ALBERTA TRANSPORTATION AND ECONOMIC CORRIDORS
GEOHAZARD ASSESSMENT PROGRAM
NORTH CENTRAL REGION – ATHABASCA & FORT MCMURRAY DISTRICTS
2023 SITE INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
NC093	22 Km north of Calling Lake	Rock Island Bridge (79692) Landslide	813:06	4.70
Legal Description		**UTM Co-ordinates (NAD 83)**		
NE 5-74-22-W4		12 6139937.91 E 351682.46		

	Date	PF	CF	Total
Previous Inspection:	June 6, 2022	10	6	60
Current Inspection	May 16, 2023	10	6	60
Road WAADT:	480		**Year:**	2022
Inspected By:	José Pineda, Tarek Abdelaziz (Thurber) Arthur Kavulok, Kristen Tappenden, Amy Driessen (TEC)			
Report Attachments:	☑ Photographs ☑ Plans ☐ Maintenance Items			

Primary Site Issue	Landslide within the NW approach fill of Bridge File (BF) 79692, impacting NW wing wall, highway and abutment supports
Dimensions:	The slide is approximately 25 m long (parallel to bridge alignment) and 40 m wide (perpendicular to bridge alignment)
Site History / Available Information:	The existing bridge structure was first in service since 1989 to replace an older bridge structure that was located about 3 m west of the existing NW wing wall. The old bridge was a three-span structure also supported on steel H piles, which were cut off and left in place. The new structure consists of a 38 m single span concrete girder bridge with the abutments and the wing walls supported on driven steel H piles. The abutments are supported on 15 m deep piles and the wing walls are supported on 10 m deep piles. The approach fill head slope is inclined at 2H:1V. The side slopes of the approach fill are approximately 3H:1V on both sides of the river. Approximately 3 m and 6 m of fill was placed on the north and south of the river alignment, respectively to accommodate the construction of the new bridge. Records indicate that an instability/slump occurred within the north head slope as early as January 2016 when the headslope fill dropped to 0.5 m below the north abutment seat. We understand that repairs have not been completed since the drop was first noticed in 2016. A geotechnical investigation was conducted in 1987 for the design of the existing bridge. Available records show that the soil at the landslide area (Test hole # 3) prior to the construction of approximately 3 m of fill embankment consist of 9 m of saturated fine to medium grained loose to compact silty sand. A 2 m thick layer of medium to high plastic clay was interbedded within the sand between elevations 634 and 636 m. The sand clay in turn is underlaid by very still to hard clay till to the termination depth of the test hole. Similar soil conditions were encountered in Test Hole # 1 and # 2 drilled on the south side of the river with the exception of the high plastic clay layer noted within the sand formation.

	A geotechnical investigation, consisting of drilling two test holes along with the installation of a slope inclinometer and vibrating wire piezometers, was completed by Thurber in 2021. The test holes mainly indicated 2 to 4 m of clay fill over high plastic clay over sand and clay till. A layer of peat was noted below the clay fill in the test hole drilled neat the base of the bridge headslope.	
Maintenance/ Repairs:	As per Emcon's work order provided to Thurber by TEC, we understand that maintenance contractor conducted the following repairs in 2020: 1) Filled voids below the slab above the NW wingwall with expanding foam or grout as approved by TEC, 2) Removed loose/desiccated materials from the north headslope surface and filled any open cracks in this are, 3) Slightly graded the north head slope and backfilled existing dips and gaps with gravel to provide at least 600 mm of cover above the underside of the abutment seat/NW wing wall, 4) Placed Class 1 riprap on the north headslope under the bridge, and 5) Filled potholes/voids on the highway/bridge deck with instant patch. Crack sealing and ACP patches were carried out in 2021 and 2022.	
Observations:	**Description**	**Worse?**
☑ Pavement Distress	Up to 100 mm dip on the highway surface, mainly within the footprint of the north approach slab (more distinct within the SBL above the NW wing wall); multiple cracks and potholes within the north approach slab up to 300 mm wide, and 50 mm deep; ACP patch placed on bridge deck in 2022 is failing	☑
☑ Slope Movement	The landslide exposed the upper 1.45 m of four of the old bridge piles; riprap placed on the bridge headslope dropped and shifted laterally towards the river; 2.7 m long crack along the face of the abutment seat (crack is about 2.7 m long (parallel to the abutment seat, 200 mm wide, and up to 300 mm deep below the abutment seat)	☑
☑ Erosion	An erosion gully (up to 1 m wide x 150 to 400 mm deep x 8 m long) developed within the granular fill regraded zone west of the NW wing wall; active erosion slumps above the river channel within the landslide toe roll.	☑
☐ Seepage		☐
☑ Bridge/Culvert Distress	Poor condition of bridge deck surface	☑
☐ Other		☐

