THURBER ENGINEERING LTD.

September 14, 2023 File No.: 32122

Alberta Transportation and Economic Corridors
Construction and Maintenance Division
North Central Region
Box 4596, 4513 – 62 Avenue
Barrhead, Alberta
T7N 1A5

Attention: Ms. Amy Driessen, P.Eng.

GEOHAZARD RISK MANAGEMENT PROGRAM CON0022163
NORTH CENTRAL REGION (ATHABASCA AND FT MCMURRAY DISTRICTS)
SECTION D CALL-OUT REPORT
HWY 754:06 – NC110 WABASCA LAKE SLIP 'N SLIDE

Dear Ms. Driessen:

This report presents the results of a call-out inspection visit completed at the above-noted site. The site is located on Hwy 754:06 km 30.9 in Wabasca, AB. The legal description of this site is NW SEC 27, TWP 80, RGE 25 W4M.

Mr. José Pineda, P.Eng., of Thurber Engineering Ltd. (Thurber) undertook a call-out inspection on August 24, 2023, in the presence of Messrs. Arthur Kavulok, Gordon Wolters, Rishi Adhikari, and Pramaya Kannel of Alberta Transportation and Economic Corridors (TEC).

It is a condition of this letter that the performance of Thurber's professional services is subject to the attached Statement of Limitations and Conditions.

1. BACKGROUND

This portion of the highway is a two-lane, undivided road with a maximum posted speed limit of 50 km/hr. The 2022 WAADT (Weighted Annual Average Daily Traffic) on this section of the highway is 2,400 vehicles per day.

Based on information provided by TEC, highway surface distress, dips and large cracks have been noted on this site since 2020 and the maintenance crew have been patching this portion of the highway on a yearly basis. The most recent patch was placed just a few days before this call-out inspection.

Based on a review of the area surficial geology, the site is situated on glaciolacustrine deposits consisting of laminated to massive sand, silt, and clay. [1] The sediment thickness is expected to exceed 100 m[2].

2. OBSERVATIONS

During the August 24, 2023, the following site observations were made:

- Sliding terrain was causing highway embankment distress along the south bound lane.
- The extent of the highway embankment distress is approximately 80 m (50 m long on the highway surface and approximately 30 m on the side slopes).
- Cracks on the highway southbound lane surface up to 300 mm wide with a drop of about 200 mm. The cracks on the side slope were up to 1.2 m wide and 200 mm deep.
- A 15 m long and 50 mm dip with twist was noted in the central area of the site.
- During the call-out inspection, highway surface cracks were showing a 50 mm wide gap since the recent ACP crack sealing done by TEC a few days in advance.
- A 300 mm sharp drop off was noted on the west side of the highway driving lane.
- High tension on an overhead cable was causing bending of some power poles due to the landslide lateral ground movement.
- Mr. Wolters was informed by the property owner across the slide that water, and sewer lines run on the east side of the highway. The property owner also indicated that two sink holes had occurred in this area east of the highway possibly due to a failed sewer line.
- Two depressions (150 mm deep and 2 m in diameter) were noted on each side of the property owner's driveway, possibly located above the sewer line.
- The highway side slope is approximately 5 m high and inclined at an angle of about 3.5H:1V in the upper 2.5 m and 8H:1V in the lower 2.5 m.
- There is a treed area about 7 m wide located at the toe of the highway side slope.
- Fiber optic and gas pipeline signs are located along the highway's west side slope.

[1] Alberta Energy Regulator / Alberta Geological Survey. Surficial Geology of Alberta. Map 601. Published 2013

[2] Alberta Energy Regulator / Alberta Geological Survey. Sediment Thickness of Alberta. Map 611. Published 2020

- The land west of the treed area at the bottom of the side slope has water ponding and cattails.

Figures 1, 2, and 3, attached at the end of this letter, include a site plan showing site features and cross-sections across the highway. Selected photographs from the call-out are also included at the end of this letter.

After the callout site inspection, Mr. Arthur Kavulok was informed by the site maintenance foreman that the highway south bound lane has dropped an additional 50 mm between August 24 and September 06, 2023.

3. ASSESSMENT

Based on the above site observations, the distress observed along the highway southbound lane reflects an actively moving landslide. The landslide movement is likely due to the presence of weak foundation soils and high groundwater level. The highway groundwater level is likely due to the proximity of the site to the wetland at the toe of the side slope. Another potential cause for high groundwater levels is the reported sewer line failure that occurred on the east side of the highway.

Based on the site observations, the landslide is about 90 m long (parallel to the highway alignment) and 30 m wide (perpendicular to the highway), and the landside's slip surface is situated about 3 m deep below ground surface.

