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

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
NC077-1	Approximately 25 km west of Slave Lake and 15.5 km east from the junction of Highways 2 and 33	West of Canyon Creek	2:48	26

Legal Description	UTM Co-ordinates (NAD 83)
SE-34-73-8-W5M	11 N 6136974 E 617878

	Date	PF	CF	Total
Previous Inspection:	June 5, 2020	11	3	33
Current Inspection:	June 6, 2022	11	3	33
Road AADT:	2220		**Year:**	2021
Inspected By:	Tarek Abdelaziz, José Pineda (Thurber) Arthur Kavulok, Gordon Wolters, Rishi Adhikari, Amy Driessen (TRANS)			
Report Attachments:	☑ Photographs ☑ Plans ☑ Maintenance Items			

Primary Site Issue:	A landslide affecting the highway north side slope; head scarp crack is located within the highway clear zone	
Dimensions:	About 30 m wide along the highway alignment and 33 m long along the slope direction.	
Site History	The landslide's head scarp was first noticed in the spring of 2012.	
Date of any remediation:	N/A	
Maintenance:	N/A	
Observations:	**Description**	**Worse?**
☑ Pavement Distress	5-200 mm wide longitudinal cracks on highway surface; transverse cracks up to 130 mm wide; 2 m long x 200 mm wide x 100 mm deep pothole on the highway EBL; 1 m long x 260 mm wide x 30 mm deep pothole on the highway WBL shoulder	☑
☑ Slope Movement	0.3 m to 1.4 m drop across the landslide head scarp cracks; most southern head scarp crack is at 4.4 m from white line (no retrogression noted in the 2022 inspection); drop across the western and eastern flank cracks by 0.8 m and 0.9 m, respectively; well-defined toe roll at the bottom of the slope; tilting and falling trees within the bottom of the slope	☐
☐ Erosion		☐
☑ Seepage	Ponding water within slide mass; seepage near the bottom of the slope; ponding water within the highway south ditch above landslide location	☐
☑ Bridge/Culvert Distress	Existing culvert located further east of the site has been noticed to be distorted and water flows from below the outlet of the pipe; accumulated sediments at the inlet of the culvert partially blocked surface water flow into the culvert	☐
☑ Other	A culvert was auger bored to the west of the site location in 2014 to enhance surface drainage in the south ditch; the landslide mass is more vegetated than observed in 2020	☐

Instrumentation: (none)

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

Further retrogression of landslide head scarp crack towards the highway was not observed and overall landslide features such as the distinct toe roll and flanks cracks remained relatively unchanged since the 2021 site inspection visit.

The existing cracks and potholes on the highway lanes may reflect poor/soft subgrade condition due to high ground water levels in this area and/or ongoing deterioration of pavement surface condition.

The presence of seepage and wet surface conditions within the slide mass suggests that the landslide movement occurred in response to a rise in ground water conditions. Poor surface drainage in south ditch, as noted in previous years, could have aggravated the situation.

The highway condition has not yet been impacted by the landslide movement. However, accelerated landslide movements may occur in the future in response to further rise in groundwater levels (e.g. due to heavy rainfall events). Accelerated landslide movement could result in the head scarp retrogression into the highway driving surface and/or appearance of landside-related cracks in the highway driving lane(s) due to partial loss of lateral support from the moving mass.

The existing drop within the highway north side slope constitutes a potential hazard for runaway vehicles.

Recommendations:

It is recommended to visit this site again as scheduled in the spring of 2024.

In the short term, the local MCI should watch closely for any cracking on the highway surface and periodically measure the distance between the landslide head scarp crack and the edge of the highway (at least twice a year between the spring and fall seasons). The existing potholes should be filled with ACP and open cracks on the highway surface should be sealed to prevent surface water infiltration into the landslide mass, which would result in further landslide movement and retrogression into the highway surface. A sharp shoulder warning sign should be placed to warn motorists of the present hazard. Consideration should also be given to installing a guard rail along the edge of the highway to protect runaway vehicles.

The south ditch should be slightly re-graded in the short term to drain the surface water into the existing culvert, located to the east of the site. The area surrounding the inlet of the culvert should also be cleaned of sediments to enhance surface water flow into the culvert. Consideration should also be given to digging narrow shallow trenches (perpendicular to the highway alignment and not exceeding 0.5 m wide x 0.5 m deep) within the landslide mass using a long reach excavator to drain ponded water and promote drainage within the landslide area.

An intermediate-term repair option might include reinforcing the side slope area above existing headscarp. In this option, 6 m long soil nails installed in 1x1 m^2 grid pattern should reduce the risk/rate of headscarp retrogression into the highway shoulder and lanes. The ballpark cost of this option would be in the range of $130,000. The estimated cost might become lower if the mobilization of the equipment could be shared with other sites.

The following options may be considered in the long-term to remediate the landslide.

