



**ALBERTA TRANSPORTATION GEOHAZARD ASSESSMENT PROGRAM  
PEACE REGION – PEACE-HIGH LEVEL  
2020 INSPECTION**

<b>Site Number</b>	<b>Location</b>	<b>Name</b>	<b>Hwy</b>	<b>km</b>
PH2a	East Hill	32+800 to 33+800	2:60	33.5
<b>Legal Description</b>		<b>UTM Co-ordinates</b>		
SW27-083-21 W5M		11V E 485640	N 6230750	

	<b>Date</b>	<b>PF</b>	<b>CF</b>	<b>Total</b>
<b>Previous Inspection:</b>	3-Jun-2019	8	3	24
<b>Current Inspection:</b>	9-Jun-2020	8	3	24
<b>Road WAADT:</b>	4580		<b>Year:</b>	2019
<b>Inspected By:</b>	Ed Szmata, TRANS Rocky Wang, TRANS		Don Proudfoot, TEL Tyler Clay, TEL	
<b>Report Attachments:</b>	<input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input checked="" type="checkbox"/> Maintenance Items			

<b>Primary Site Issue:</b>	Widespread slumping on the cutslope is occurring in this segment. Much of this slumping is shallow. A large deep-seated upslope failure at 33+550 appears intermittently active.	
<b>Dimensions:</b>	Landslide at 33+550 is about 200 m wide and extends 100 m to 120 m upslope of roadway. Smaller shallow slumps extend the height of the cutslope and on average measure 15 m wide.	
<b>Maintenance:</b>	Minor erosion is occurring locally in ditches on both sides of roadway which should be regraded. No maintenance activity since 2011.	
<b>Observations:</b>	<b>Description</b>	<b>Worsened?</b>
<input type="checkbox"/> Pavement Distress		<input type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	<p>The toe of the shallow slumps between 32+800 to 33+200 are in the northeast ditch and there was fresh headscarps with active retrogression (Photo 2-01). The active scarp is offset 1.5 m from the gravel road north of the highway.</p> <p>No significant expansion since 2016 of the landslide at 33+450 that was first observed</p>	<input checked="" type="checkbox"/>



	during the 2013 inspection (Photo 2-02). Landslide at 33+550 is active and toe is locally encroaching into ditch. Ditch partially blocked, no significant changes since 2017 (Photo 2-03).	
<input checked="" type="checkbox"/> Erosion	Minor local ditch erosion and pooling (Photo 2-01). More significant, active erosion was noted on the south side of the highway between 33+300 to 33+700 (Photo 2-04).	<input checked="" type="checkbox"/>
<input type="checkbox"/> Seepage		<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert Distress	Near km 33+000 the culvert inlet is partially buried, and the outlet is damaged. Flow into the dual elephant trunk drains is blocked at one inlet.	<input type="checkbox"/>
<input checked="" type="checkbox"/> Other		<input type="checkbox"/>
<b>Instrumentation:</b>		
No instrumentation installed in this area.		
<b>Assessment:</b>		
<p>There has been recent slide activity and retrogression at the cut slopes near km 33+100 and it is retrogressing towards the gravel road above the Highway (Grouard Trail / Township Road 834A). Ditch has become blocked in some areas and water is pooling. Ditch should be cleared and flow to the culverts and elephant trunk drains restored.</p> <p>Potential exists that the landslide at 33+550 could flow onto roadway. Movements of this landslide to date have been slow, but could accelerate after a heavy precipitation event.</p> <p>Ditch erosion on the south side of the highway is creating gullied areas with potential for future sidewall instability that could affect the south highway shoulder between 33+300 to 33+700.</p>		
<b>Recommendations:</b>		<b>Cost</b>
Continue to visually monitor as part of annual inspection of PH2.		-
Surface drainage should be re-established in north ditch and culvert / trunk drain maintenance is required.		- Maintenance
South ditch between 33+300 to 33+700 should be repaired with granular fill and check dams installed to help reduce rates of erosion.		\$20k
Landslide at 33+550 may require crest unloading or other stabilization measures if rates of movement accelerate or excessive material accumulates in roadway ditch.		-



Repair of shallow slides could consist of excavating the slide areas and reconstructing the slope with granular fill. \$ 600,000



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<b>Site Number</b>	<b>Location</b>	<b>Name</b>	<b>Hwy</b>	<b>km</b>
PH2b/2c	East Hill	Retaining Wall 33+850 to 34+050	2:60	33.85- 34.0
<b>Legal Description</b>		<b>UTM Co-ordinates</b>		
SW27-083-21 W5M		11V E 485345	N 6230685	