It is anticipated that the landslide will continue to move at high rates, which could result in complete loss of the highway southbound lanes and possibly the failures of the fiber optics, gas, and the overhead power lines. The highway failure will likely be abrupt, and it may occur in the near future.

4. RISK LEVEL

Based on the TEC's Risk level rating system, the risk level for this site has been assessed as follows:

Risk (130) = PF (13) x CF (10)

This risk level was based on a Probability Factor (PF) of thirteen (active with high rate of movement, steady or increasing) and a Consequence Factor (CF) of ten (sites where the safety

of public and significant loss of infrastructure facilities or privately owned structures will occur if a slide occurs.).

5. RECOMMENDATIONS

The following recommendations should be considered in the short-term:

- Notify the owners of the adjacent infrastructure (gas, fibre, water, sewer, power) about the landslide hazard present in this portion of the highway. Of particular concern is the overhead power line that appears to be about to snap at any time. Water and sewer lines should not have been impacted by the landslide. However, the County should be aware of the situation and inspect the condition of their underground utility lines in this area.
- The MCI should monitor the highway condition on a regular basis, and seal open cracks as they re-appear on the highway surface.
- A warning sign should be placed off the highway surface to warn motorists of the existing hazard due to uneven highway surface.
- ACP patch should be placed on the highway, as needed, to provide a smooth ride to the motorists.
- Depending on the timeline of implementing the long-term repair measure, and if deems acceptable to TEC, consideration may be given at some point to turning the SBL at the landslide location to a gravel road to facilitate maintenance and reduce associated costs with frequent maintenance.

Long-term remedial measures to mitigate the landslide movement at this site may include: (a) reinforcing the landslide's slip plane using a driven steel pile wall installed within the west side slope of the highway, (b) offloading the landslide mass by excavating a portion of the highway SBL and rebuilding the new SBL using Light Weight Fill (LWF) material along with the installation of subdrains/trench drains to reduce ground water levels and prevent flotation of the LWF, and (c) buttressing the landslide mass using an earth fill toe berm on the west side of the highway.

Based on our previous experience with landslide sites of similar conditions and configurations (e.g., Highway 858 near Lac la Biche), driven steel pile wall would likely be the most feasible and the fastest remedial option to mitigate the landslide movement. The pile wall option does not require lane closure, relocations of utilities and/or negotiations with utility corridor owners, environmental permits/ approvals to clear trees and work within the potential wetland area located within the west side of the bush line. It is also expected that the LWF option will be more expensive to construct than the pile wall option.

Due to the high-risk level at this site, it is recommended that the long -term repairs be implemented in the near future.

It is suggested that a geotechnical investigation program, consisting of drilling test holes along with the installation of instrumentation (slope inclinometers and piezometers), be completed before the end of 2023. Consideration should be given to drilling at least three test holes (one in the middle and one at each flank of the landslide) at this site to obtain reasonable coverage within the extent of the landslide. The new instruments should be read at least twice, and then added to TEC's GRMP in the Spring of 2024.

A decision should be made by TEC to whether undertake a preliminary engineering assessment (to explore other remedial options) or to just proceed with the detailed design of the pile wall option for this project after completing the above-mentioned geotechnical investigation. It all depends on TEC's risk tolerance, available budget, and the proposed timeline to repair this site.

The ballpark cost to install a driven steel pile wall at this site would be in the range of $1.5 million (excluding engineering).

THURBER ENGINEERING LTD.

6. CLOSURE

We trust that this letter provides the information you require at present. We would be pleased to answer any questions that you may have regarding this letter.

Yours very truly,
Thurber Engineering Ltd.
Tarek Abdelaziz, Ph.D., P.Eng.
Partner | Senior Geotechnical Engineer

PROFESSIONAL ENGINEER ALBERTA
JOSÉ G. PINEDA CARDENAS
September 14, 2023
ID 93452

PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
RM SIGNATURE:
RM APEGA ID #: 91085
DATE: September 14, 2023
PERMIT NUMBER: P005186
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

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

Attachments:

- Statement of Limitations and Conditions
- Callout Figures 1, 2, and 3 – Site Plan Showing Approximate Site Features and Cross-Sections A-A' and B-B'
- Selected Photographs from the Site Inspection Visit

Cc: Kristen Tappenden, Ph.D., P.Eng.

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.

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

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

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

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.

