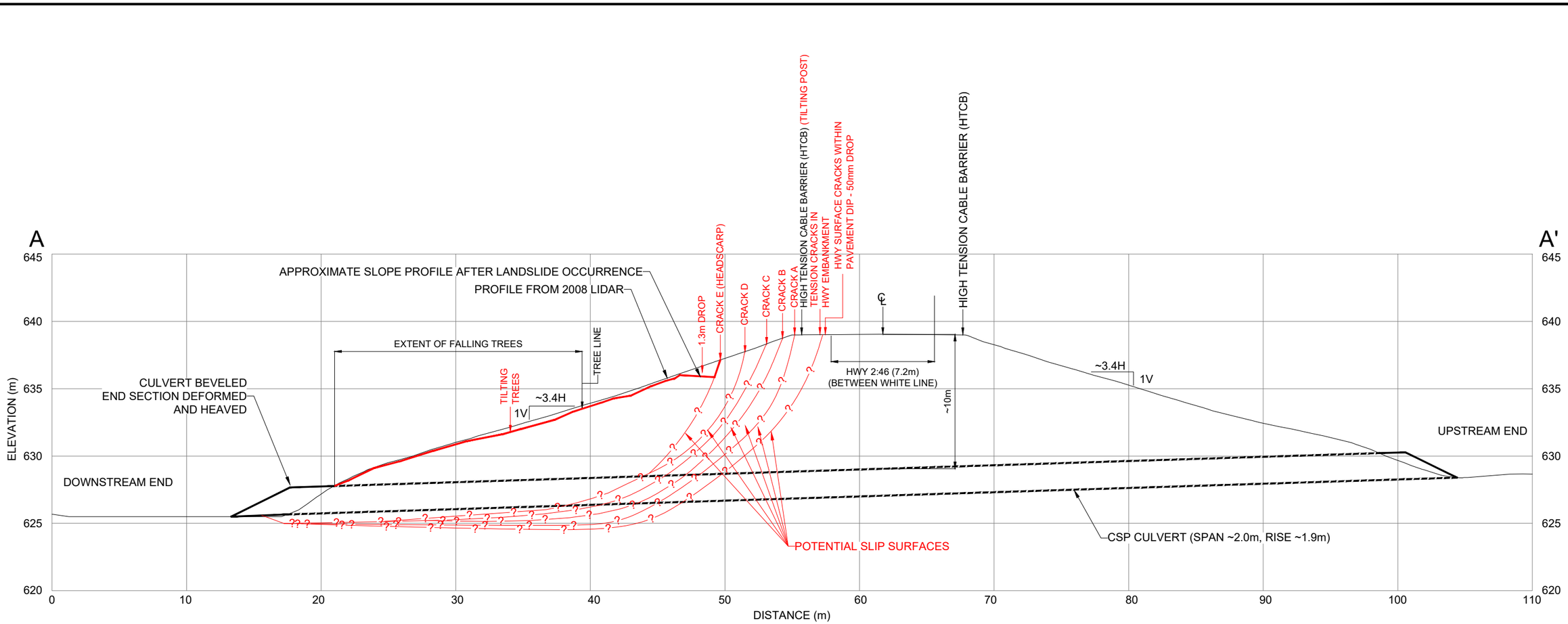

NOTE:
GROUND PROFILE AFTER LANDSLIDE OCCURRENCE WAS OBTAINED THROUGH SIMPLE FIELD MEASUREMENTS. HENCE, THE ACCURATE GROUND PROFILE MAY VARY FROM WHAT IS PRESENTED IN SECTION A - A'.

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NORTH CENTRAL REGION (ATHABASCA AREA)
2020 GEOHAZARD ASSESSMENT

CROSS - SECTION A - A'

FIGURE 2

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:300
DATE	JULY 2020
FILE No.	13357

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Photo No. 1 – Looking at WBL landslide; note the presence of open tension cracks on the highway shoulder; main head scarp crack of landslide is about 5.6 m from the edge of pavement

Photo No. 2 – Looking west at the north embankment landslide's head scarp and western flank; note the presence of fallen and tilting trees, and seepage along the western flank; landslide mass was noted to be wet at the time of the inspection.

Photo No. 3 – Looking southeast at the landslide's head scarp and eastern flank; note the presence of multiple tension cracks within the slope downslope of the highway location

Photo No. 4. Looking northwest at the CSP culvert outlet; note silt accumulation as well as fallen trees near the culvert outlet

Photo No. 5 – Looking east; water ponding a bit around culvert outlet location

Photo No. 5a (Taken by AT in 2016) – Erosion and debris at the culvert outlet; note the absence of riprap at the culvert outlet location

Photo No. 5b (Taken by AT in 2018) – Erosion and debris around culvert outlet; culvert outlet heaved by about 300 mm above the creek bed

Photo No. 6 – Two beaver dams noted upstream of the culvert inlet

Photo No. 7 – Looking at CSP Culvert Inlet (1.9 m diameter); scattered riprap was noted at inlet location

Photo No. 8. Looking north at the south side slope of the highway embankment

Photo No. 9 – Looking inside CSP Culvert outlet; note reverse curvature in the roof (Photograph was taken by AT during bridge culvert inspection completed on June 3,2020). This is approximately 27 to 30 m from the culvert outlet location.