THURBER

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

Site Number	Location	Name	Hwy	km
PH71	Daishowa West Hill	Daishowa West Hill Slide - Km 26.8	986:01	26.8
Legal Description		**UTM Coordinates**		
SE¼ 09-085-21 W5M		11V E 485015 N 6245524		

		Date	PF	CF	Total
Previous Inspection:		4-Jun-2019	3	4	12
Current Inspections:	Upslope of Wall	11-Jun-2020	3	4	12
	Downslope of Wall	11-Jun-2020	13	2	26
Road WAADT:		900		**Year:**	2019
Inspected By:		Ed Szmata, TRANS Rocky Wang, TRANS		Don Proudfoot, TEL Tyler Clay, TEL	
Report Attachments:		☑ Photographs ☑ Plans		☑ Maintenance Items	

Primary Site Issue:	Pavement distress and minor subsidence were first observed in 2012 within the Eastbound Lane (EBL) due to landslide movement to the south. The damage in the EBL worsened in 2013 and eventually progressed into a significant slope failure involving a segment of the highway that required the closure of the EBL and construction of a detour in the winter of 2013. Further landslide expansion and retrogression into one of the original Westbound Lanes (WBLs) required the construction of another detour in 2015. A pile wall and highway re-alignment were constructed between 2016 to 2018.	
Dimensions:	The highway at the site runs east to west on a sidehill cross-section. The road embankment is about 21.5 m high with side slopes in the order of 3H:1V. Originally the highway at the site area had 2 WBLs and 1 EBL each about 4 m wide. The EBL pavement damage observed in 2012 was 33 m long and included a drop up to 100 mm. In 2013 the damage developed into a slope failure 100 m long with a main scarp up to 6 m high. The landslide extents in 2015 expanded to affect a 130 m long segment of the highway with main scarp up to 6.5 m in height. A 140 m long reinforced concrete anchored tangent pile wall to mitigate landslide movement was completed in 2017 (Photo 71 -7).	
Maintenance:	.	
Observations:	**Description**	**Worsened?**

☑ Pavement Distress	Minor reflective cracking observed at the top of the pile wall that follows the edge of the pile cap. No major change from the 2019 condition. (Photo 71-10)	☐
☑ Slope Movement	Tension cracks and slide scarps with up to approximately 4.5 m of downdrop observed downslope of the pile wall along previously observed slide extents (Photos 71-8). Main slide scarp was offset approximately 23 m from base of pile wall and tension cracks were offset approximately 7 m from the base of the wall (Photos 71-7).	☑
☑ Erosion	Upslope ditch between 26+500 to 26+600 had increased scour and gullying within the invert (Photo 71-3). Increased erosion within the washed out backslope area (first noted in 2019) that was repaired with granular fill near 26+600 (Photo 71-3). Road runoff west of the wall flows around armored swale and has created an erosion gully (Photo 71-5). Road runoff had caused minor rill erosion between the armored swale and road edge at the east end of the pile wall near km 26+850 (Photo 71-11). The backslope area directly north of the pile wall was in relatively good condition with good vegetation coverage (Photo 71-12).	☑
☑ Seepage	At the downslope base of the wall on the east end, drain outlets were slowly dripping and oxidation staining was visible on the paving blocks (Photo 71-9).	☐
☑ Bridge/Culvert Distress	One of two culvert inlets in the north ditch near km 26+650 has been blocked due to silt buildup (Photo 71-7).	☑
☐ Other		☐

Instrumentation:

Instrumentation installed as part of the geotechnical investigation has been sheared off and/or decommissioned.

Instrumentation has been installed to monitor pile wall performance that includes:

- Three shape-acceleration arrays (SAA) installed within concrete piles of the wall (**SAA-P022**, **SAA-P060**, and **SAA-P097**)
- Nine vibrating wire load cells on the wall anchor plates (**VC1917** to **VC1925**)
- Six vibrating wire (VW) piezometers (**VW16-1A**, **VW16-1B**, **VW16-1C**, **VW16-2A**, **VW16-2B** and **VW16-2C**)
- Three test holes south (downslope) of the pile wall with one slope inclinometer (**SI16-3**) and six additional VW piezometers (**VW16-3A**, **VW16-3B**, **VW16-4A**, **VW16-4B**, **VW16-5A** and **VW16-5B**)

- Twenty-eight VW strain gauges

SAA-P022, six of the twenty-eight strain gauges and **VW16-5B** stopped functioning before the end of construction. As of May 7, 2017, **VW16-4B** is no longer functional.