	<b>Date</b>	<b>PF</b>	<b>CF</b>	<b>Total</b>
East Wall				
<b>Previous Inspection:</b>	3-Jun-2019	3	5	15
<b>Current Inspection:</b>	9-Jun-2020	3	5	15
West Wall				
<b>Previous Inspection:</b>	3-Jun-2019	3	6	18
<b>Current Inspection:</b>	9-Jun-2020	3	6	18
<b>Road WAADT:</b>	4580	<b>Year:</b>		2019
<b>Inspected By:</b>	Ed Szmata, TRANS Rocky Wang, TRANS		Don Proudfoot, TEL Tyler Clay, TEL	
<b>Report Attachments:</b>	<input checked="" type="checkbox"/> Photographs		<input type="checkbox"/> Maintenance Items	
	<input checked="" type="checkbox"/> Plans			

<b>Primary Site Issue:</b>	<p>Large deep-seated landslide was occurring below roadway at 34+050 with potential to adversely affect highway if retrogression or reactivation were to occur. Active landslide caused roadway settlement on the eastbound lane at 33+910 since January 2013. Further east at 33+875 an instability of fill within an infilled ravine was previously mitigated with a cantilevered, cast-in-place concrete pile wall reinforced with steel wide-flange with a concrete header beam. Fill slope below wall had ongoing downslope movement and piles were becoming exposed.</p> <p>A new concrete, tied-back tangent retaining wall to mitigate the slide movement between (33+925 to 34+000) and support the roadway was installed from August 2016 to October 2017. At the same time, a new concrete cantilever wall was also constructed immediately upslope of the old wall to replace it and stabilize the old ravine area.</p>
<b>Dimensions:</b>	<p>Landslide at 34+050 laterally continuous below roadway extending approximately 200 m south to North Heart River.</p> <p>About 40 m of roadway experiences settlement due to slide activity on the eastbound lane at 33+910.</p> <p>Unstable ravine width at 33+875: 65 m</p>



	Previous cantilevered wall length: 40 m New anchored tangent pile retaining wall length: 175 m	
<b>Maintenance:</b>	No maintenance since construction of the new wall.	
<b>Observations:</b>	<b>Description</b>	<b>Worsened?</b>
<input checked="" type="checkbox"/> Pavement Distress	ACP above the pile wall has minor dips and new cracking is present in previously observed areas with apparent increased settlement from 2019 condition (Photo 2-08).	<input type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	The fill slope below the wall and area of previously observed movement has been regraded as part of the pile wall installation work. No newly developed scarps or tension cracks were observed downslope of the pile wall since construction completed (Photos 2-05 and 2-06). Potentially active area west and downslope of the pile wall at 34+050 did not appear to have significant retrogression (Photo 2-07).	<input type="checkbox"/>
<input checked="" type="checkbox"/> Erosion	Erosion at the end of the armored drainage outlet area at the west end of the pile wall. Minor ditch erosion.	<input type="checkbox"/>
<input type="checkbox"/> Seepage		<input type="checkbox"/>
<input type="checkbox"/> Bridge/Culvert Distress		<input type="checkbox"/>
<input type="checkbox"/> Other		<input type="checkbox"/>
<b>Instrumentation:</b>		
<p>Four (4) Slope Inclinerometers within the new pile walls:</p> <ul style="list-style-type: none"> <li>• SI-P40: 0.1 mm/yr in the downslope direction over the length of the pile and no discernible movement over the combined length of the pile and waler measured since Fall 2019. Total cumulative pile head movement of 2.9 mm in the upslope direction and total cumulative movement of 6.5 mm in the upslope direction over the combined length of the pile and waler.</li> <li>• SI-P58: 1.2 mm/yr in the downslope direction over the length of the pile and a rate of movement of 0.8 mm/yr in the downslope direction over the combined length of the pile and waler since Fall 2019. Total cumulative pile head movement of 5.5 mm in the upslope direction and total cumulative movement of 8.2 mm in the upslope direction over the combined length of the pile and waler.</li> <li>• SI-P90: No discernible movement over both the length of the pile and the combined length of the pile and waler since Fall 2019. Total cumulative pile head movement of 11.6 mm in the upslope direction and total cumulative movement of 14.6 mm in the upslope direction over the combined length of the pile and waler.</li> <li>• SI-P116: 0.5 mm/yr in the downslope direction over the length of the pile and no discernible movement over the combined length of the pile and waler measured since Fall 2019. Total cumulative pile head movement of 2.7 mm in the downslope direction and total cumulative</li> </ul>		

movement of 2.9 mm in the downslope direction over the combined length of the pile and waler.

Pile number 74 contains one (1) SAA (SAA-P74) and thirty (30) vibrating wire strain gauges.

- SAA-P74: 1.6 mm/yr in the downslope direction over the length of the pile and an average rate of movement of 0.8 mm/yr over the combined length of the pile and waler since Fall 2019. Total cumulative pile head movement of 6.5 mm in the upslope direction and total cumulative movement of 10.1 mm in the upslope direction over the combined length of the pile and waler.

