

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION –
GRANDE PRAIRIE DISTRICT - NORTH
2023 INSPECTION**



Site Number	Location	Name	Hwy	km
PH001	Dunvegan	Dunvegan Hill, North	2:68	12.60
Legal Description		UTM Co-ordinates		
NE¼ 08-080-04 W6M		11U E 400694	N 6198867	

	Date	PF	CF	Total
Previous Inspection:	July 15, 2021	6	5	30
Current Inspection:	June 1, 2023	11	4	44
Road WAADT:	2,491		Year:	2022
Inspected By:	Rishi Adhikari, TEC Max Shannon, TEC		José Pineda, Thurber	
Report Attachments:	<input checked="" type="checkbox"/> Photographs	<input checked="" type="checkbox"/> Plans	<input checked="" type="checkbox"/> Maintenance Items	

Primary Site Issue:	A landslide in the highway backslope. Upslope debris flow/rock fall hazard		
Dimensions:	Extends 90 m wide and 90 m north from the highway into the backslope. The lower 30 m of the backslope, where bedrock is exposed is inclined at 1H:1V. The upper 25 m of the backslope where the landslide is located in the colluvium, is inclined at 2H:1V.		
Maintenance:	Debris from upslope slides was removed from the highway surface and north side ditches and shoulders in July 2018 and lock block and jersey barrier walls were erected along the shoulder of the highway to protect the highway from the rockfall hazard.		
Observations:	Description	Worsened?	
<input checked="" type="checkbox"/> Slope Movement	The approximate plan outline of the landslide is shown on Figure 1. The exposed backscarp height at the center of the landslide was about 6 m. A graben had formed along the base of the scarp. The soil exposed in the backscarp, and slide mass appears to consist mainly of silty sand, with some clay and hard/strong sandstone pieces embedded within it.	<input type="checkbox"/>	
<input checked="" type="checkbox"/> Other	Currently, the slide material is toppling over the edge of the steep bedrock slope at a relatively slow rate. The landslide debris has historically accumulated in the SBL ditch was cleaned in 2022. The landslide debris consisted primarily of small chunks and small to large sized slabs of silty weathered sandstone bedrock and colluvium mixed with organics. Some vegetation is starting to grow at the toe of the slide	<input type="checkbox"/>	
Instrumentation:	There are no available records of previous geotechnical investigations and there are currently no instruments installed at the site.		

Assessment:	
<p>In the past, similar landslides and debris flows in this area have typically occurred in the gullies due to the concentration of surface runoff water from heavy rain fall events. The inferred slip surface for this landslide is along the top of the upper sandstone bedrock layer at an approximate elevation 423 m (Refer to Figure 2).</p> <p>This landslide is considered to have been triggered by either a temporary rise in groundwater perched in the colluvium or a concentration of surface water runoff at this location. The primary concern for this site is the potential for further colluvium and weathered sandstone bedrock debris accumulating along the edge of the upper sandstone ledge debris to continue to fall onto the highway causing a risk to public safety. Furthermore, there is also a risk that the cascading landslide debris can dislodge undermined sandstone slabs from the two sandstone layers below that might travel faster and further out into the highway and possibly strike a vehicle.</p> <p>The maintenance contractor has erected concrete lock blocks and jersey barriers to help contain the debris to keep it off the highway. However, there is still a risk that the remainder of the slide debris volume (about 20,000 m³) could fall catastrophically onto the highway in a fast-moving mudslide if it gets saturated during a heavy precipitation event. If the slide material came down in a big single event it could dislodge the concrete barriers and flow out onto and close the highway.</p> <p>The provision of the concrete barriers has reduced but not eliminated the risk of further rock falls to the travelling public.</p>	
Recommendations:	Cost
<p>A warning sign should be posted at the top and bottom of the hill to warn of higher risk of rockfall and mudslide activity particularly during wet weather conditions.</p> <p>If possible, the remaining slide mass should be carefully removed from the top of the slope to reduce the potential for further debris to fall onto the highway below. Due to the possibility of crumbling of the edge of the sandstone bedrock layer, equipment should be kept back at a minimum distance of 3 m from the crest of the steep backslope. This could be accomplished using a long reach excavator that would access the site from privately owned land to the north of the landslide. The excavator would push the failed material over the crest of the slope. This would need to be monitored with spotters equipped with two-way radios positioned at the top of the steep backslope section and along the highway. Once the outer 15 m of the landslide debris has been removed, the backscarp should be flattened to an inclination of 2.5H:1V and the remaining slide debris should be cut-down and flattened as a buttress with a slope angle of 5H:1V. Depending on the extent of the backscarp, this may require the acquisition of privately-owned land above the current landslide.</p> <p>An alternate plan would be to leave the landslide mass to tumble down the backslope at its own rate and complete regular maintenance to remove the fallen debris during dry weather conditions to maintain a storage capacity behind the barriers and allow the ditch to pass runoff drainage. This option is what is currently being done at site but carries a higher risk of injury to the public if an extended period of heavy rain fall occurs.</p>	\$250,000

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.