SI16-3: rates of movement of 5.6 mm/yr and 0.3 mm/yr over 0.1 m to 3.8 m depth and 9.9 m to 11.1 m depth, respectively, since Fall 2019 readings. Total cumulative movements of 12.8 mm and 1.7 mm over the respective movement zones.

SAA-P060: Did not show an overall trend of downslope movement since Fall 2019. SAA-P060 has shown a total pile head movement of 14.7 mm in the downslope direction to date. An overall stable trend of movement has been measured since the end of construction.

SAA-P097: showed an average rate of movement of 1.3 mm/yr in the downslope direction over the length of the pile since Fall 2019 and a total pile head deflection of 16.5 mm in the downslope direction to date. An overall trend of slow movement in the downhill direction has been measured since the end of construction, with peaks of higher downhill movement rates during the winter months.

VW Strain Gauges: The strain gauges showed relatively small changes in microstrain value since the previous readings in Fall 2019, with the greatest changes in strain occurring in the strain gauges within the upper 7 m of the pile. Within this upper zone, the strain gauges on the upslope pile face showed increases in tension, while the strain gauges on the downslope side showed increases in compression. The strain gauges located near the top of pile P066 on the downslope (tension) face of the pile generally show the highest strain values. Six (6) of the twenty-eight (28) strain gauges originally installed are no longer functional.

VW Piezometers: VW16-1A, VW16-2B, VW16-2C and VC16-3B showed decreases in groundwater level of 0.35 m, 0.25 m, 0.06 m and 0.04 m, respectively, since Fall 2019. VW16-1B, VW16-1C and VW16-3A showed increases in groundwater level of 0.13 m, 0.08 m and 0.19 m, respectively, since Fall 2019. VW16-2A, VW16-4A and VW16-5A were dry, however VW16-4A showed a groundwater level above the tip between April 18, 2020 and May 17, 2020. VW16-1C, VW16-3A and VW16-4A all recorded all-time high groundwater levels since Fall 2019.

Load Cells: The load cells all showed an increase in measured load compared to Fall 2019, ranging from 1.79 kN in VC1921 (P060C) to 7.78 kN in VC1923 (P022B). VC1924 (P022A), VC1925 (P022C) and VC1921 (P060C) showed all-time high measured loads between February 5, 2020 and February 17, 2020. Since the end of construction, the load cells show an overall trend of increasing load, with the highest seasonal loads measured towards the end of each winter in response to frost heave pressures. The current loads measured in the upper two anchor rows are above the design loads.

Assessment:

The landslide has been mitigated by the construction of a tangent concrete pile wall reinforced by three rows of anchors. The pile wall is designed to retain and support the road embankment and prevent further slide retrogression upslope into the highway.

Slope movement is expected to continue downslope of the pile wall, which has been observed to be active along previous slide extents since 2016. The pile wall is designed to accommodate

THURBER

approximately 6.5 m of slope subsidence or ‘drop’ below the second row of anchors downslope of the pile wall. Movement of the soil bench downslope of the wall should therefore be monitored on an annual basis to determine if/when another row of support anchors might be required. The pile wall should have an ongoing assessment by site inspection (including to check for changing site conditions) and instrument monitoring to ensure it is performing as intended. In general, the instrument readings to date indicate that the wall is performing as intended and the strain and displacement measurements are within design tolerances; however, further assessment is recommended to track that performance is within expected limits. Erosion damage and sediment buildup was observed in some areas in the backslope and upslope ditch through the site area. These areas should be addressed by the repair contractor as part of the warranty process. The culvert inlet at the west end of the site requires to be cleaned out. Where the surface runoff from the road is flowing around the armored inlet consideration should be given to an asphalt berm at the edge of pavement to direct runoff or installing a swale with ECM along the road edge in this area to reduce further erosion rates. It is recommended to create a post-construction monitoring and design performance review plan (i.e. Asset Management Plan) to provide recommendations for ongoing monitoring and for future pass-off from construction / design to operations.

