

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
NORTH CENTRAL REGION – ATHABASCA &
FORT MCMURRAY DISTRICTS
2022 SITE INSPECTION**



Site Number	Location	Name	Hwy	km
NC006	11 Km East of Slave Lake	Mitsue Recreation Area	2:46	47.33
Legal Description		UTM Co-ordinates (NAD 83)		
NW-7-72-4-W5M		11	N 6122200	E 651552

	Date	PF	CF	Total
Previous Inspection:	June 23, 2021	14	5	70
Current Inspection:	June 07, 2022	14	5	70
Road AADT:	2,240	Year:		2022
Inspected By:	José Pineda, Tarek Abdelaziz (Thurber) Gordon Wolters, Arthur Kavulok, Amy Driessen, Rishi Adhikari (Alberta Transportation)			
Report Attachments:	<input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input type="checkbox"/> Maintenance Items			

Primary Site Issue	Active landslide causing severe deterioration to highway conditions	
Dimensions:	About 80 m wide (parallel to the highway alignment) and 60 m long (perpendicular to the highway alignment)	
Site History:	<p>In the Spring of 2019 Mr. Gordon Wolters, local MCI of AT, noticed a sudden severe depression on the highway surface. AT requested Thurber to conduct a call out.</p> <p>During Thurber's inspection on June 10, 2019, it became clear that the current landslide area is adjacent to a previously repaired landslide in 2007 (previously known as NC06-1).</p> <p>The repairs at the NC06-1 site included the installation of surface and sub-surface drainage improvement measures and the construction of a toe berm to stabilize the landslide movement. The drainage improvement measures consisted of installing sub-drains, constructing a riprap lined swale, flushing, and tying older sub-horizontal drains to a drainage collection manhole at the bottom of the slope. The site NC06-1 was inspected by Thurber as part of the GRMP until 2012 when it was determined that the 2007 remedial measures appeared to have mitigated the slope movement. The instruments installed at the old landslide site are not read under the current GRMP.</p> <p>In 2020, Thurber installed geotechnical instruments, consisting of slope inclinometers and vibrating wire piezometers, within the active landslide area to assess depth of movement and soil and groundwater conditions. These instruments are currently read under the GRMP.</p>	
Maintenance	ACP patch placed in 2021 on the west bound lane covering most of the landslide impacted section of the highway.	
Observations:	Description	Worse?
<input checked="" type="checkbox"/> Pavement Distress	25 mm dip noted on the western portion of the 2021 ACP patch.	<input type="checkbox"/>

<input checked="" type="checkbox"/> Slope Movement	Reflective landslide within the 2021 ACP patch area; eastern flank diagonal cracks, located outside the patched area, are up to 50 mm wide and with a 10 mm drop across the crack surfaces multiple tension cracks on the north side slope; depression in the north side slope between the culvert outlet and the eastern edge of the bush; guardrail displaced laterally by approximately 250 mm to the north (middle section of the landslide); titling and bent trees in the bush; distinct toe roll in the bush	<input type="checkbox"/>
<input type="checkbox"/> Erosion		<input type="checkbox"/>
<input checked="" type="checkbox"/> Seepage	Water flowing under the 760 mm CSP culvert inlet	<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert Distress	760 mm CSP culvert outlet was damaged; restricted water flow from culvert outlet	<input type="checkbox"/>
<input checked="" type="checkbox"/> Other	Settlement of drill benches, constructed in the winter of 2020 to install geotechnical instruments, created severe open cracks in the highway side slope; the upper settlement crack is about 1 m from the highway guardrail; water ponding within the highway south ditch	<input type="checkbox"/>

Instrumentation Readings (4 SIs and 7 VWs):

SI20-1, installed in the south ditch of the highway, and SI20-4, installed further downslope of the potential toe of the active landslide, continued to show no discernable movement.

SI20-2 and SI20-3 installed within the extent of the active landslide have shown movements within the upper 3 m. SI20-2 which is closer to the top of the highway embankment showed a maximum rate of movement of 287 mm/yr in the spring of 2021. In the spring of 2022, SI20-2 did not show any discernible movement, and SI20-3 showed a rate of movement of 4 mm/yr. However, SI20-2 was repaired in the spring of 2022 and hence the most recent reading may not reflect the actual movement rate in this SI.

The vibrating wire piezometers showed groundwater depths ranging from 1.1 m in VW20-4A to 7.2 m in VW20-1.

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

The re-appearance of landslide cracks on the ACP patch, and the presence of a dip on the highway surface suggest that the landslide continued to be active.

The LiDAR data suggests that the highway was originally built in a landslide terrain. It appears that the placement of up to 7 m of fill and high groundwater conditions are the main triggers of the active landslide movement.

The ACP patched placed in 2021 has improved the driving conditions. However, the highway condition is expected to continue deteriorating until an effective remedial measure is implemented.