Don Proudfoot, P.Eng.
Partner | Senior Geotechnical Engineer

Jose Pineda, P.Eng.
Associate | 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

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.

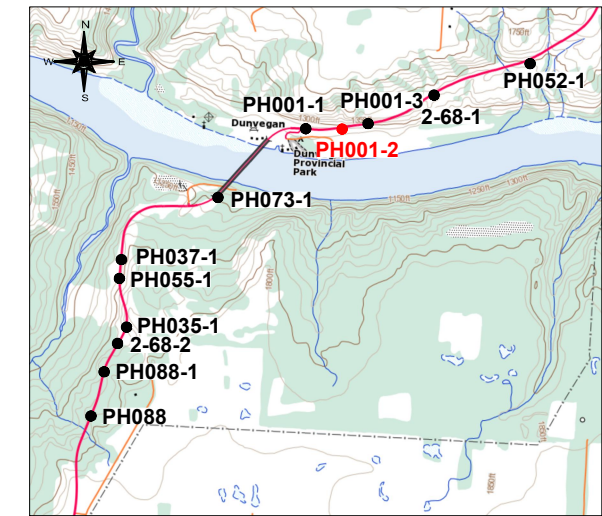
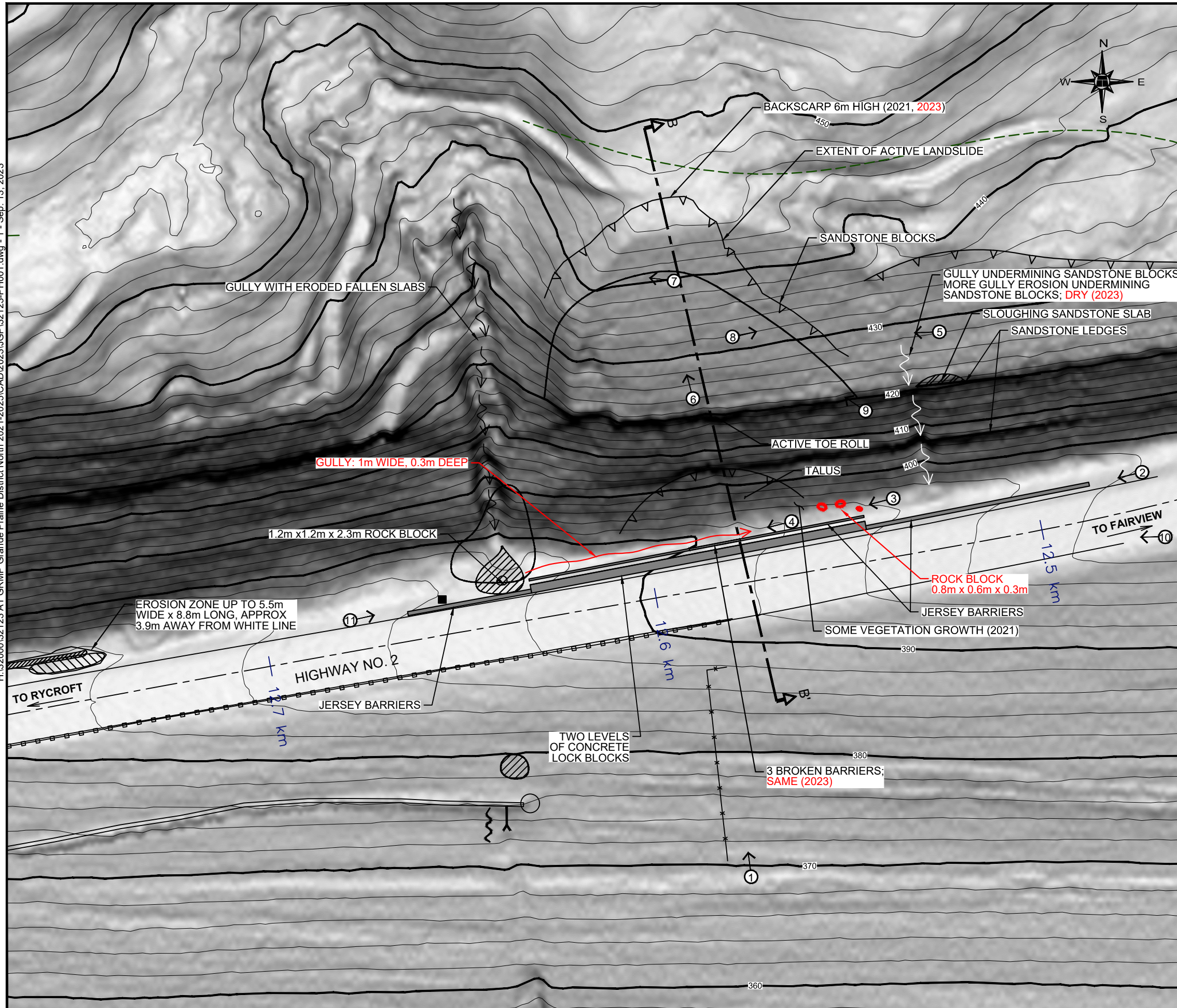
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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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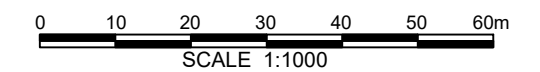
KEY PLAN
SCALE: 1:75 000

