

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION –
GRANDE PRAIRIE DISTRICT – NORTH
2021 INSPECTION**



Site Number	Location	Name	Hwy	km
PH037	Dunvegan	Dunvegan South 1+250 to 2+000	2:68	15.674
Legal Description		UTM Co-ordinates		
NW¼ 06-080-04 W6M		11U E 398514	N 6197340	

	Date	PF	CF	Total
Previous Inspection:	June 12, 2020	13	8	104
Current Inspection:	July 15, 2021	10	7	70
Road WAADT:	2,380		Year:	2020
Inspected By:	Rocky Wang, TRANS Ed Szmata, TRANS Roger Skirrow, TRANS Max Shannon, TRANS Jason Parr, TRANS		Don Proudfoot, Thurber José Pineda, Thurber	
Report Attachments:	<input checked="" type="checkbox"/> Photographs	<input checked="" type="checkbox"/> Plans	<input checked="" type="checkbox"/> Maintenance Items	

Primary Site Issues:	<p>Flow slides and shallow slumps occur along gullies eroded below the highway where ditch drainage is directed downslope towards Dunvegan Creek at Sta. 2+000.</p> <p>There is a large deep-seated landslide which crosses the highway between Sta. 1+650 and Sta.1+850 (Photos 5, 6, and 7).</p> <p>There are several slides downslope of the SBL shoulder between Sta. 1+350 and 1+650, the largest of these being at Sta. 1+400, with a backscarp that has retrogressed into the highway shoulder (Photos 9, 10, 11, and 12).</p> <p>There are old rotational features further downslope at Sta. 1+860 and at Sta. 1+600 to 1+700, with a sag pond.</p> <p>There are several shallow slumps upslope of the NBL at Sta. 1+455, 1+610, 1+860, 1+900 and 1+985.</p>						
Dimensions:	<p>The 1+800 slide is 160 m to 200 m wide at the downslope road shoulder, and the backscarp appears to be along the upslope ditch.</p> <p>The 1+400 slide is 40 wide at the SBL shoulder, with the backscarp crack on the highway shoulder between the guardrail and the white line about 0.3 m from the white line.</p>						
Maintenance:	<p>An ACP patch was placed over the dip and ruts in the ACP at the south end of the 1+800 slide in October of 2017 and at the north end of the 1+800 slide in 2019. ACP patch was also placed in the summer of 2020 on the northbound lane at the south flank of the 1+800 landslide.</p>						
Observations:	<table border="1"> <thead> <tr> <th></th> <th>Description</th> <th>Worsened?</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> Pavement Distress</td> <td>Dips across road at 1+690 and 1+820 associated with both ends of slide. Cracks and loss of the edge of the paved road in the shoulder of the pavement at 1+400 landslide</td> <td><input checked="" type="checkbox"/></td> </tr> </tbody> </table>		Description	Worsened?	<input checked="" type="checkbox"/> Pavement Distress	Dips across road at 1+690 and 1+820 associated with both ends of slide. Cracks and loss of the edge of the paved road in the shoulder of the pavement at 1+400 landslide	<input checked="" type="checkbox"/>
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<input checked="" type="checkbox"/> Pavement Distress	Dips across road at 1+690 and 1+820 associated with both ends of slide. Cracks and loss of the edge of the paved road in the shoulder of the pavement at 1+400 landslide	<input checked="" type="checkbox"/>					

