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
NC102 (previously known as NC24B and NC24D)	Adjacent to Hwy 41, N. of Junction Hwy 29 at km 8.8	Kehiwin Lake	41:23	8.7
Legal Description		**UTM Co-ordinates (NAD 83)**		
SW-31-58-6-W4M		12U N 507240	E 5989184	

	Date	PF	CF	Total
Previous Inspection:	June 25, 2021	6	3	18
Current Inspection:	May 18, 2023	6	3	18
Road WAADT:	1,220		**Year:**	2022
Inspected By:	José Pineda, Tarek Abdelaziz (Thurber) Kristen Tappenden, Amy Driessen, Arthur Kavulok (TEC)			
Report Attachments:	☑ Photographs ☑ Plans ☑ Maintenance Items			

Site History/Existing Information	A landslide occurred at this location in 2010 and the landslide head scarp crack encroached into the highway southbound lane. The landslide was repaired in 2011 using a 112 m long cantilever cast-in-place concrete pile wall (NC24B pile wall), installed on the west side of the highway, approximately 3 m downslope of the guardrail location. Three slope inclinometers (SI11-1 to SI11-3) were installed in the pile wall to assess the effectiveness of the remedial measure. A dip developed suddenly on the highway SBL to the south of NC24B pile wall in May 2014. Geotechnical instruments, consisting of slope inclinometers and piezometers, were installed in 2015 to the south of the NC24B pile wall to monitor the landslide movement rates and determine soil and groundwater conditions.
Primary Site Issue	Pavement distress on the highway SBL to the south of the NC24B pile wall, creating a bump/twist near the south end of the guardrail
Dimensions:	About 35 m long along the highway SBL to the south end of the existing wall
Date of any remediation:	A cast-in-place concrete pile wall (i.e., NC24D pile wall) was constructed in the fall of 2016 to retain the landslide movement. NC24D pile wall is an extension to the original wall completed in 2011 (i.e., NC24B wall). Two slope inclinometers (SI16-1 and SI16-2) were installed in the NC24D pile wall to assess the effectiveness of the remedial measure.
Maintenance:	Crack sealing took place fall 2014; ACP patch in 2015 to smoothen the bump within the south end of the dip; ACP patch was completed in October 2017

Observations:	Description	Worse?
☑ Pavement Distress	N/A	☐
☑ Slope Movement	10 to 100 mm wide reflective cracks with up to 5 mm drop on the highway surface above NC24B wall; 5 to 40 mm wide cracks with up to 10 mm drop above NC24D pile wall. A 0.3 to 1.2 m deep scarp crack, located about 3.4 m from guardrail exposing 4 piles from the NC24B Pile Wall near SI11-1	☑
☐ Erosion		☐
☐ Seepage		☐
☐ Bridge/Culvert Distress		☐
☐ Other		☐

Instrumentation: (11 SIs, 8 PNs, 3SPs)

The total pile head deflection, since construction completion, in the NC24B and NC24D pile walls ranges from zero to 6 mm; no discernable movements in SI15-1 and SI10-1 (located in the east ditch of the highway); the rate of movement in SI15-2, SI15-3, SI10-3 (located downslope of the pile walls) is 2.4 mm/yr, 0 mm/yr, and 6.1 mm/yr, respectively; SI15-4, located to the south of the NC24D pile wall, is moving at 2.8 mm per year.

Between the fall of 2022 and the spring of 2023, the variation in groundwater levels ranged from a decrease of 0.3 m to an increase of 0.1 m.

Assessment (Refer to attached Figure)**:**

The NC24B and NC24D pile walls have been effective in stabilizing the landslide movements. The reflective landslide cracks appeared on the highway surface above both walls will continue to open and widen over time until the pile walls mobilize the full magnitudes of the landslide stabilizing forces.

The design of the NC24B pile wall accounted for partial loss of the downslope soil mass (i.e., up to 4 m). Hence, the integrity of the wall should not be impacted due to the exposure of the concrete piles unless the downslope mass drops by more than 4 m. However, the slump developed downslope of the wall may get bigger and deeper in the future, and the head scarp crack may potentially expose more piles. Future loss of the exposed soils between the spaced piles, if occurs for example due to repeated freeze/thaw cycles or saturation of soils after a heavy rainfall event, may eventually impact the integrity of the highway due to progressive loss of soils the wall and the highway.

Recommendations:

The site visit could be skipped next year; however, instrumentation monitoring should be continued at this site.

Open cracks on the highway surface above the pile walls should be sealed to reduce groundwater infiltration into the landslide masses.

The local MCI should watch for the development of any new cracks on the highway lanes, particularly upslope of SI15-4 location (i.e., SI located outside the pile wall extent).

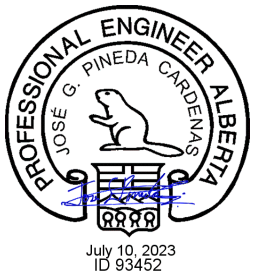
The slump area around the exposed four piles should be monitored and any cracks on the side slopes or the highway above this location should be sealed.