LEGEND

- SCARP
- SLOPE BREAK
- GULLY
- DIRECTION AND PHOTO NUMBER

NOTE:

1. JUNE 1, 2023 OBSERVATIONS SHOWN IN RED



PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
PH001 DUNVEGAN HILL - NORTH

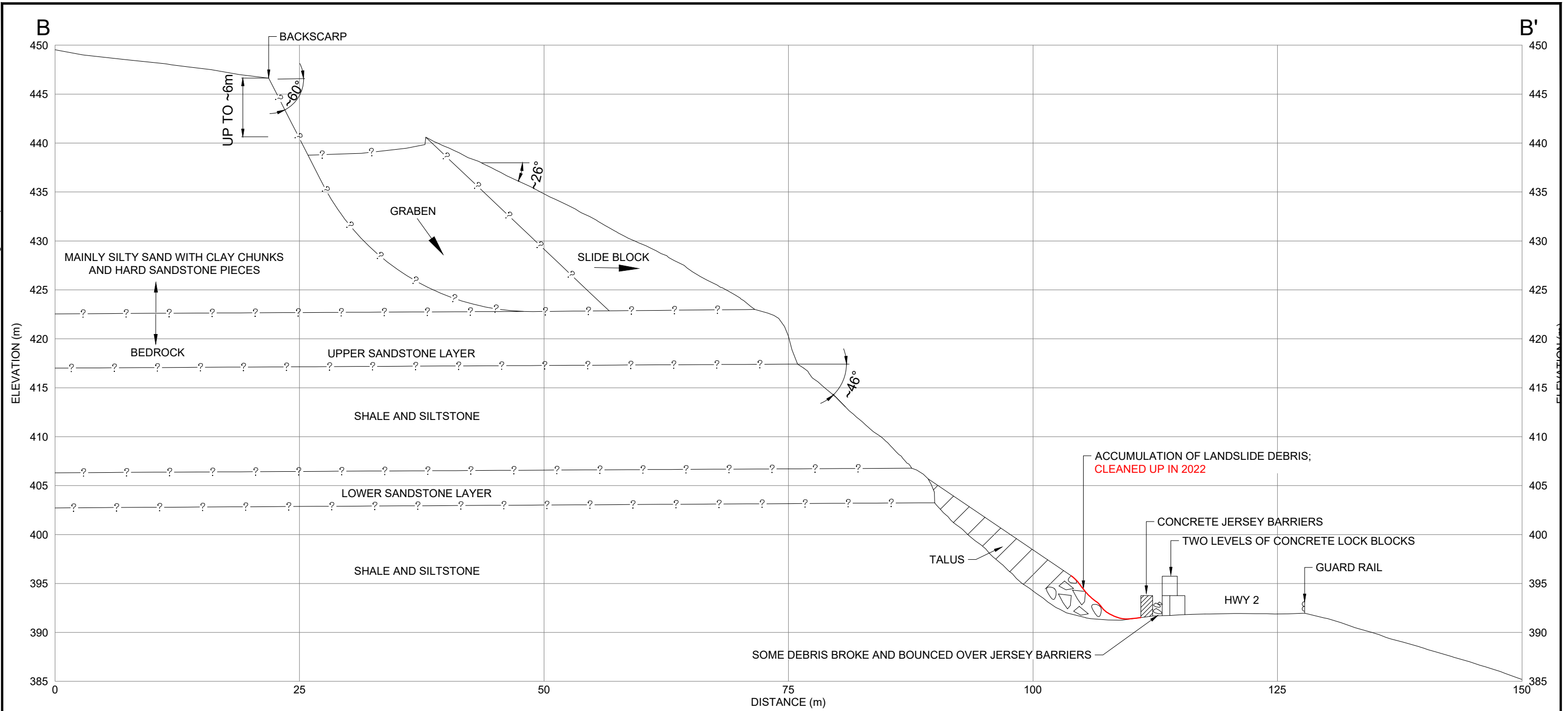
2023 PH001 INSPECTION PLAN


FIGURE 1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	DWP
SCALE	1:1000
DATE	SEPTEMBER 2023
FILE No.	32123



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**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
PH001 DUNVEGAN HILL - NORTH**

CROSS - SECTION B - B'

FIGURE 2

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	DWP
SCALE	1:400
DATE	SEPTEMBER 2023
FILE No.	32123



THURBER ENGINEERING LTD.



Aerial Photo 1: Looking north at the landslide site and surrounding area



Photo 2: Looking west at the highway backslope and concrete barriers below the landslide



Photo 3: Looking west at accumulated debris in the ditch below the landslide.



