ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
NORTH CENTRAL REGION – ATHABASCA & FORT MCMURRAY DISTRICTS
2022 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 23, 2021	10	6	60
Current Inspection	June 6, 2022	10	6	60
Road AADT:	480		**Year:**	2021
Inspected By:	José Pineda, Tarek Abdelaziz (Thurber) Arthur Kavulok, Rishi Adhikari, Amy Driessen (Alberta Transportation)			
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 AT, 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 AT, 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.

Observations:	**Description**	**Worse?**
☑ Pavement Distress	Up to 60 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;	☑
☑ Slope Movement	Scarp crack west of the northwest wing wall with differential heights of 1.7 m to 3 m was regraded with gravel up to the old bridge exposed piles; the eastern flank of the landslide that extended below and 10 m east the NW wing wall exposing 6 of the abutment piles was not visible due to the repairs completed by AT in 2020; distinct toe roll approximately 40 m long along the river channel; the landslide exposed four of the old bridge piles 3 m west of the existing bridge and west of this point the scarp crack was up to 1.4 m high	☐
☑ 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; signs of active erosion along the landslide toe roll	☑
☐ Seepage		☐
☐ Bridge/Culvert Distress	Poor condition of bridge deck surface	☑
☑ Other		☐

Instrumentation Readings (1 SI and 4 VW Piezometers):

The following provides a summary of the readings collected in the spring of 2022:

SI20-1 showed a rate of movement of 11.2 mm/yr over 1.9 m to 3.8 m depth since it was previously read in October 2021, corresponding to an overall cumulative movement of 29.7 mm over the same zone since the SI was initialized.

The groundwater levels in the four vibrating wire piezometers ranged between 2.5 to 5.9 m below ground surface with an increase in water level ranging from 0.2 to 0.6 m since the previous readings.

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

The site condition did not change significantly since the 2021 site inspection.

There is a history of instability at the bridge location since 2016. The placement of relatively steeply inclined fill (i.e., transitioning from 2H:1V at the head slope to 3H:1V at side slopes), 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 AT are satisfactory in the short-term; however, the landslide is relatively active based on the instrumentation monitoring results. The ongoing landslide movement may expose the underside of the NW wing and abutment seat in the future and impact the integrity of the highway and the bridge.

Ongoing toe erosion by the river resulted in the development of two distinct minor 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 the highway /bridge fail in the future at this location in response to an accelerated landslide movement, a major detour will be required.

Recommendations:

The surface condition of the bridge deck is very poor, and this needs to be addressed by AT's bridge group in the near future.

This site should be visited again in the spring of 2023.

<u>Short-Term Measures</u>

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 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 recently noted 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. A structural engineer should be retained to assess

the impact of the landslide on the integrity of the bridge.

Long-Term Repair Measures

The long-term measures will consist of the following:

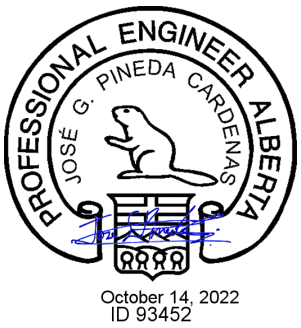
- Install continuous pile walls (concrete or sheet pile walls) on the west side of the highway to stabilize the landslide movement.
- Flatten slopes downslope of the pile wall location to offload the landslide mass.
- Undertake in-stream work to restore the channel width and armor the banks.
- Regrade the area under the bridge and use soil nails or a pile wall to stabilize the landslide movement.

The ballpark cost for this option would be in the range of $2.5 to 3 million (excluding engineering). Land negotiation and regulatory authority approvals will also be required to implement this option.

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 | Senior Geotechnical Engineer



PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
RM SIGNATURE:
RM APEGA ID #: 91085
DATE: October 14, 2022
PERMIT NUMBER: P005186
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

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

THURBER

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

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5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