Instrumentation Readings (1 SI and 2 VW Piezometers):

The following provides a summary of the readings collected in the spring of 2023:

SI20-1, installed to the west of the bridge headslope, showed a rate of movement of 1.9 mm/yr over 1.9 m to 3.8 m depth since it was previously read in October 2022, corresponding to an overall cumulative movement of 31 mm over the same zone since the SI was initialized.

The groundwater levels in the two vibrating wire piezometers is about 3 m below ground surface with an increase in water level of 0.2 m since the previous readings.

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

The site condition deteriorated since the 2022 site inspection.

The presence of native high plastic clay and peat below the NW approach fill, ongoing toe erosion by the river appear to be the main triggering factors for the observed landslide movement. Elevated ground water levels within the approach fill may have also been another contributing factor to the landslide movement. It is suspected that high groundwater levels in the river may have been higher than the design elevation. The previously observed desiccated/cracked and clay fill between the abutment seat and the river indicates that groundwater levels may have been as high as the elevation of the underside of the abutment seat.

The settlement of the approach slab created a low spot at the north edge of the NW wing wall (on highway side) and hence surface drainage from the highway is currently directed towards the NW approach fill side slope rather than to the south side of the bridge as per the original design. The erosion gully developed within the recently placed gravel fill is a direct consequence of concentrated surface water runoff along the face of the NW wing wall. The erosion gully will likely continue to grow bigger in size, and this may result in future exposure of the underside of the wing wall.

The temporary repairs completed by TEC have performed well to date. However, the landslide is still active as evidenced from the vertical and lateral movements of the riprap within the bridge headslope, and the further drop of the approach slab. The new gap formed along and below the abutment seat will continue to get bigger unless repaired and may result in the exposure of a few of the abutment supports.

The ongoing landslide movement will eventually expose the underside of the NW wing and abutment seat and/or piles and this may impact the integrity/performance of the highway and the bridge.

Ongoing toe erosion by the river resulted in the development of two distinct slumps immediately above the stream level. These slumps may get bigger in size and result in a significant loss of toe support at the base of the slope and hence an accelerated movement of the landslide.

If an accelerated landslide movement occurs, a major detour will likely be required at this site.

Recommendations:

This site should be visited again in the spring of 2024.

Short-Term Measures

The local MCI should monitor the site periodically to assess whether the temporary repairs are performing satisfactorily.

In the short term, consideration should be given to the following:

- Place additional gravel or low strength fillcrete to fill the gap formed along the face of the abutment seat.
- Place an ACP patch on the north side of the bridge. The patch should be designed to eliminate the dip on the highway, provide a smooth ride to motorists, eliminate existing low spot near the northern edge of the NW concrete curb, and divert highway runoff away from the wing wall and landslide area; consider placing sandbags or extending the NW concrete curb further north to ensure that runoff is diverted away from the landslide area. Consideration may also be given to installing a half CSP pipe along the highway NW side slope to direct surface water away from the landslide area and the northern edge of the wingwall.
- Add granular fill to backfill the erosion gully developed near the NW wing wall.
- Place riprap within eroded areas at the toe of the slope.

Due to the implications of a major failure in response to ongoing landslide movement, it is recommended to repair this site as soon as funds become available.

Long-Term Repair Measures

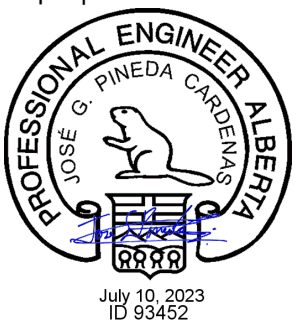
Various long-term repair options were presented in the preliminary engineering report prepared by Thurber in 2022 to deal with the landslide movement. The repair options included the installation of soil nails or sheet pile walls.