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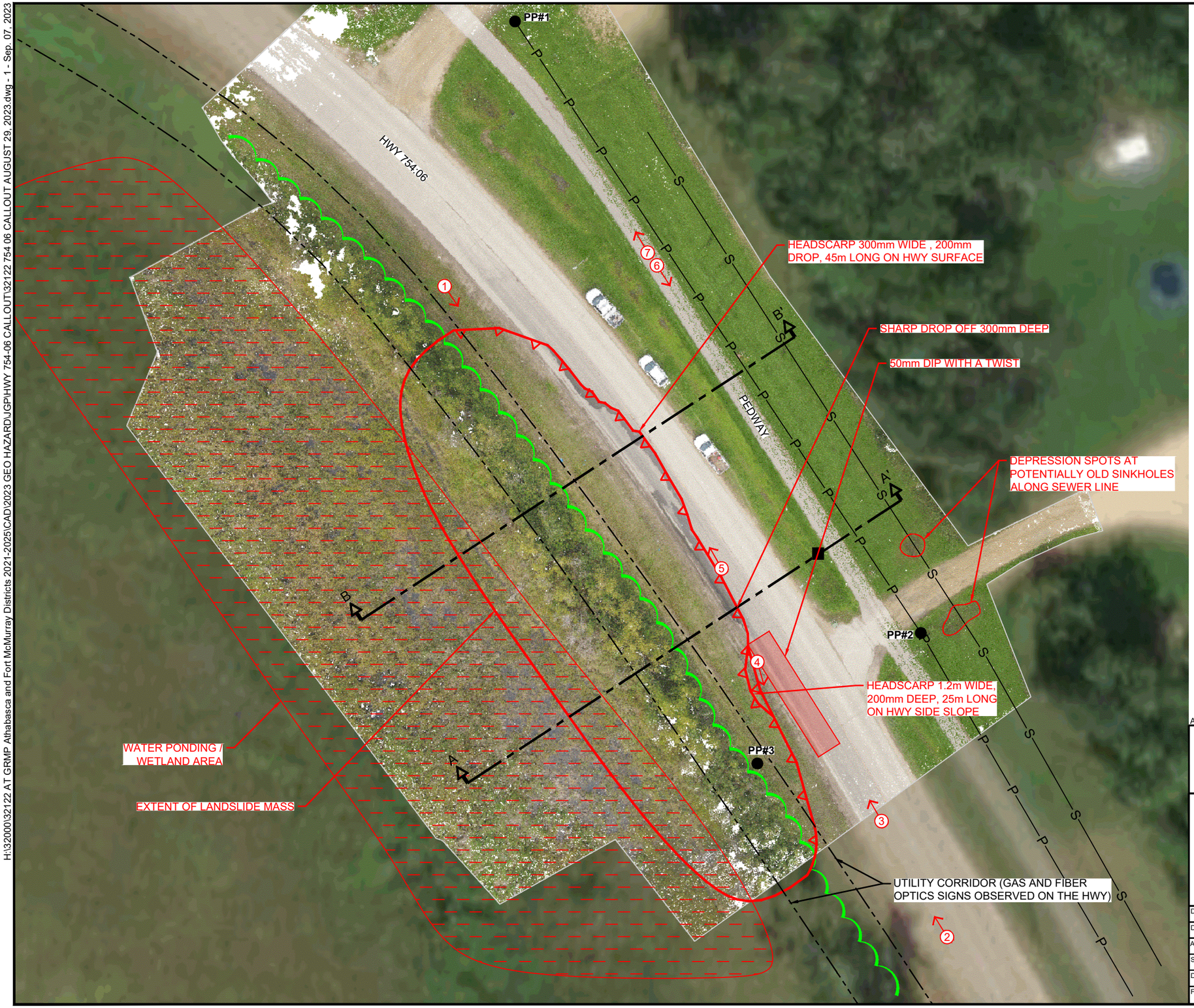

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LEGEND

- ACTIVE HEADSCARP
- TREE LINE
- WATER PONDING / WETLAND AREA
- POWER POLE
- LIGHT POST
- POWER LINE
- SEWER LINE
- PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION

NOTES:
1. SITE FEATURES BASED ON APPROXIMATE FIELD MEASUREMENTS, HAND HELD GPS, AND LIMITED PHOTOGRAMMETRY
2. AUGUST 24, 2023 OBSERVATIONS SHOWN IN RED

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

AIR PHOTO OUTSIDE SITE FROM ESRI WORLD IMAGERY EXPORTED ON AUGUST 29, 2023

Alberta

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

NC110 - WABASCA LAKE SLIP 'N SLIDE
HWY 754:06 km 30.9
SITE PLAN SHOWING APPROXIMATE SITE FEATURES

CALLOUT FIGURE 1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:500
DATE	SEPTEMBER 2023
FILE No.	32122