1. Excavate and replace the landslide mass with gravel: In this option, sub-drains should be included within the gravel replacement zone to prevent future rise in ground water levels. This option will require negotiations with utility companies and land acquisition. The ballpark cost of this option would be in the range of $700,000.

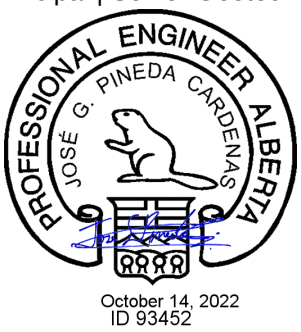
2. Construct an earth-fill toe berm to buttress the landslide mass: In this option, it will be required to locate a borrow source and construct a riprap-lined swale to divert the drainage gully around the edges of the toe berm. This option will also require negotiations with utility companies and land acquisition. The ballpark cost of this option would be in the range of $500,000.

Prior to the design and implementation of a preferred remedial measure, it is recommended to drill at least one test hole within the landslide mass to determine soil and groundwater conditions.

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.

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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.

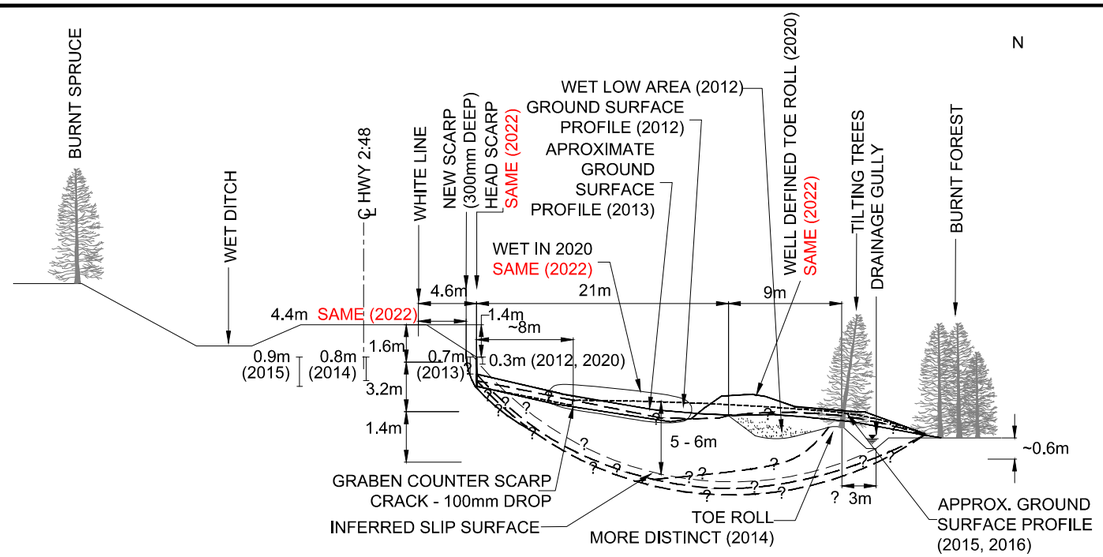
d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted 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.

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.



CROSS SECTION A -A'
APPROX. SCALE: 1:500

0 5 10 15 20 25 30m
APPROX. SCALE 1:500

NOTES:

1. THE DIMENSIONS SHOWN ON THE SITE PLAN AND CROSS SECTION ARE BASED ON SIMPLE FIELD MEASUREMENTS AND MAY DEVIATE FROM THE ACTUAL CONDITIONS.
2. JUNE 6, 2022 OBSERVATIONS ARE SHOWN IN RED.

LEGEND

- ACTIVE SCARP
- WET/LOW AREA
- FENCE LINE
- TREE LINE
- OVER HEAD POWER LINE
- TELUS LINE
- PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION
- POWER POLE

Alberta

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

NC077-1: HWY 2:48 (km 26)
WEST OF CANYON CREEK LANDSLIDE
SKETCH SITE PLAN & CROSS SECTION A-A'

DWG NO. 32122-NC077-1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	APPROX. 1:500
DATE	OCTOBER 2022
FILE No.	32122

THURBER ENGINEERING LTD.

Photo No.1 – Looking west at longitudinal cracks on the highway surface at the landslide location

Photo No.2 – Looking east at transverse and longitudinal cracks on the highway surface at the landslide location; wide open cracks are more pronounced within the highway EBL

Photo No.3 – Looking north at a 60 to 130 mm wide transverse crack on the highway surface to the east of the landslide location; Pothole is 1 m long, 260 mm wide, 30 mm deep

Photo No.4 – Looking east at the landslide developed on the highway side slope; head scarp crack measured at 4.4 m from the white line (same as measured in 2020)

Photo No.5 – Looking southeast at the head scarp crack of landslide mass; a distinct toe roll was noted at the bottom of the slope; more vegetation grew within the landslide mass