

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
NORTH CENTRAL REGION – ATHABASCA &
FORT MCMURRAY DISTRICTS
2021 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 5, 2020	14	5	70
Current Inspection:	June 23, 2021	14	5	70
Road AADT:	2,120	Year:	2020	
Inspected By:	José Pineda, Tarek Abdelaziz (Thurber) Gordon Wolters, Arthur Kavulok, Kristen Tappenden, Bernard Ching, Brent Herrick (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	Potholes up to 300 mm wide x 100 mm deep were patched in 2020	
Observations:	Description	Worse?
<input checked="" type="checkbox"/> Pavement Distress	Up to 250 mm drop in the west bound lane shoulder; up to 200 mm wide cracks on the highway surface;	<input checked="" type="checkbox"/>

<input checked="" type="checkbox"/> Slope Movement	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 checked="" type="checkbox"/>
<input type="checkbox"/> Erosion		<input type="checkbox"/>
<input checked="" type="checkbox"/> Seepage	Water flowing under the 900 mm CSP culvert inlet	<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert Distress	900 mm CSP culvert outlet was damaged; restricted water flow from culvert outlet	<input checked="" 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 800 mm from the highway guardrail	<input checked="" type="checkbox"/>

Instrumentation Readings (Spring 2021):

Two instruments installed within the extent of the active landslide (SI20-2 and SI20-3) have shown movement within the upper 3 m. During the recent Spring 2021 readings, SI20-2 which is closer to the top of the highway embankment showed a rate of movement of 287 mm/yr. Whereas SI20-3, showed a rate of movement of 22 mm/yr. SI20-1, installed in the south ditch of the highway, and SI20-4, installed further downslope of the potential toe of the active landslide, have not shown discernable movement.

The vibrating wire piezometers showed groundwater depths ranging from 1.23 m in VW20-4A to 6.76 m in VW20-1.

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

The site condition has deteriorated since the 2020 site visit.

The highway was constructed as a cut and fill section at the landslide location. 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 active landslide is about 80 m wide and 60 m long, and it has created a severe drop within the highway WBL (particularly within the middle section of the landslide) and a distinct distress in the highway north side slope.

The LiDAR suggests that there is a dormant ancient landslide located west of the active landslide. This dormant landslide may also become active in the future and could impact the highway conditions.

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. Recent winter benching for instrument installation further impacted the culvert outlet by further restricting the surface water free flow into the gully. These factors may have resulted in high ground water levels in the highway embankment.

The site observations and instrument monitoring indicate that the landslide is very active and is moving at high rates. The drop in the westbound lane is significant and constitutes a safety hazard to motorists. 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, and will likely impact the stability of the side slope and retrogress back to impact the integrity of the guardrail and the highway surface.

Recommendations:

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). Consideration should be given to placing ACP patch along the impacted section of the highway by the landslide movement to eliminate existing hazard and provide a smooth ride to motorists. The thickness of the patch should be the minimum needed to eliminate existing hazard without overloading the landslide mass.

If it is not planned to place ACP patch in the near future, all highway 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, as needed, to warn motorists of existing hazard.

The south ditch and north side slopes should be slightly re-graded to direct surface water towards the culvert and provide suitable surface drainage into the gully located north of the highway. The culvert inlet and outlet should be cleared of garbage and sediment and slight grading should be done near the inlet and outlet locations to prevent water ponding near culvert ends.

A bobcat should be used to slightly grade and contour the drilling benches and seal the settlement cracks within the north side slope.

Since the landslide is very active and 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:

Option 1: Reinforce the slip surface through the construction of a cantilever pile wall 3 m north of the edge of the highway. The ballpark cost of a 100 m long cast-in-place concrete pile wall would be in the range of \$1,800,000 (excluding engineering). This option is not weather dependent in terms of constructability and it does not require environmental studies, land acquisition or regulatory authority approvals.