Overall, the strain gauges have shown relatively small changes in microstrain since Fall 2019 and show an overall trend of gradually increasing compression on the upslope pile face and gradually increasing tension on the downslope pile face. The changes in strain have been more noticeable in the upper 20 m of the pile.

Sixteen (16) vibrating wire load cells were installed on select anchors. The majority of the load cells showed an increase in measured load compared to Fall 2019, ranging from an increase of 1.48 kN in G118PU (VC1980) to an increase of 10.84 kN in G40WU (VC1975). Load cells G39WL (VC1977), G40WU (VC1975), G58WU (VC1972) and G190PL (VC1968) all registered all time high recorded loads between the fall of 2019 readings and the current readings. Overall, the load cells show a trend of relatively stable loads, except for anchors G39WL and G40WU in Wall Section 2, which currently show a trend of gradually increasing load.

Overall, the load cells show a trend of relatively stable loads except for two anchors in Wall Section 2 which currently show a trend of increasing load. The load cells have shown a higher value during the winter months due to frost forces, which is typical for tied-back walls of similar configuration.

Nine (9) pneumatic piezometers and one (1) standpipe were installed prior to construction:

- PN13-2A, PN14-2A, PN14-2B, PN14-3A, PN14-3B and PN14-4A showed increases in groundwater level of 0.14 m, 0.16 m, 0.14 m, 0.18 m, 0.12 m and 0.09 m, respectively, since Fall 2019. PN13-3A and PN13-3B showed decreases in groundwater level of 0.05 m and 1.39 m, respectively, since Fall 2019.
- SP14-1 showed a decrease in groundwater level of 0.05 m since Fall 2019.

Existing pre-construction slope instrumentation that is operational includes:

- S113-3: No discernible movement measured (instrument may not be deep enough to intercept the active slip surface).
- S114-2: *A new zone of movement, which was not previously recorded, was observed over 17.4 m to 21.0 m depth since Fall 2019. This is of significance since this zone is below the tips of the piles in Wall Section 2.* Historically creep-like movement has been measured, approximately 1-2 mm/yr between 24.7 m to 27.8 m depth and from 24.7 m to 27.1 m depth.
- S114-3: Historically has had creep-like movement. Negligible movement measured since Fall 2019. Movement rates have greatly diminished since the September 2016 readings.
- S114-4: Approximately 3.5 mm/yr movement rate measured over 17.3 m to 19.7 m depth. Creep-like movement has been measured between Fall 2016 to Spring 2019 but there has been an increasing movement rate trend within the last two readings.

**Assessment:**

Large deep-seated landslides are widespread below roadway in this area and have potential to affect highway if they retrogress. The new retaining wall is performing as expected to mitigate settlement issues related to the landslide movement at 33+900. The pile wall is designed to accommodate ongoing



downslope movement of the slide mass below the wall. Based on instrument data and site observations there is ongoing creep downslope of the wall and movement rates upslope of the wall have diminished significantly.

Close review of the surface conditions around SI14-2 and future readings is recommended as current trends show potential movement of a failure surface occurring below the pile tips.

It is recommended that a complete pile wall system performance review is completed to compare the measured responses to the expected design values. To date the wall appears overall to be behaving within design tolerances in terms of load and strain measurements; however, further assessment is recommended especially for Design Section 4 to confirm that the performance is within expected limits.

Erosion at the drainage outlets should be monitored by regular visual inspection and if the condition significantly worsens, consideration should be given to extending the armoring or installing a drainpipe to prevent gully retrogression towards the road and disturbance of existing riprap.

<b>Recommendations:</b>	<b>Cost</b>
Continue to visually monitor as part of annual inspection of PH2 and monitor wall instrumentation to ensure the mitigation is performing as designed. It is recommended that the instrument readings be used to complete a pile wall system performance review to compare the measured responses to the expected design values, especially for Design Section 4 to confirm that the performance is within expected limits.	-
Should confirm whether the camera monitoring posts need replacement (i.e. damaged Styrofoam balls) and how long the camera monitoring system (installed by Queens University) will be kept in place.	-
Ongoing pavement repairs as required until movement upslope from the wall is reduced.	Maintenance



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<b>Site Number</b>	<b>Location</b>	<b>Name</b>	<b>Hwy</b>	<b>km</b>
PH2d	East Hill	34+100 to 34+780 Site 1	2:60	34.5
<b>Legal Description</b>		<b>UTM Co-ordinates</b>		
SW27 & SE 28-083-21 W5M		11V E 484800	N 6230710	