Photo 4: Area where sandstone slabs, talus, boulders accumulated the most prior to the 2022 clean up.



Aerial Photo 5: Looking northwest where landslide debris has been toppling over the edge of the steep bedrock slope



Aerial Photo 6: Looking northeast along backscarp of the landslide



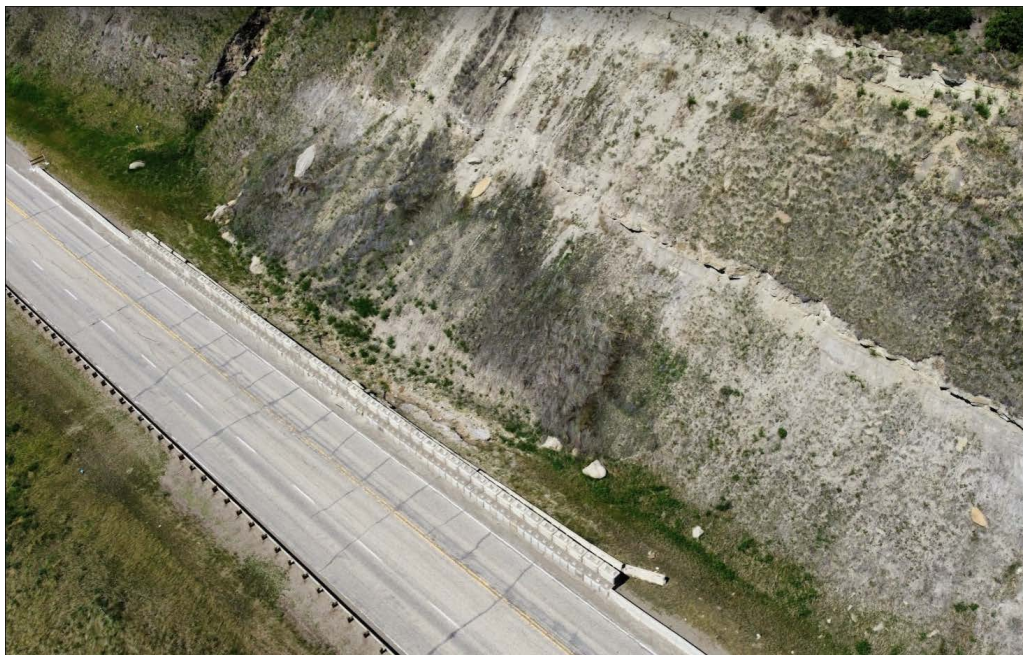
Aerial Photo 7: Looking west landslide backscarp western flank



Aerial Photo 8: Looking east landslide backscarp eastern flank



Aerial Photo 9: Note graben formed along the backscarp, sandstone rock slabs resting on the slope near the bottom, and seepage in the central area developing near the toe of the slide.



Aerial Photo 10: Few recent sandstone rock slabs accumulating behind the Concrete Jersey Barrier



Photo 11: Looking east at steep rock backslope and a few sandstone blocks accumulating behind the Concrete Jersey Barrier |