The ballpark cost to complete the repairs was estimated to range between $1.5 and $2.5 million (including engineering and contingencies) for the installation of soil nails and sheet pile walls, respectively.

Closure:

It is a condition of this letter report that Thurber's performance of its professional services will be subject to the attached Statement of Limitations and Conditions.

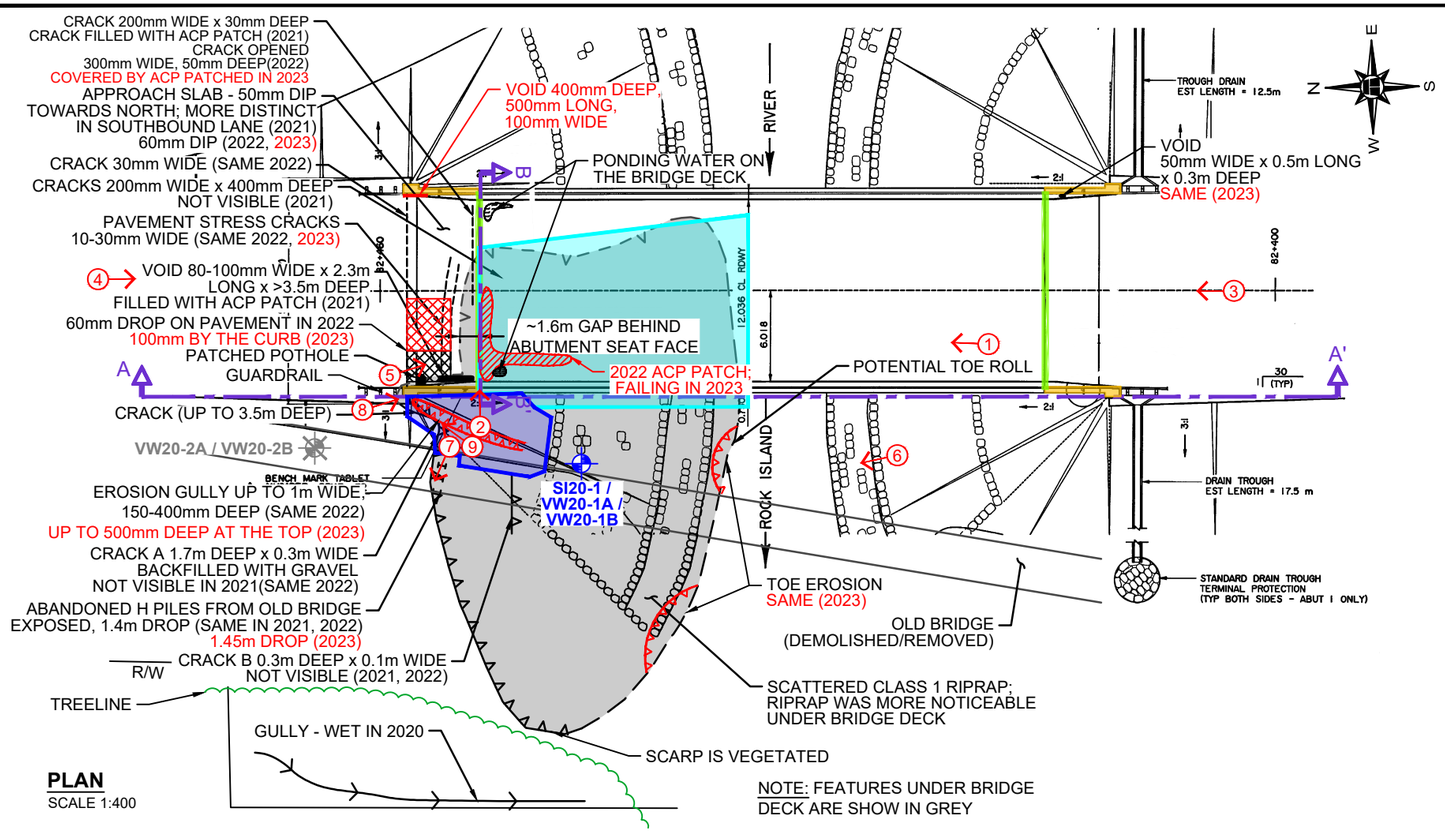
Yours very truly,
Thurber Engineering Ltd.
Tarek Abdelaziz, Ph. D, P.Eng.
Principal | Geotechnical Review Engineer