	<b>Date</b>	<b>PF</b>	<b>CF</b>	<b>Total</b>
<b>Previous Inspection:</b>	3-Jun-2019	11	5	55
<b>Current Inspection:</b>	9-Jun-2020	11	5	55
<b>Road WAADT:</b>	4580	<b>Year:</b>		2019
<b>Inspected By:</b>	Ed Szmata, TRANS Rocky Wang, TRANS		Don Proudfoot, TEL Tyler Clay, TEL	
<b>Report Attachments:</b>	<input checked="" type="checkbox"/> Photographs		<input checked="" type="checkbox"/> Maintenance Items	
	<input checked="" type="checkbox"/> Plans			

<b>Primary Site Issue:</b>	Site of large landslide that crossed Highway 2 in 1980s. Mitigated on upslope side of roadway by crest unloading. Mitigated on downslope side of highway by toe berm. North Heart River was channelled through large diameter steel culverts which were breached many years ago. Area below road embankment at 34+550 km is unstable; with shallow and deep-seated instabilities as well as widespread gully erosion. Potential exists for retrogressive movement downslope of roadway to adversely affect road embankment.	
<b>Dimensions:</b>	Site 1 landslide is 750 m wide extending 200 m to 500 m downslope of roadway to North Heart River and 300 m upslope of roadway to crest of valley slope. Embankment width in area of concern at 34+550 is 120 m.	
<b>Maintenance:</b>	Minor erosion is occurring in ditches on both sides of roadway which should be regraded. No maintenance activity since 2011.	
<b>Observations:</b>	<b>Description</b>	<b>Worsened?</b>
<input type="checkbox"/> Pavement Distress		<input type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	Road fill embankment between 34+450 to 34+600 (old Site 1) had no visible signs of new slope movement/instability (Photo 2-09). Shallow slumping is occurring on upslope side of the roadway within Site 1 landslide. Shallow and deep-seated movements are active just below the large road embankment at 34+550 (Photo 2-10). Visually, top of scarps below and just west of the embankment appears similar to	<input type="checkbox"/>





	2019 condition (Photo 2-11). Shallow earth slide in backslope at 34+400 partially blocking south ditch with no major change from the 2019 condition.	
<input checked="" type="checkbox"/> Erosion	Widespread erosion and gulying occurring on steep slopes of upper berm below road embankment. Minor erosion of ditches both sides of roadway.	<input checked="" type="checkbox"/>
<input type="checkbox"/> Seepage		<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert Distress	North Heart River diversion culverts breached.	<input type="checkbox"/>
<input checked="" type="checkbox"/> Other	Elephant Trunk Drain breached in ravine downslope of roadway. Several joints leaking due to band/joint failure causing deep gulying and sidewall instability at 34+650 (Photos 2-12 and 2-13). Pipe leaking is now occurring further upslope relative to the 2019 condition.	<input checked="" type="checkbox"/>
<p><b>Instrumentation:</b></p> <p>DOWNSLOPE:</p> <p><u>Outside of Embankment Area:</u>  SI 63 – No discernible movement.  SI 64 – No discernible movement.</p> <p><u>Below Road Embankment:</u>  SI 10-3 - Near toe of road embankment - No discernible movement.  SI 10-4 - 50 m from toe of embankment - Sheared since June 2012 at 6.7 m depth  SI 10-5 - 100 m from toe of embankment - Sheared since Fall 2011 at 12.2 m depth</p> <p>UPSLOPE:  No operational instrumentation on the upslope side of roadway.</p>		
<p><b>Assessment:</b></p> <p>Deep-seated movements within the old berms on downslope side of roadway continue to be of concern to the stability of the road embankment at 34+550. Mitigation would be required if SI 10-3 began to register ground movements. The upslope portion of the Site 1 landslide is affected by numerous local shallow instabilities in the form of slumps. These slumps typically do not affect the roadway and toe out above the ditch. The possibility of deep-seated creep movement of the old rupture surface cannot be ruled out, although there is no surviving instrumentation to confirm or disprove.</p> <p>Erosion at the breach in the elephant trunk drain does not impose risk to the highway currently but ongoing gulying and sidewall instability could begin to retrogress further upslope and destabilize upper portions of the slope closer to the road. The drain itself has become compromised further upslope and has created a new leak origin area. As gulying continues it is expected the trunk drain</p>		



will undergo further stress and these new leak points will continue to move upslope along the joints if left unmitigated.

<b>Recommendations:</b>	<b>Cost</b>
Continue to visually monitor as part of annual inspection of PH2. Slope inclinometers should continue to be monitored twice annually.	-
South ditch should be cleared before it eventually becomes blocked at 34+400. North ditch should be cleared of silt buildup between 34+500 to 34+600.	Maintenance
The trunk drain should be spliced at the breach and gullies filled in with granular material to reduce rate of erosion in the affected area.	\$50 – \$100k