

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



Site Number	Location	Name	Hwy	km
NC104	Approximately 7.7 km north of Hwy 29 (North of Elk Point)	<b>KEHIWIN LAKE</b>	41:23	7.7
Legal Description		UTM Co-ordinates (NAD 83)		
NE-25-58-7-W4M		12 N 5988325	E	506652

	Date	PF	CF	Total
<b>Previous Inspection:</b>	June 25, 2021	11	4	44
<b>Current Inspection:</b>	May 18, 2023	11	4	44
<b>Road WAADT:</b>	1,220	<b>Year:</b>	2022	
<b>Inspected By:</b>	José Pineda, Tarek Abdelaziz (Thurber) Kristen Tappenden, Amy Driessen, Arthur Kavulok (TEC)			
<b>Report Attachments:</b>	<input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input type="checkbox"/> Maintenance Items			

<b>Primary Former Site Issue:</b>	Landslide (NC104, previously known as NC24C) developed abruptly to the south of the km 7.8 pile wall (NC103 site previously known as NC24A) after occurrence of heavy rainfall events in 2011, causing pavement distress in the highway surface.
<b>Dimensions:</b>	Cracked section of highway to the south of the southern limit of the NC103 site: About 180 m long (parallel to the highway alignment) and 80 m wide (parallel to the slope direction).  Area susceptible to future local landslides to the south of the cracked section of the highway: About 160 m long.
<b>Date of any remediation:</b>	Remedial measures were implemented between the fall of 2016 and the fall of 2017 and consisted of the following: (a) the construction of a 230 m long cast-in-place tied-back pile wall to the south of NC24A to retain the cracked section of the highway (NC24C tied-back wall), (b) the construction of a 125 m cast-in-place cantilever pile wall (NC24 pile wall extension) to the south of the NC24C tied-back wall as a precautionary measure against future landslides. The NC24C pile wall extension (NC24C interim pile wall) was designed to accommodate the installation of additional piles, anchors and waler (if needed) in the future subject to instrumentation monitoring results, (c) installation of twin culverts and lining of C2 culvert by others, (d) grouting of culvert C1, ditch regarding and lining with TRM. Slope inclinometers load cells were installed in the NC24C tied-back pile wall to monitor the wall movement and anchor loads. Slope inclinometers, a Shape Accelerometer Array (SAA) and strain gauges were installed in selected piles of the NC24C pile wall extension to assess wall movements and the bending moment in one of the piles.
<b>Maintenance:</b>	After the first site visit was completed on May 12, 2011, the most pronounced distressed area of the highway surface was patched in the fall of 2011; patched again in fall 2012; cracks opened again and sealed in the early spring of 2013; cracks were sealed in June 2014. ACP patch

	was completed after construction in the fall of 2017.	
<b>Observations:</b>	<b>Description</b>	<b>Worse?</b>
<input type="checkbox"/> Pavement Distress	Reflective cracks 10 to 20 mm wide, no drop	<input checked="" type="checkbox"/>
<input type="checkbox"/> Slope Movement	N/A	<input type="checkbox"/>
<input type="checkbox"/> Erosion		<input type="checkbox"/>
<input type="checkbox"/> Seepage		<input type="checkbox"/>
<input type="checkbox"/> Bridge/Culvert Distress		<input type="checkbox"/>
<input checked="" type="checkbox"/> Other	Sharp drop off on the west side of highway due to previous ACP patches; cattails in the south ditch	<input type="checkbox"/>
<b>Instrumentation: (1SAA, 16SIs, 7PNs, 5SPs, 16VCs, 18SGs)</b>		
<p>The following provides the slope inclinometers' rate of movements in the Spring of 2023:</p> <ul style="list-style-type: none"> <li>• SI15-15 (located in the east ditch within the southern limit of the landslide) = 0.7 mm/yr.</li> <li>• SI15-16 and SI15-21 (located near the west edge of the highway downslope of the pile walls) ranged between 0.1 and 0.5 mm/yr.</li> <li>• SI12-11, SI15-17, SI15-20 (located at the bottom of the highway west side slope) ranged between -0.1 and 0.4 mm/yr.</li> </ul> <p>Total pile head movement:</p> <ul style="list-style-type: none"> <li>• N24C tied-back pile wall: SI16-1= -6.2 mm, SI16-2 = -3.5 mm, SI16-3 = -2.9 mm, SI16-5 = -1.0 mm.</li> <li>• N24C Interim pile wall: SI17-1= 5.3 mm, SI17-2 = 10.4 mm, SI17-3 = 16.7 mm, SI17-4 = 10.6 mm, SAA17-1 = 2.0 mm.</li> </ul> <p>Vibrating wire load cell readings ranged from 173 kN to 254 kN; The readings of the strain gauge, installed in Pile 146 of the NC24C Interim pile wall, showed relatively small change in micro-strain.</p> <p>Groundwater levels fluctuated in the piezometers and ranged from an increase of 0.1 m in SP15-16 to a decrease of 0.3 m in PN15-21.</p>		
<b>Assessment (Refer to attached Figure):</b>		
<p>The site condition has not changed significantly since the 2021 site inspection visit.</p> <p>The site observations and instrumentation readings indicate that implemented remedial measures have been effective in stabilizing the landslide mass. Reflective highway surface cracks may however get wider over time until the pile wall mobilizes the full magnitude of the stabilizing force.</p> <p>The interim pile wall has been performing satisfactorily. There is no immediate need to install the full retaining system at this location. The pile head deflections are still below the revised threshold (i.e., 57 mm), recommended by the structural consultant, GeoMetrix.</p> <p>The presence of cattails in the ditch may indicate poor surface drainage in the ditch, but this will need to be confirmed through further monitoring of the site. Poor drainage, and possibly water ponding, in the ditch can result in elevated groundwater levels and an accelerated landside movement at the interim pile wall location.</p> <p>The existing sharp drop off near the edge of pavement still constitutes a safety hazard to runaway vehicles.</p>		

**Recommendations:**

This site should be visited again in the spring of 2025, as per the GRMP's schedule.

The local MCI should watch closely for the development of new cracks or widening or existing cracks in the highway surface. Open cracks should generally be sealed to reduce surface water infiltration into the landslide mass.

The local MCI should also check whether the south ditch is draining towards the C2 pipe and the twin culverts. If water is ponding within the ditch, consideration should be given to re-grading the ditch to promote positive drainage.

Consideration should be given for placing the least amount of fill off the highway surface to smoothen the existing sharp drop off and eliminate the existing hazard. Otherwise, sharp shoulders warning signs should be erected to warn the motorists of the existing hazard.

**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

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





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**Photo No. 1 - Looking north at highway surface; no reflective cracks or dips noted at the south end of the site**



**Photo No.2 - Looking northeast at the twin culverts outlets; Sediment and silt fence cleared; no flow in 2023**



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**Photo No.3 - Looking at the twin culverts inlets; no flow**



**Photo No.4 - Looking north at the TRM lined ditch; no water flowing; note cattails in the ditch area**



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**Photo No.5 – Looking north at sharp shoulder drop off on the west side slope**



**Photo No.6 - Looking at data logger DT1 installed at pile 146 location; vegetation grew at previously noted subsidence at the base of the data logger**



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**Photo No.7 – Looking south at reflective cracks 10 to 20 mm wide, no drop**



**Photo No. 8 – Looking south at reflective cracks 10 to 20 mm wide, no drop**





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**Photo No. 9 – Looking south at ditch and a gully lined with TRM**