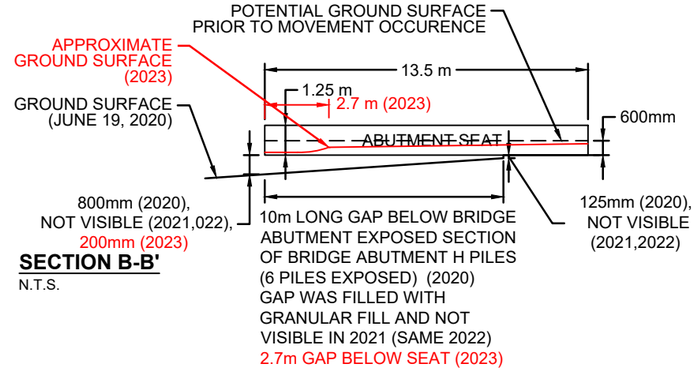
PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
RM SIGNATURE: _____
RM APEGA ID #: 91085
DATE: July 10, 2023
PERMIT NUMBER: P005186
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

José Pineda, M.Eng., P.Eng.
Associate | Senior Geotechnical Engineer

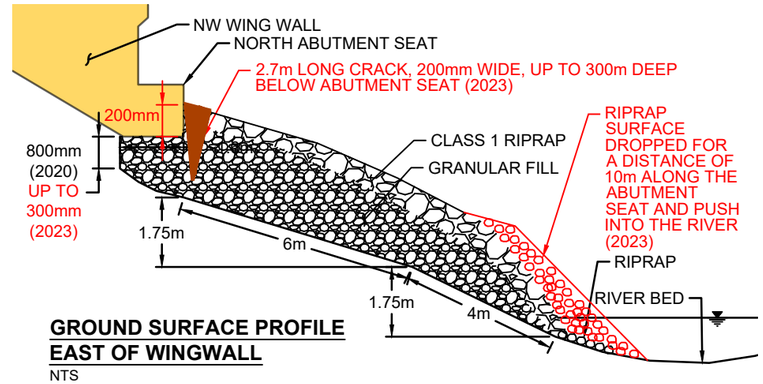
H:\32000\32122 AT GRMP Athabasca and Fort McMurray Districts 2021-2025\CAD\2023 GEO HAZARD\UGP\32122 NC093-1.dwg - 1 - Jun. 16, 2023