Option 2: Buttress the landslide through the construction of a large toe berm and reduce groundwater levels through the installation of sub-horizontal drains connected to a manhole that drains into the gully through an outflow pipe. The construction of the berm will require either extending the culvert under the berm or the construction of a new riprap channel to convey the flow from the outlet of the culvert to the existing gully to the north of the berm. This option will require a common borrow material source; environmental, hydraulic, and historical resources studies; land acquisition; approvals from regulatory authorities for in-stream work, tree clearing; and land acquisition. The ballpark cost for this option would be in the range of \$1,300,000 (excluding engineering). This option should ideally be implemented under warm weather conditions.

There may be additional repair methods that could be considered; however, this should be determined based on the results of the instrumentation and additional analyses as part of the preliminary engineering stage.

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.
Senior Geotechnical Engineer



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.

4. USE OF THE REPORT

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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.

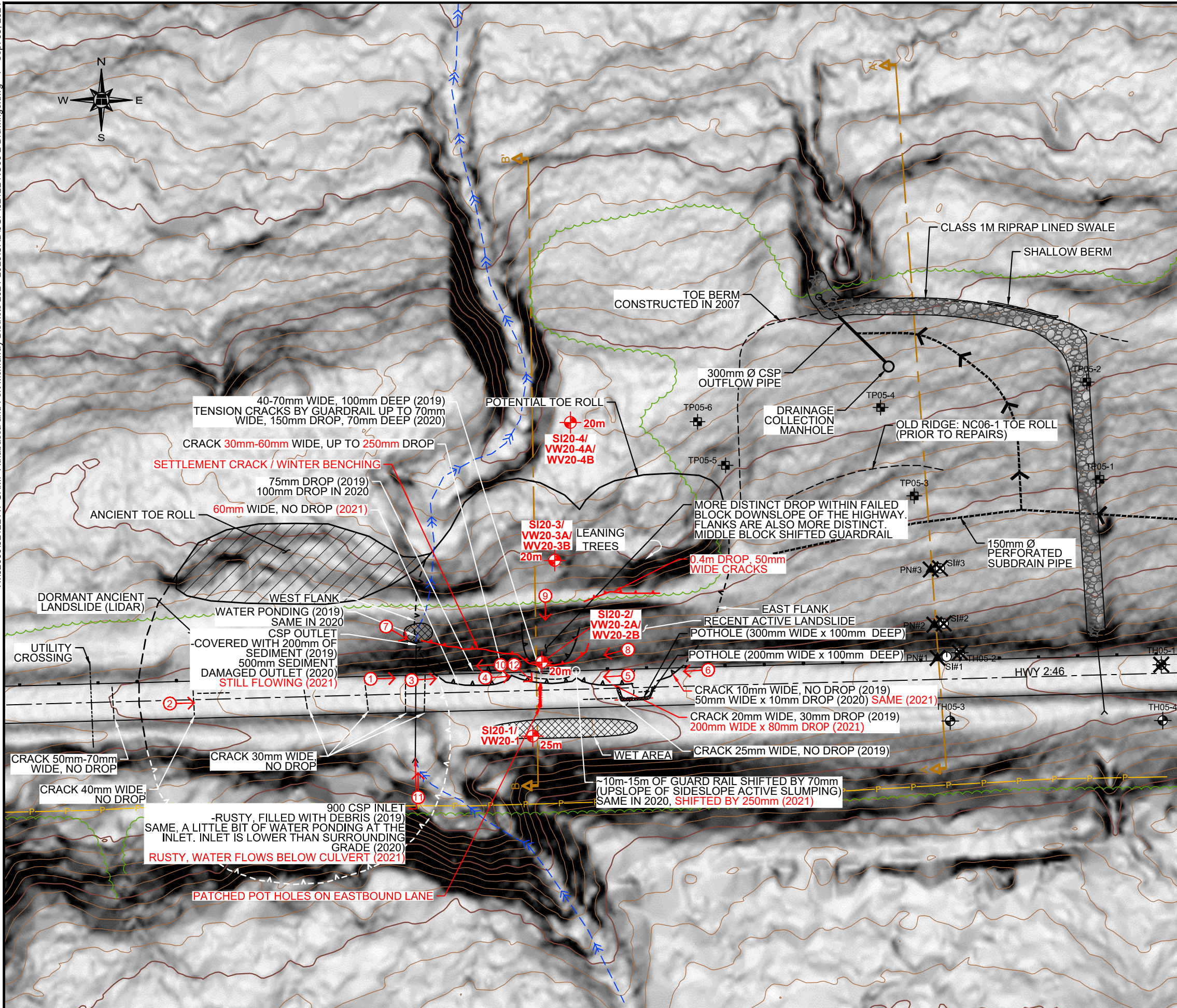
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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