<input checked="" type="checkbox"/> Slope Movement	<p>Additional slope movement downslope of Sta. 2+000 to 1+900 indicated by cracking at crests of gullies further downslope.</p> <p>Backscarp cracks were noted in the upslope ditch at the Sta. 1+800 landslide.</p> <p>Additional movement in the slide feature below the highway in the sideslopes. The slide at 1+860 has a backscarp that is at 0.8 m from the guardrail (Photo 4).</p> <p>On-going movement in the sliding zone below the highway between Sta. 1+400 to 1+490. The backscarps at this location range between 5 to 7 m high and the slide are impacting the southbound shoulder with cracks at 0.3 m from the white line and four guardrail posts impacted (two posts are hanging and two posts are partially exposed).</p>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Erosion	<p>Up to 2 m wide by 1 m deep erosion gullies in the upslope ditch between 1+590 and 2+000.</p>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Seepage	<p>Some seepage and tension cracks have been observed below the highway at Sta. 1+540.</p>	<input type="checkbox"/>
<input type="checkbox"/> Bridge/Culvert Distress		<input type="checkbox"/>
<input type="checkbox"/> Other		<input type="checkbox"/>
<p>Instrumentation:</p> <p>Fifteen slope inclinometers, 24 piezometers (22 pneumatic and 2 standpipe) were read on July 14, 2021.</p> <p>Overall, the slope inclinometers showed a similar or increasing rate of movement compared to the fall of 2020 readings. New zones of movement were observed in SI18-6 near the 1+800 slide at a depth of 42.4 m. SI18-10 at Station 1+500 also showed a new zone of movement at a depth of 23.2 m.</p> <p>On the northern portion of the site (between Stations 1+300 to 1+600) Slope Inclinometer SI-54 did not show discernable movement whereas SI-55 and SI-56 showed a change in the rate of movement of -3.1 mm/yr to 6.3 mm/yr, respectively. SI18-9 showed a rate of movement of 2.3 mm/yr and SI18-10 showed a rate of movement of 7 mm/yr in the upper 3 m.</p> <p>On the southern portion of the site (between Station 1+600 to 1+900), SI-58 showed a rate of movement of 0.4 mm/yr in the upper 3.6 m. SI-59 showed a rate of movement of 7 mm/yr in the upper 7 m. SI-61 showed a rate of movement of -0.7mm/yr. SI09-7 showed a rate of movement of 0.3 mm/yr from 18.5 m to 20.3 m. SI18-4 showed no discernable movement. SI18-5 showed a rate of movement of 6 mm/yr from 17 m to 20 m depth, SI18-6 showed a rate of movement of 7 mm/yr from 32 to 35 m, and SI18-7 had a rate of movement of 9 mm/yr.</p> <p>Standpipe piezometer SP09-6 showed a water level at 27.4 m below ground surface (no change since the 2020 readings). SP09-8 continued to be dry. Most of the pneumatic piezometers showed an increase in groundwater level compared to the fall of 2020. The change in water levels from the Fall of 2020 readings ranged from an increase of 0.8 m in PN18-9B to a decrease of 0.07 m in PN18-7-C.</p>		

Assessment:

Ongoing slide activity was observed at the Sta. 1+400 slide in 2016 right through 2021. Soil below the matting and around the soil nails, installed in 2010, has failed superficially, with more substantial failure extents below the surface treated area. It is anticipated that the rate of retrogression will likely accelerate above the areas where the soil nails have been bent downward due to a combination of confining soil loss and slope movement. The backscarp located at the shoulder of the SBL ranges between 5 to 7 m high. The SI's installed within the footprint of the 1+400 slide had rapid rates of movement in the spring and summer of 2018 (50 to 700 mm/yr.) and sheared off at a depth of 2 m as a result of mud flow after the fall of 2018.

The 1+800 slide is a deep-seated slide that is currently affecting all three lanes of the highway over a 200 m length with the backscarp likely within the NBL ditch bottom. Based on the ongoing slope inclinometer monitoring, the 1+800 slide plane depth varies within the embankment of the highway from about 18 m near the SBL shoulder to a depth of 28 m below the NBL shoulder with the toe of the landslide likely situated some 300 m further downslope towards Dunvegan Creek. Rates of movement in the 1+800 slide SI's typically vary from small creep movements to 6 mm/yr. and have accelerated to about 20 mm/yr. in recent years. The 1+800 slide continues to exhibit moderate rates of movement up to 9 mm/yr; however, its footprint currently affects the entire highway embankment whereby a complete closure of the highway could result from a sudden increase in slide activity.