It is recommended that fill be brought to site to slightly grade/contour the slump area and cover the exposed four piles. The fill should be lightly compacted around the exposed piles.

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.

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

N
W E
S

KEHIWIN LAKE

NC24B PILE WALL (2011)
RIGHT OF WAY BOUNDARY
NC24D PILE WALL (2016)
EDGE OF WATER
3+100
SW 31-58-6-4
(PLAN 3697RS)
O.R.R. LINE R.O.W.
HWY 41:23
℄
EDGE OF SURVEYED AREA

SI11-3
PB10-3
PB10-1
PN10-2A/B
SI/PN10-3
SI11-2
SI/PN10-1
PN10-5
PB10-4
SI11-1
PN10-6
PB10-2
SI/PN15-3
SI/PN15-2
SI16-1 (P04)
SI/PN15-1
SI16-2 (P08)
SI/PN15-4

HEADSCARP CRACK
3.4m FROM GUARD RAIL:
EXPOSED 4 PILES (2023)
800mm DEEP (2023)
500mm DEEP (2023)
300mm DEEP (2023)
1.2m DEEP (2023)

20mm WIDE, NO DROP (2021)
30mm WIDE, NO DROP (2023)
50mm WIDE, NO DROP (2021)
50-70mm WIDE, 5mm DROP (2023)
REFLECTIVE CRACKS
5-10mm WIDE, NO DROP
40-70mm WIDE, NO DROP (2021)
70-100mm WIDE, 5mm DROP (2023)
11m LONG, 50mm WIDE, NO DROP (2021)
60mm WIDE, 5mm DROP (2023)

ACP PATCH (OCTOBER 2017)
10 mm WIDE, NO DROP
10-40mm WIDE, 10mm DROP (2021, 2023)
REFLECTIVE CRACK
10mm WIDE, NO DROP
10-20mm WIDE, NO DROP (2021, 2023)
5mm WIDE, NO DROP (2018)
10mm WIDE, NO DROP (2019)
20mm WIDE, NO DROP (2021, 2023)
5-10mm WIDE, NO DROP (2016)
CRACK EXTENDED SOUTH
10-20mm WIDE, NO DROP (2018)
SAME IN 2019
30-40mm WIDE, NO DROP (2021, 2023)

LEGEND

- km 8.8 PILE WALL
- FENCE LINE
- BUSH LINE
- ACTIVE SLIDE CRACKS ON HIGHWAY
- INACTIVE SLIDE CRACKS ON HIGHWAY
- TEST HOLE LOCATION
- SI — SLOPE INCLINOMETER
- PN — PNEUMATIC PIEZOMETER
- PB — POORBOY / STANDPIPE
- DAMAGED/BLOCKED INSTRUMENT
- 550 — GROUND SURFACE CONTOUR
- P — OVERHEAD POWER LINE (APPROXIMATE)
- T — TELUS LINE (APPROXIMATE)
- S — SILT FENCE
- GUARD RAIL
- HIGHWAY DIP AREA
- ACP PATCH
- (P04) — PILE NUMBER
- ① — PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION

NOTES:

1. MAY 18, 2023 OBSERVATIONS SHOWN IN RED
2. CONTOUR INTERVAL IS 0.5m.
3. CONTOURS INSIDE SURVEYED AREA WERE SURVEYED BY WSP. ELEVATION CONTOURS OUTSIDE SURVEYED AREA WERE DERIVED FROM LiDAR DATA.
4. NC24D PILE WALL IS AN EXTENSION TO THE ORIGINAL NC24B PILE WALL CONSTRUCTED IN 2011.

0 10 20 30 40 50 60m
SCALE 1:1000

Alberta

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

NC102: HWY 41:23 KEHIWIN LAKE (km8.8)
SITE PLAN SHOWING FEATURES AND INSTRUMENT LOCATIONS

DWG NO. 32122-NC102-1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:1000
DATE	JUNE 2023
FILE No.	32122

THURBER ENGINEERING LTD.

Photo No.1 - Looking north at the 2017 ACP patch placed on the highway surface at the NC24D pile wall location; no visible dip on highway surface.

Photo No.2 - Looking north at up to 20 mm wide reflective cracks, no drop on the SBL at the NC24D pile wall location

Photo No.3 - Looking north at up to 30 to 40 mm wide reflective cracks on the highway surface at the NC24D pile wall location

Photo No.4 - Looking south at longitudinal open cracks (10 to 40 mm wide) on the highway at the NC24D pile wall location

Photo No. 5 – Looking north at a reflective crack (60 mm wide with 5 mm drop) on the highway surface above NC24B pile wall location

Photo No. 6 – Looking south from the northern flank of the NC24B landslide location at open reflective cracks (30 to 100 mm wide with 5 mm drop)

Photo No. 7 – Looking south at a minor slump developed immediately downslope of the NC24B pile wall; the slump exposed the tops of four concrete piles.