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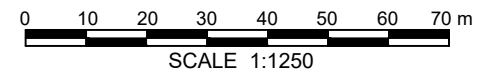


LEGEND

- APPROXIMATE 2020 INSTRUMENT LOCATION (DEPTH (m))
- APPROXIMATE TEST HOLE (TH) LOCATION
- APPROXIMATE TEST PIT (TP) LOCATION
- APPROXIMATE PNEUMATIC PIEZOMETER (PN) LOCATION
- APPROXIMATE SLOPE INCLINOMETER (SI) LOCATION
- INSTRUMENT NON-OPERATIONAL
- ACTIVE HEADSCARP
- DORMANT SCARP CRACK
- CRACK
- GUARD RAIL
- OVERHEAD POWERLINE
- TREE LINE
- GULLY
- 620 GROUND CONTOUR
- APPROXIMATE DIRECTION AND NUMBER OF PHOTO

NOTES:

1. SITE FEATURES ARE APPROXIMATE
2. LIDAR PROVIDED BY ALBERTA TRANSPORTATION
3. JUNE 23, 2021 OBSERVATIONS SHOWN IN RED

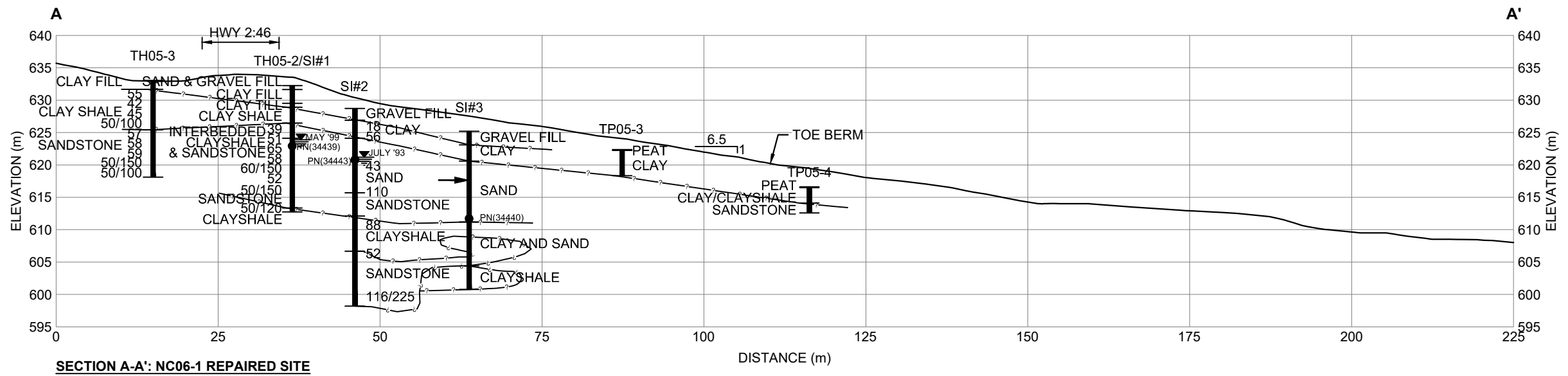


**NORTH CENTRAL
(ATHABASCA AND FORT McMURRAY DISTRICTS)
2021 GEOHAZARD ASSESSMENT
NC06: HWY 2:46 MITSUE RECREATION AREA (km 47.6)
SITE PLAN SHOWING LANDSLIDE FEATURES**