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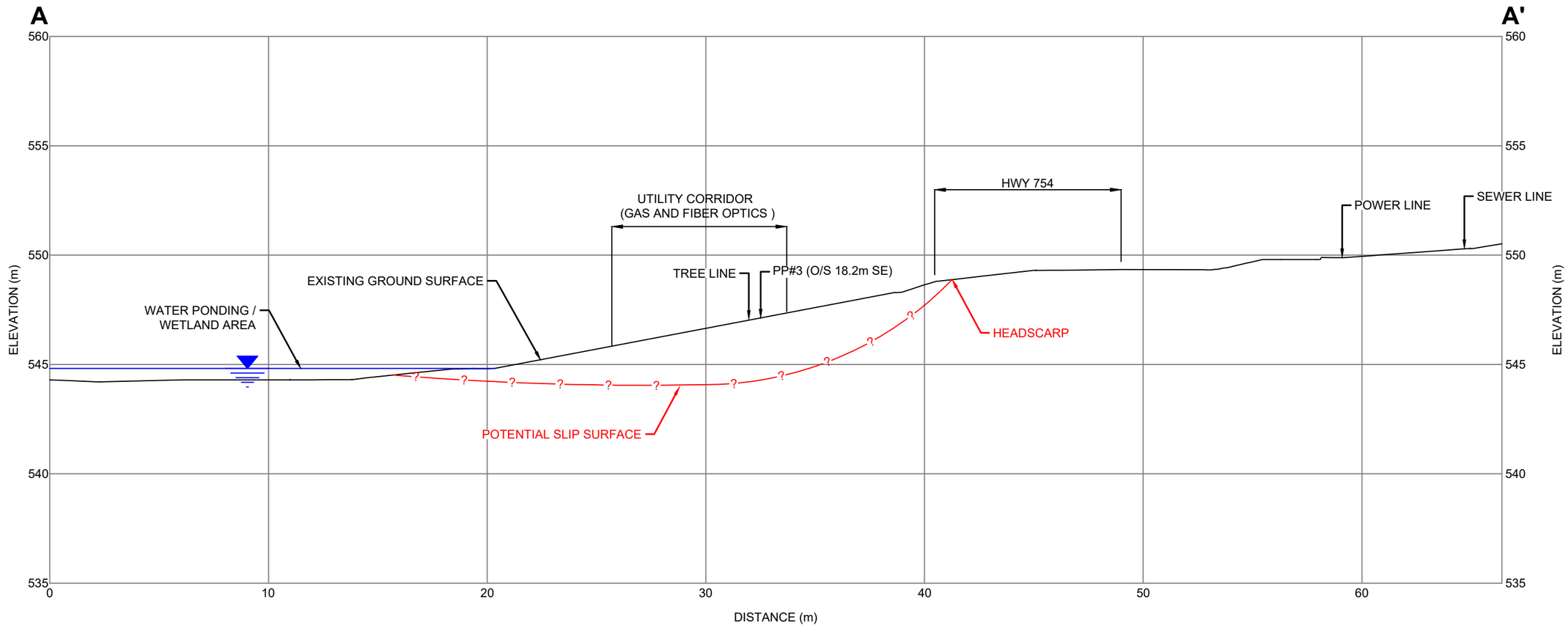

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2. AUGUST 24, 2023 OBSERVATIONS SHOWN IN RED

Alberta

NORTH CENTRAL
(ATHABASCA AND FORT MCMURRAY DISTRICTS)
2023 GEOHAZARD ASSESSMENT
NC110 - WABASCA LAKE SLIP 'N SLIDE
HWY 754:06 km 30.9
CROSS - SECTION A - A'

CALLOUT FIGURE 2

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:200
DATE	SEPTEMBER 2023
FILE No.	32122