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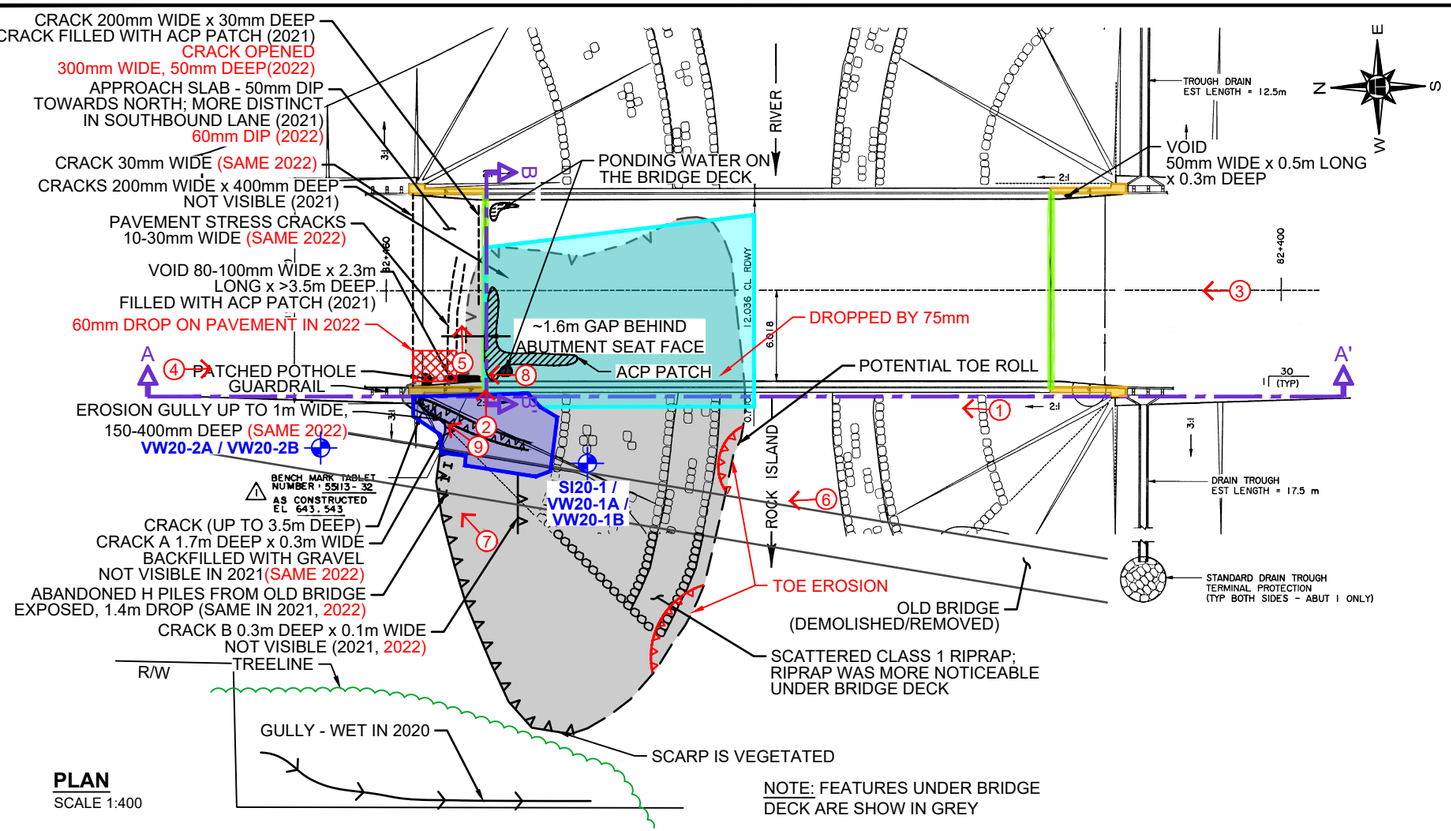
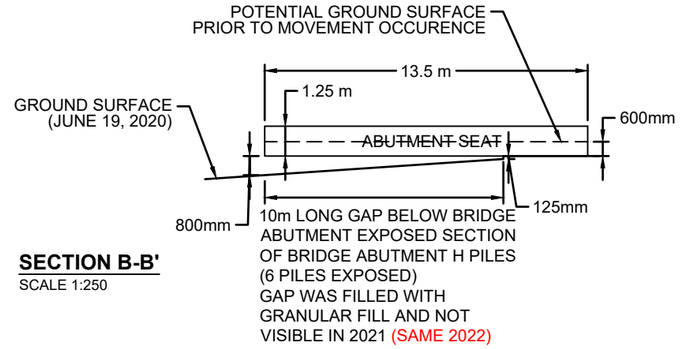
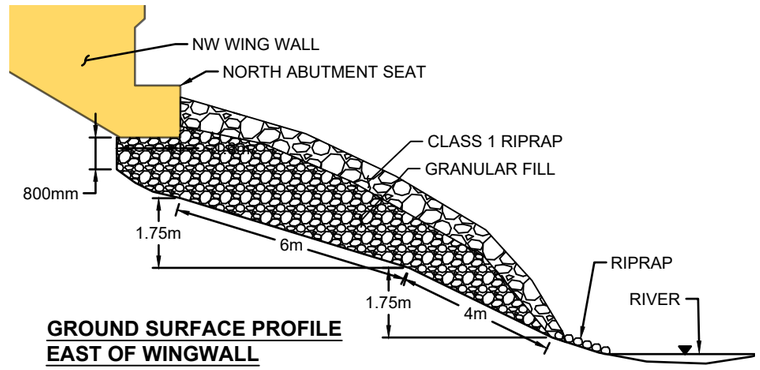