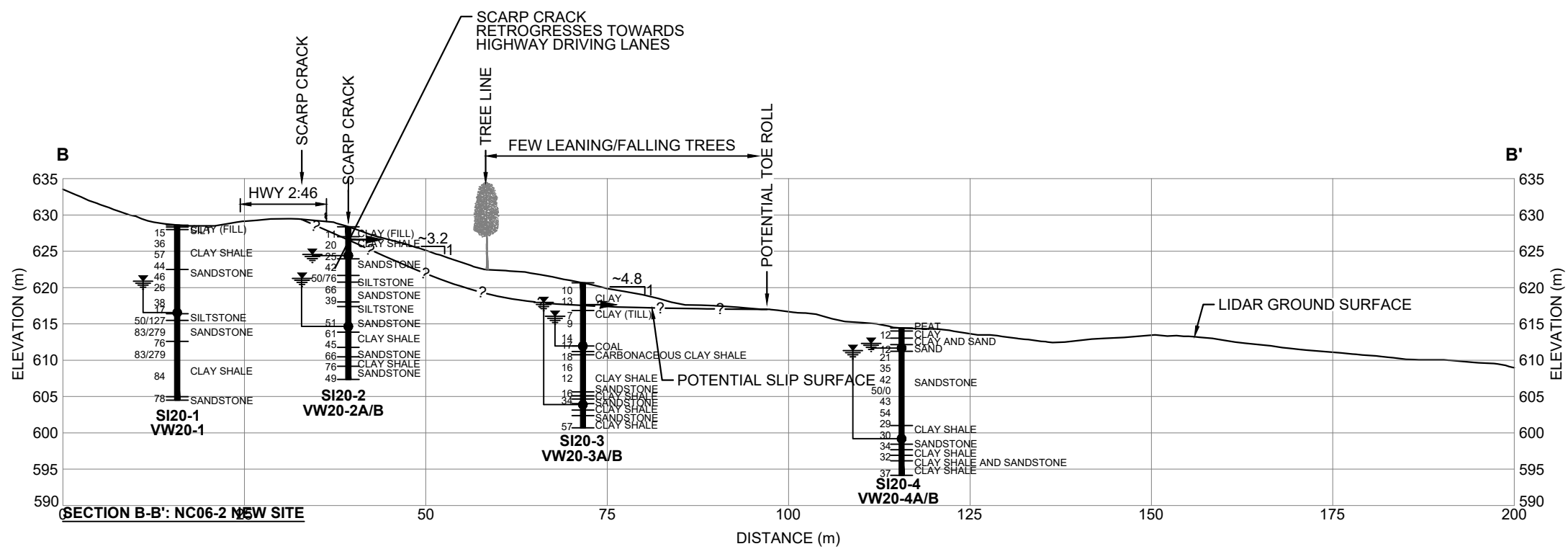
FIGURE 1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:1250
DATE	AUGUST 2021
FILE No.	32122






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)
 2021 GEOHAZARD ASSESSMENT**

**NC06: 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	AUGUST 2021
FILE No.	32122



THURBER ENGINEERING LTD.



Photo No. 1 – Looking east toward the landslide and side slope distress between eastern edge of the tree line and the culvert outlet location. Note flatter side slopes constructed east of the tree line as part of the old landslide repair completed in 2007



Photo No. 2 – Looking southeast at a transverse crack. Note the presence of a natural gully at the back slope as well as power lines



Photo No. 3 – Diagonal cracks on the highway surface near the western flank of the landslide (western section of landslide block)



Photo No. 4 – Most active landslide block impacting the highway (middle section of landslide block). Note multiple retrogressive cracks impacting the highway WBL; cracks are 30 to 60 mm wide X 70 mm deep under the guardrail with up to 150 mm drop



Photo No. 5 – Diagonal cracks to the east of the most active area (up to 200 mm wide with 80 mm drop)



Photo No. 6 – Looking west at the middle section of the landslide block;



Photo No. 7 – Looking at damaged 900 mm culvert outlet. Water is still flowing from the culvert outlet



Photo No. 8 – Side slopes near the landslide head scarp



Photo No. 9 – Looking south at active landslide area



Photo No. 10 - Tension cracks on the side slope extending up to the guardrail



Photo No. 11 – 900 mm diameter culvert inlet. Culvert was rusty and filled with garbage



Photo No. 12 – Looking south at patched potholes on the east bound lane