Recommendations:	**Cost**
Continue to visually inspect the repaired slide area regularly and read instruments to monitor pile wall performance (particularly after heavy and/or prolonged rain or rapid snowmelt).	-
Maintenance should continue to check the ditch structures and culverts and cleanout as required. Water runoff near km 26+050 should be managed via an armored swale or asphalt berm to direct water to existing armored swale.	Maintenance

NOTES:

1 DRAWING MUST BE USED IN CONJUNCTION WITH THE ATTACHED REPORT REFERENCE 13351 DATED DECEMBER 2020 AND IS SUBJECT TO THE STATEMENT OF LIMITATIONS AND CONDITIONS INCLUDED IN THE REPORT.

2 AIR PHOTO BASE FROM ESRI IMAGERY SERVICE (DIGITAL GLOBE, 2016).

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PEACE REGION (PEACE RIVER/HIGH LEVEL)

DAISHOWA
HWY 986:01 (PH71)
KEY PLAN

FIGURE PH71-1

DRAWN BY	ICB
DESIGNED BY	TTC
APPROVED BY	WCW
SCALE	1:12 500
DATE	DECEMBER 18, 2020
FILE No.	13351-B2E

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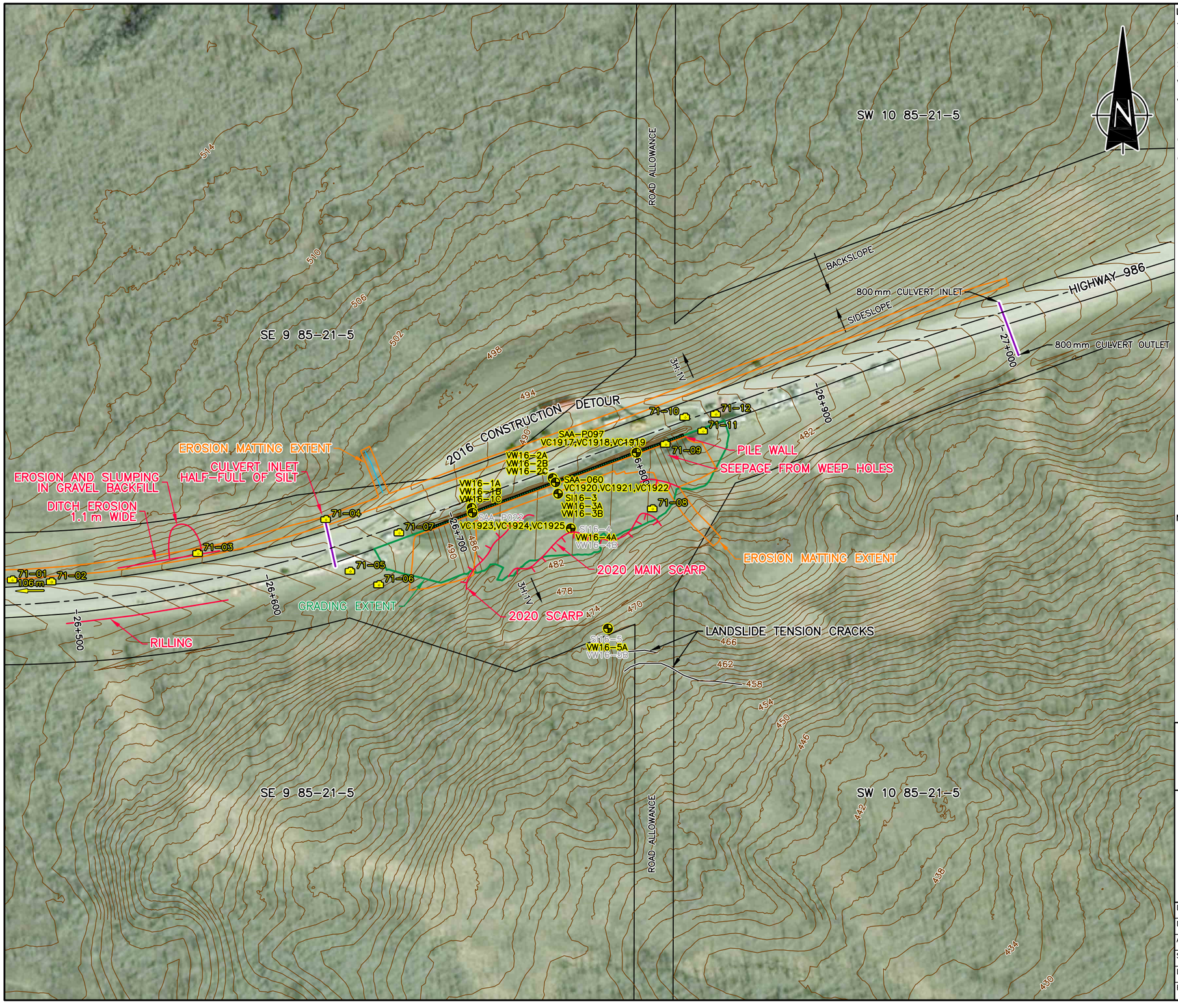