The surface water in the south ditch was noted to be draining under the highway centerline culvert. The outlet of the culvert previously noted to be lower than adjacent terrain has kept the water ponding inside the culvert outlet until it overflows to drain into the gully.

The site observations and past instrument monitoring have indicated that the landslide is very active and is moving at high rates. If the landslide continues to move at high rates, additional landslide retrogression could result in partial or full road closure and a major detour may be required.

The open cracks noted in the highway side slope are likely due to the settlement of the winter drilling benches after spring thaw. These cracks, if noted sealed, will likely impact the stability of the side slope, and retrogress back to impact the integrity of the guardrail and the highway surface.

Recommendations:

It is recommended that this site be visited again in 2023.

In the short term, the local MCI should monitor the highway periodically for signs of distress and watch closely for the development of additional retrogressive cracks and highway dips (particularly after prolonged rainfall events). Any open surface cracks should be sealed to prevent surface water infiltration into the landslide mass, which would result in further landslide movement and retrogression. Speed reduction signs should also be used, if the highway condition deteriorates significantly, to warn motorists of the existing hazard.

The south ditch should be slightly re-graded to direct surface water towards the culvert inlet. The final ditch surface should be lined with TRM type C for erosion protection. The existing culvert should be grouted and replaced with a new pipe. Riprap protection should be provided at the inlet and outlet locations of the new pipe.

The cracks developed within the north side slope in response to the failure of the winter drilling benches are currently vegetated and may stabilize with time. These cracks should however be monitored, and a bobcat should be used to slightly contour and seal these cracks, if needed.

Since the landslide is very active and the failure of the highway lane(s) may occur abruptly, it is recommended to get the site repaired in the near future. The repair may include any of the following options. These options are based on the preliminary engineering assessment completed for this site.

Option 1: Reinforce the slip surface through the construction of a 15 m deep cantilever pile wall, 3 m away from of the northern edge of the highway. The ballpark cost of a 100 m long cast-in-place concrete pile wall would be in the range of \$2,000,000 (excluding engineering). This option does not require land acquisition or regulatory authority approvals.

Option 2: Buttress the landslide through the construction of a large toe berm on the north side of the highway. The construction of the berm will require significant tree clearing and timber salvage, and the extension of the existing culvert under the berm to convey the flow from the outlet of the culvert to the natural gully located to the north of the berm. This option will require a borrow source, environmental permits/approvals, historical resources review, and land acquisition. The ballpark cost for this option would be in the range of \$1,500,000 (excluding engineering). This option should ideally be implemented under warm weather conditions.

One of the main disadvantages of Option 2 is the requirement for a 36-month waiting period to confirm that the identified pileated woodpecker nest within the footprint of the toe berm is abandoned. Due to the active nature of the landslide, Option 1 is the recommended option to remediate this site.

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 | Senior Geotechnical Engineer

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



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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.

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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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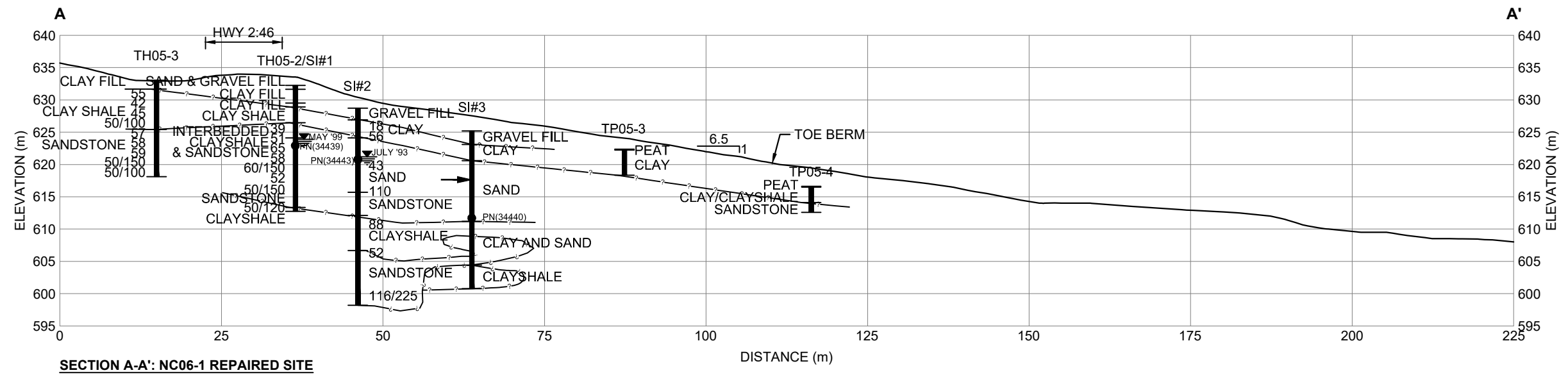
- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification 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