The 1+400 slide is retrogressing rapidly and was recently noted to be impacting the SBL shoulder. When considering the existing smaller slide features to the south, this suggests that the expansion of this slide further to the south should be anticipated.

Thurber provided a preliminary engineering assessment report with three remedial options with ballpark "A" cost estimates to address the features affecting the highway through the site in July of 2018.

Shallow surface movement elsewhere is expected to continue, with the possibility of further shallow surface failures developing. This is likely a function of the soil type at this location and is triggered by rainfall or snowmelt and gradual loss of cohesion in the surface due to weathering.

Erosion and slope movement downslope of the highway near Sta. 2+000 are a function of water flows in the ditch and are expected to worsen.

Recommendations:

Cost

Short Term

Consider closing the climbing lane starting at the boat launch turn off to approximately Sta. 1+500. Reduce the posted speed to 80 km/hr.

Maintenance

Continue to monitor visually for sign of activity at both slides and close the outer SBL at the 1+400 slide should tension cracks or dips appear in the roadway surface. Apply small asphalt patches at each end of the 1+800 slide to smooth out the dip when required for traffic safety.

Intermediate Term

\$500,000

Install driven steel pile walls at the Sta. 1+400 landslide location to temporarily maintain the climbing lane until a more permanent repair is implemented.

Long Term

Thurber's preliminary engineering assessment provided three remedial options ranging from a realignment further to the east to completely circumvent the landslide features to maintaining the existing alignment with pile walls built at the 1+400 to 1+800 slides.

\$45 million to
\$110 million

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.
Principal | Senior Geotechnical Engineer

José Pineda, 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.

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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.

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7. INDEPENDENT JUDGEMENTS OF CLIENT

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Photo 1.
Looking northwest from Sta. 2+000 at erosion gully in SBL ditch south of ditch block



Photo 2.
Looking west from Sta. 1+980 below the SBL highway



Photo 3.
Looking east at
backslope skin
failure at Sta.
1+900 (More
movement since
2020).



Photo 4.
Looking south
from Sta. 1+890
at the slump in
the sideslope of
the SBL. The
scarp is 1.1 m
high and
0.8 m from the
guardrail.



Photo 5.
Looking south from Sta. 1+800 at the new ACP patch placed in 2020 and the erosion gully developed on the ditch up to 1.6 m wide and 0.6 m deep.



Photo 6.
Looking northeast across the dip in the highway at the south end of the 1+800 slide.



Photo 7.
Looking from the shoulder of the SBL at Sta. 1+660 across the dip in the highway at the north end of the 1+800 slide.



Photo 8.
Looking north near Sta. 1+550 at rough area (drill access bench) with some seepage and tension cracks



Photo 9.
Looking northwest across soil matting and nails which were installed in August 2010 at Sta. 1+450 slide. Backscarp (5 m to 7.5 m high) continues to retrogress and is now impacting the highway. Two guardrail posts are hanging and other two posts are partially exposed.



Photo 10.
Looking north from Sta. 1+450 backscarp. The slide scarp has retrogressed since 2020 and cracks are now 0.1 m west of the white line.



Photo 11. Looking south from Sta. 1+390 at the backscarp of the 1+400 slide which is impacting the highway shoulder. Slide crack is 60 mm wide and is 0.3 m from white line plus two other cracks closer to the guardrail



Photo 12. Looking southeast towards the 1+400 slide. The slide has further retrogressed towards the highway, is wider than in 2020 and there is a 5 m to 7.5 m drop below the guardrail.



Photo 13.
Looking south at
the fresh slump
slide that is
impacting the
highway at Sta.
1+400.



Photo 14.
Looking
northwest from
the north side of
the erosion gully
at Sta. 1+360