LEGEND:

TEST HOLE LOCATION	⊕
SLOPE ACCELEROMETER ARRAY	SAA
SLOPE INCLINOMETER	SI
VIBRATING WIRE LOAD CELL	VC
VIBRATING WIRE PIEZOMETER	VW
PHOTOGRAPH LOCATION	71-01
CULVERT	
CONTOUR (1 m INTERVAL)	

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2 BASE MAP FROM GENIVAR.

3 AIR PHOTO BASE FROM ESRI IMAGERY SERVICE (DIGITAL GLOBE, 2016).

4 STATIONING SUPPLIED BY GENIVAR PLAN # "19923-D01" DATED 2013-09.

5 EROSION MATTING EXTENT AND 2017 ROAD LIMITS SUPPLIED BY WSP FILE "2017 ASBUILT COMPILED AUG 23.dwg"

0 25 50 100 150 m

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PEACE REGION (PEACE RIVER/HIGH LEVEL)

DAISHOWA
HWY 986:01 (PH71)
LOCATION PLAN

FIGURE PH71-2

DRAWN BY	ICB
DESIGNED BY	TTC
APPROVED BY	WCW
SCALE	1:2 000
DATE	DECEMBER 18, 2020
FILE No.	13351-C7A

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	**Photo 71-1.** Granular backslope repair on north side of road was in good condition (26+350).
	**Photo 71-2.** Second area of granular backslope repair on north side of road. Minor ditch erosion but overall slope was in good condition (26+500).

	**Photo 71-3.** Backslope area upslope of the highway above the pile wall near the west end of the site looking towards the northwest (26+550). Granular fill within the backslope has eroded and partially washed out. Increased erosion within backslope and ditch since 2019. Georidge ditch barriers have been outflanked in some sections.
	**Photo 71-4.** View toward the west looking upslope in the north ditch at the culvert inlets (26+650). One of the two culverts has been blocked due to silt buildup.

	**Photo 71-5.** West of the wall on the south side of the road (26+650), water runoff from the road currently flows around the armored swale in an erosion rill. Slightly worse from the 2019 condition.
	**Photo 71-6.** View of the armoured swale at the culvert outlets (26+650). No issues were noted at the time of inspection.

	**Photo 71-7.** At the west end of the pile wall looking towards the east downslope of the wall.
	**Photo 71-8.** Looking towards the west at the downslope area below the wall at the main scarp where landslide movement has continued since the pile wall was constructed. Scarps and cracking has typically followed along previously observed slide extents prior to the regrading and wall construction.

	**Photo 71-9.** Weep holes at the east end of the wall had active seepage and area was wet.
	**Photo 71-10.** Looking west along the highway above the pile wall. Pavement was in good condition. Previous buildup of sand and gravel below the guardrail at the east end of the wall was cleaned/washed out.

	**Photo 71-11.** Looking towards the east at the east end of the pile wall at the armoured drainage swale. Minor rill erosion was observed between the swale and road edge in areas of poor vegetation.
	**Photo 71-12.** Looking northeast towards the backslope area across from the pile wall (26+800). Slope had good vegetation coverage and no issues were observed.