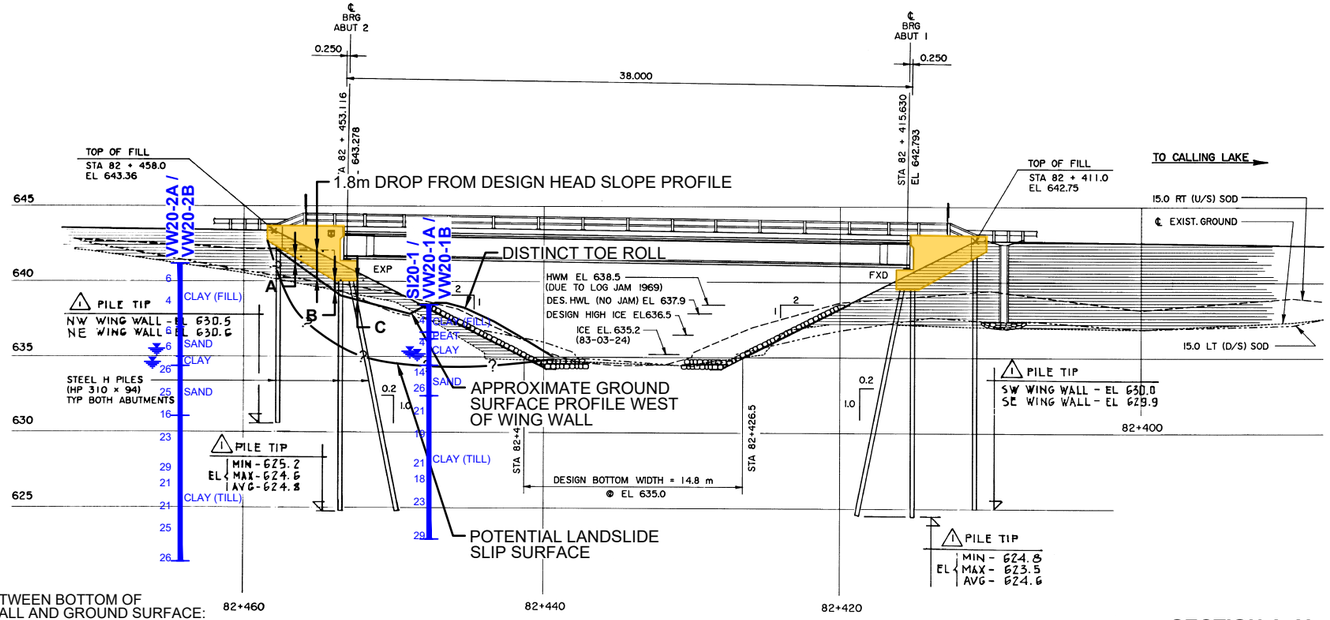
PLAN
SCALE 1:400



SECTION B-B'
SCALE 1:250



GROUND SURFACE PROFILE
EAST OF WINGWALL
NTS



SECTION A-A'
SCALE 1:400

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

LEGEND

- APPROXIMATE 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
- GRANULAR FILL PLACED IN 2020 AGAINST THE NW WING WALL
- ① — PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION

NOTES:
1. JUNE 6, 2022 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)
2022 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	OCTOBER 2022
FILE No.	32122

THURBER ENGINEERING LTD.

Photo No. 1 – Landslide Area (Looking North)

Photo No. 2 – North Abutment (Looking East) showing riprap placed by AT in 2021

Photo No. 3 – Bridge deck and highway surface condition (Looking north at the south expansion joint).

Photo No. 4 – Bridge deck and highway surface condition (Looking south at north expansion joint). Note poor condition of bridge deck wearing surface, and existing dip within the highway SBL by the NW wingwall

Photo No. 5 – Cracks along north expansion (Looking east)

Photo No. 6 – Looking north at the NW approach fill headslope; note two distinct slumps just above the stream

Photo No. 7 – Old bridge H piles showing 1.4 m drop by landslide (Looking East)

Photo No. 8 –Previous voids, formed behind the wing wall on the highway side and filled with instant patch in 2020 did not open again

Photo No. 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; slight erosion developed within new fill placed against the wing wall.