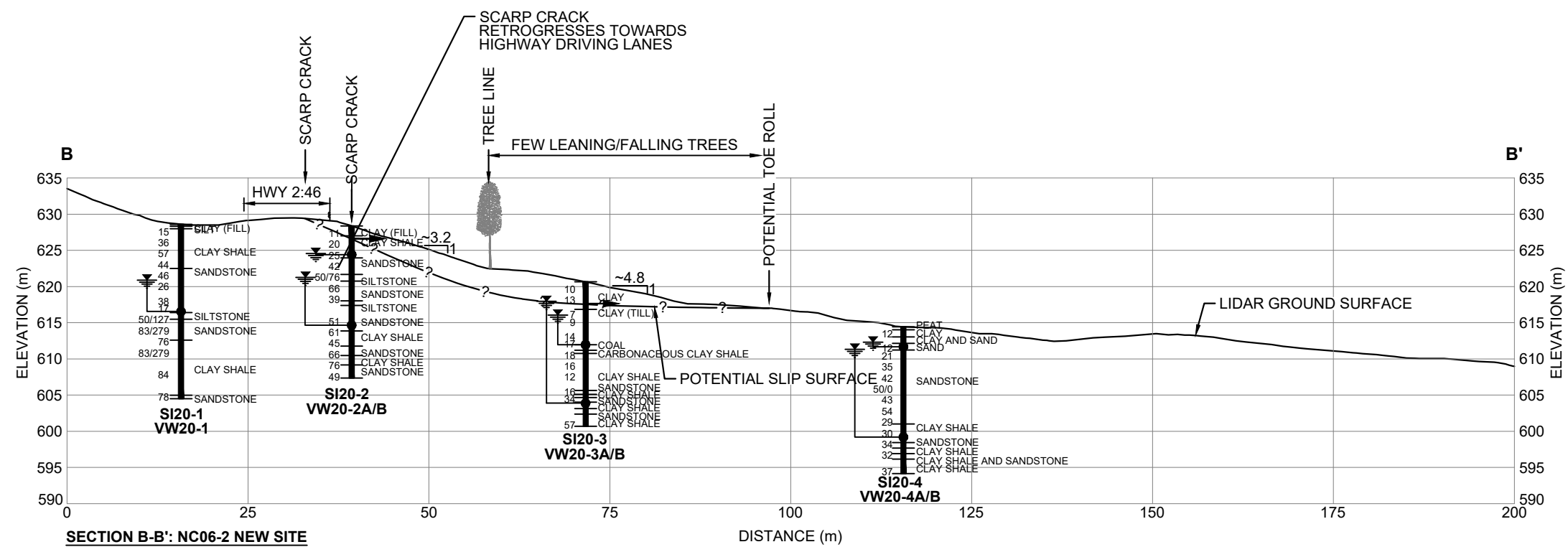
Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, 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.

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SECTION A-A': NC06-1 REPAIRED SITE



SECTION B-B': NC06-2 NEW SITE

- LEGEND**
- 15 I SPT N VALUE
 - ☼ WATER LEVEL IN PIEZOMETER
 - PNEUMATIC PIEZOMETER TIP LOCATION
 - DEPTH OF MOVEMENT IN SLOPE INCLINOMETER

NOTE
 DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.




**NORTH CENTRAL REGION
 (ATHABASCA AND FORT MCMURRAY DISTRICTS)
 2022 GEOHAZARD ASSESSMENT**

**NC006: HWY 2:46 MITSUE RECREATION AREA (km 47.6)
 CROSS-SECTIONS**

FIGURE 2

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:750
DATE	SEPTEMBER 2022
FILE No.	32122



THURBER ENGINEERING LTD.



Photo No. 1 – Looking east toward the landslide and 2021 ACP patch; more vegetation grew on the highway side slope



Photo No. 2 – Looking east at reflective cracks near the eastern limit of the landslide



Photo No. 3 – Most active landslide block impacting the highway (middle section of landslide block); note the presence of multiple retrogressive cracks impacting the highway WBL



Photo No. 4 – Looking west toward the landslide and 2021 ACP patch; landslide cracks extend beyond the patched area



Photo No. 5 – Looking west at the most active area; note guardrail bowing out by 250 mm



Photo No. 6 – Looking south at highway side slopes; more vegetation noted in 2022



Photo No. 7 – Looking west at active landslide cracks on the highway side slope; these cracks may reflect the failure of the restored drill benches constructed in the winter of 2020. to install the instrumentation.



Photo No. 8 – 760 mm diameter culvert inlet. Culvert was rusty and filled with garbage



Photo No. 9 – Looking north at patched potholes on the east bound lane



Photo No. 10 – Looking at wet area within the south ditch to the east of the 760 mm CSP culvert inlet location