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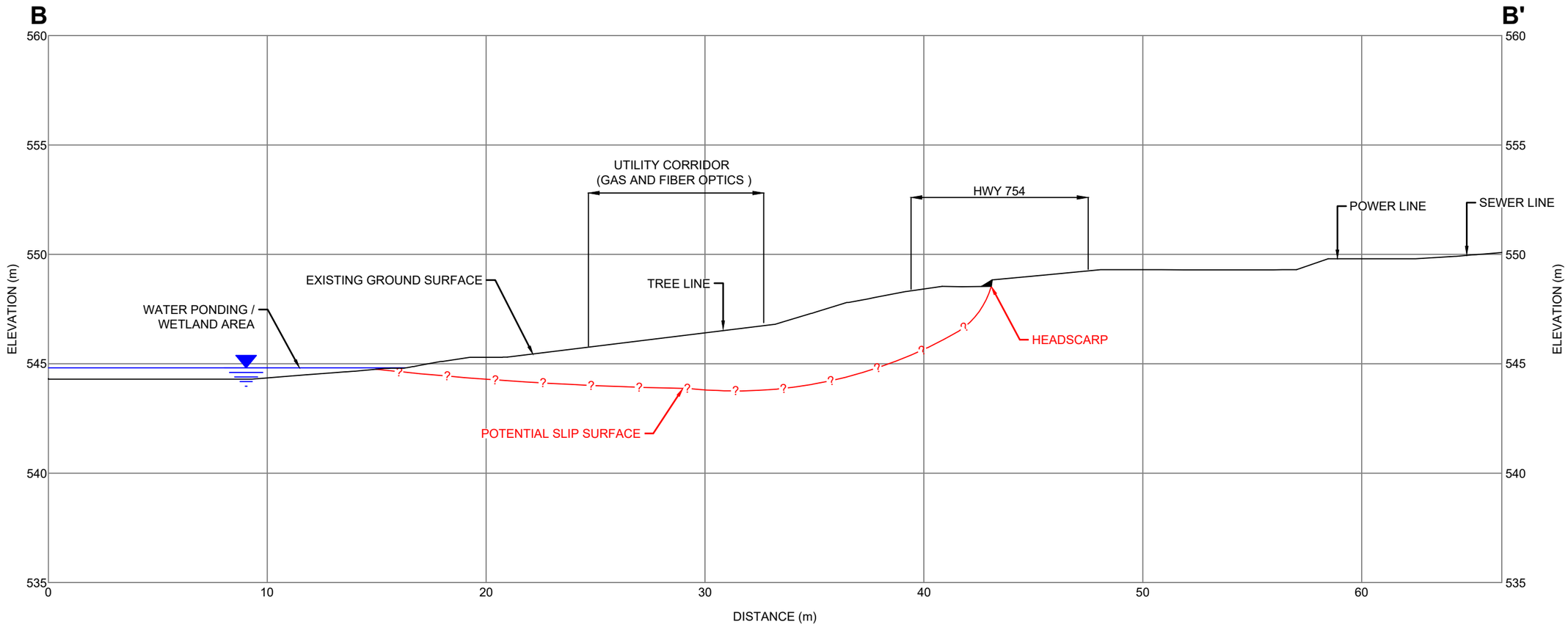

NOTES:
1. SITE FEATURES BASED ON APPROXIMATE FIELD MEASUREMENTS, HAND HELD GPS, AND LIMITED PHOTOGRAMMETRY
2. AUGUST 24, 2023 OBSERVATIONS SHOWN IN RED

Alberta

NORTH CENTRAL
(ATHABASCA AND FORT MCMURRAY DISTRICTS)
2023 GEOHAZARD ASSESSMENT
NC110 - WABASCA LAKE SLIP 'N SLIDE
HWY 754:06 km 30.9
CROSS - SECTION B - B'

CALLOUT FIGURE 3

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:200
DATE	SEPTEMBER 2023
FILE No.	32122

THURBER ENGINEERING LTD.

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Photo 1. Northern flank of landslide. Head scarp crack was patched a few days before August 24, 2023 site visit. Note the sharp drop off on the highway shoulder (approximately 300 mm drop).

Photo 2. Looking north at the landslide area. Anchor Power Pole No. 3 on the LHS and the Power Pole No. 2 on the RHS of the photo are bent due to the high tension in the overhead cable.

Photo 3. Longitudinal cracks (30 mm wide by 30 mm deep) within the previously patched area. There is a 50 mm dip with a twist on the southern portion of the site.

Photo 4. Southern flank of the landslide (looking south); 1.2 m wide x 0.2 m deep landslide crack on the highway west side slope.

Photo 5. Looking north at the severely impacted section of the highway by the landslide movement. Head scarp crack at this section (near the northern flank of the landslide) is 300 mm wide with up to 200 mm drop.

Photo 6. Pedway on the east side of the highway. Note Power Pole No. 2 and Anchor Pole No. 3 tilting due to the landslide movement.

Photo 7. Minor water ponding on the east side of the highway

Aerial Photo 8. Landslide impacting approximately 80 m of highway surface extending from the recent ACP patch placed on the northern flank of the slide to south of Power Pole No. 2 as shown within the black arrows. Note ponding water west of the treed area (bottom part of the photo).