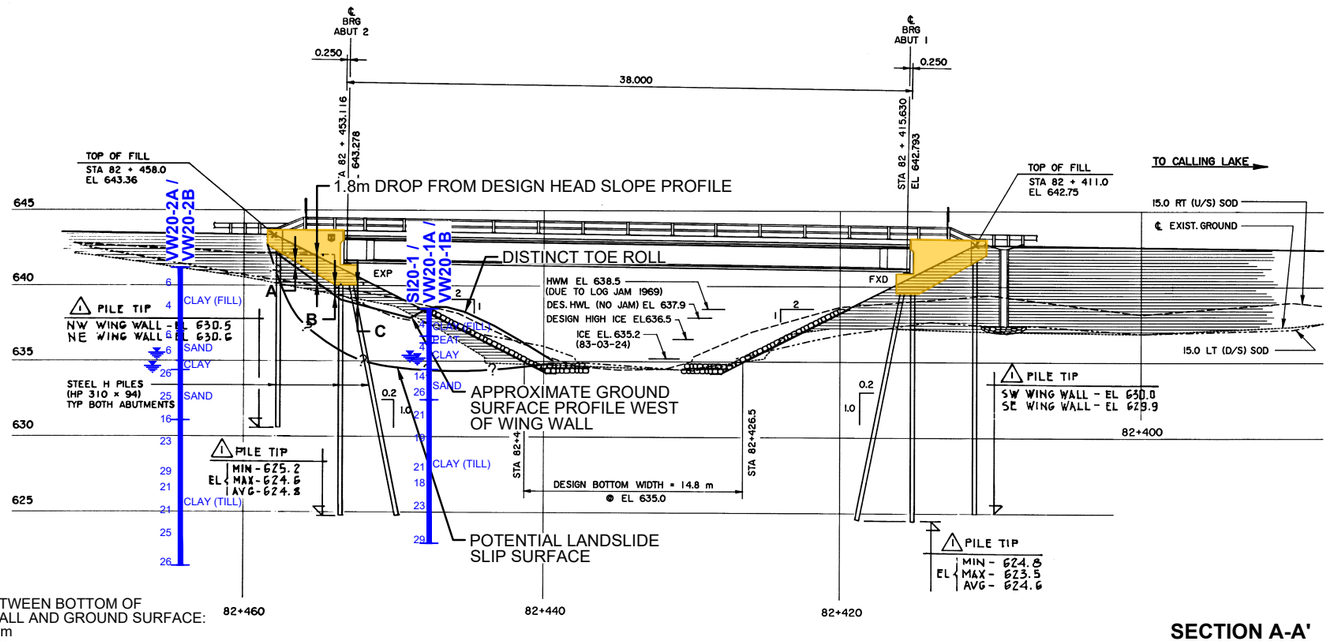
PLAN
SCALE 1:400



SECTION B-B'
N.T.S.



GROUND SURFACE PROFILE EAST OF WINGWALL
NTS



GAP BETWEEN BOTTOM OF WINGWALL AND GROUND SURFACE:
A: 300mm
B: 200mm
C: 800mm

SECTION A-A'
SCALE 1:400

LEGEND

- APPROXIMATE INSTRUMENT LOCATION
- DAMAGED INSTRUMENT LOCATION
- HEADSCARP CRACK
- WING WALL
- GULLY/DITCH
- EXISTING RIPRAP
- BRIDGE EXPANSION JOINT
- POTENTIAL EXTENT OF LANDSLIDE
- SI — SLOPE INCLINOMETER
- VW — VIBRATING WIRE PIEZOMETER
- 5m — DEPTH (m) OF VIBRATING WIRE PIEZOMETER OR SLOPE INCLINOMETER
- EXTENT OF CLASS 1 RIPRAP AND GRANULAR FILL UNDER THE BRIDGE PLACED IN 2020
- PLACED AGAINST THE NW WING WALL IN 2020
- PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION
- WATER LEVEL
- PAVEMENT DISTRESS

NOTES:
1. MAY 16, 2023 OBSERVATIONS ARE SHOWN IN RED.
2. IN 2020, ALBERTA TRANSPORTATION PLACED GRAVEL AGAINST THE NW WING WALL AND UNDER THE BRIDGE AGAINST THE NORTH BRIDGE ABUTMENT.

0 5 10 15 20 25m
SCALE APPROX. 1:400

Alberta

NORTH CENTRAL REGION
(ATHABASCA AND FORT MCMURRAY DISTRICTS)
2023 GEOHAZARD ASSESSMENT

NC093: HWY 813:06 ROCK ISLAND BRIDGE HEADSLOPE (km 4.7)

DWG NO. 32122-NC093-1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	AS SHOWN
DATE	MAY 2023
FILE No.	32122

THURBER ENGINEERING LTD.

Photo 1. Landslide Area (Looking North).

Photo 2. North Abutment (Looking East) showing riprap placed by TEC in 2021; The riprap top surface appears to have dropped for a distance of about 10 m along the face of the abutment seat and the riprap along this zone shifted laterally towards the river.

Photo 2A. A Close look at the NW corner of the abutment seat. There is a 2.7 m long gap formed along the face of the abutment seat.

Photo 3. Bridge deck and highway surface condition (Looking north at the south expansion joint). ACP patch placed in 2022 to seal cracks and potholes at the joints and on the bridge deck.

Photo 4. Bridge deck and highway surface condition (Looking south at north expansion joint). The approach slab dip by the NW wingwall was noted to be worse than the dip noted in 2022.

Photo 5. Sealed Cracks along north expansion joint (Looking east). ACP patch placed on the bridge deck in 2022 is failing.

Photo 6. NW approach fill headslope; note two distinct slumps just above the stream level.

Photo 7. Exposed old bridge H piles within the active landslide mass.

Photo 8. A void forming between the highway side slope and the top edge of the NE wingwall

Photo 9. Northwest wingwall: soil staining on the wall face shows original design elevation of fill; approximately 1 m of gravel was placed in 2020 to buttress/cover the gap formed below the wing wall; vegetation has grown within the backfilled area since 2020; erosion up to 500 mm at the top developed within new fill placed against the wing wall.