ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
NORTH CENTRAL REGION – ATHABASCA
2019 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	Km
NC 014-1	Northeast boundary of the Town of Fort Assiniboine	Fort Assiniboine	661:02	1.8
Legal Description		**UTM Co-ordinates (NAD 83)**		
NW-1-62-6-W5M		11 N 6023391 E 644779		

	Date	PF	CF	Total
Previous Inspection:	May 07, 2018	8	4	32
Current Inspection:	June 10, 2019	8	4	32
Road AADT:	1,000		**Year:**	2018
Inspected By:	Tarek Abdelaziz, José Pineda (Thurber) Rishi Adhikari, Arthur Kavulok (TRANS)			
Report Attachments:	☑ Photographs ☑ Plans ☐ Maintenance Items			

Primary Site Issue:	Slope creep movements causing pavement distress to a side hill alignment due to seasonal high ground water levels; a localized active landslide causing a severe deterioration of the highway SBL within the Mid-Hill slope section
Dimensions:	About 250 m long (Mid Hill slope section)
Remediation	N/A
Maintenance:	Silt in Manholes 1 and 2 was hydrovacced from the interior of the CSP pipes. Highway cracks were spray patched in the fall 2014. Mr. Dale Kluin of the County Council provided the following information during the 2017 site visit: ▪ Slope stability issues occurred during the construction of the highway in the 70's. ▪ Two subdrain pipes were installed in the highway east ditch to reduce groundwater levels in the sandy soils. The subdrains were installed approximately 2.4 m below the ditch grade. ▪ The subdrain system extends from Manhole MH4 located near the top of the hill to the existing creek near the bottom of the hill. ▪ After the installation of the subdrain system, icing issues were noted in the highway ditch and its surface. The icing issue was believed to be in response to uncontrolled surface flow from the hill side towards the highway alignment. ▪ Two manholes were constructed in the highway backslope to collect surface water from springs/natural drainage gullies. Each of the manholes was connected to a vertical CSP drop pipe filled with cobbles through a trench drain filled with rock. A trench drain filled with rock was also used to convey the flow from the vertical CSP drop pipe to the subdrain system in the ditch. Visual inspection of the drainage system during the 2017 site visit indicates the subdrain system consists of two 150 mm HDPE perforated pipes as observed from the inside of MH5 (cleanout manhole) and at the subdrain outlet locations. Highway Mid-Hill section was patched in 2017.

Investigation/Findings (2018)	A dewatering pilot test was carried out in 2018 to assess the effectiveness of a proposed drainage scheme to enhance the stability of the slope. The pilot test included the installation of a gravity well to drain the upper water bearing sand aquifer (saturating the landslide mass) to a lower sand and gravel aquifer (below the landslide mass). The pilot test confirmed that a gravity well will not be suitable to reduce groundwater levels at this the site. This is due to (a) high clay and silt contents in the upper aquifer and (b) difficulty associated with developing the well in the upper aquifer. Hence a decision was made to abandon the gravity well and the implementation of the proposed drainage improvement scheme at this site. The gravity well was decommissioned in the Spring of 2019.	
Observations:	**Description**	**Worse?**
☑ Pavement Distress	10 to 15 mm depression in the SBL of the Mid-Hill slope area, and 10 mm depression in the SBL within the upper slope area	☑
☑ Slope Movement	Mid-Hill slope section: 10 to 40 mm wide reflective cracks in the Mid-Hill slope section with up to 15 mm differential height across crack surfaces Creep movement open cracks to the north and south of Mid-Hill slope section Upper slope section of the hill (North of Mid-Hill slope section): Guardrail sagged and shifted laterally; the head scarp crack of the subdued graben feature downslope of the highway is 1.5 m deep and is located about 1.2 to 1.4 m away from the guardrail	☑
☐ Erosion		☐
☑ Seepage	▪ **MH#1:** Water level at 1.1 m from top of manhole (same as 2018 measurements) ▪ **MH#2:** Heavily oxidized interior walls; water level is at 5.3 m from top of manhole; the wall of the manhole and the subdrain pipes were covered with silt; flow from one of the sub-horizontal drains (heaviest since observed) ▪ **Subdrain:** Not observed in 2019	☐
☐ Bridge/Culvert Distress		☐
☑ Other	3.3 m long x 2.0 m wide x 0.3 m deep drop/settlement near the edge of the road; dormant small backslope slump (3.5 m long vegetated scarp crack with up to 500 mm drop)	☐

Instrumentation: (2SIs, 4MWs, and 11 SPs)

SI06-16 was sheared off in the past at 7.8 m below ground surface. SI06-15 has been blocked since 2007 and SI06-12 has been blocked since 2011. No discernable movement in SI06-6 and 06-11. Since Fall 2018 groundwater levels in most of the standpipes piezometers showed increase of groundwater levels ranging between 0.05 m to 0.11 m. SP06-3 showed an increases of groundwater levels of 1.16 m. The monitoring wells showed an increase of groundwater levels from 0 to 0.25 m.

Assessment:

The site observations and historical instrument readings indicate that the slopes outside the Mid-Hill section of the hill (including the upper slope section to the north of the Mid- Hill section) continued to experience creep movements due to seasonal fluctuations in ground water levels. The cracks outside the Mid Hill sections continued to get wider overtime due to the lack of frequent maintenance (i.e. crack sealing).

At the Mid-Hill slope section, the movement is more pronounced due to fill placement at this location to establish the highway profile. The widening of the landslide cracks and the observed further drop of the SBL within the Mid-Hill slope section since the 2018 inspection indicate that the landslide continued to be very active. It is anticipated that the landslide will continue to move and cause further deterioration to the highway condition.

The local landslide located downslope of the highway to the north of the Mill-Hill slope section (i.e. within the upper slope section of the hill) appears to be less active than the local landslide of the Mid-hill slope section. However, it may eventually retrogress into the highway surface. The existing dip in the highway SBL and the noted sag and shift in the guardrail at the upper slope section location are probably a reflection of old movements.

The surface and subsurface drainage improvement measures installed above and below the highway surface during the construction of the highway (i.e. subdrain pipes in the east ditch, CSP pipes and manholes above the highway surface, and sub-horizontal drains near the bottom of the slope) appear to have reduced groundwater levels and improved the overall stability of the hill.

The constant water level in MH#1 is likely caused by partial silting of the rock filled channel running downslope of MH#1 and hence slightly impeding free flow of water out of the manhole.

One of the sub-horizontal drains inside MH#2 was heavily flowing. The remaining sub-horizontal drains connected to MH#2 were dry and may have become completely silted up and plugged. MH#2 has no outflow pipe and the collected flow from the flowing sub-horizontal drain is likely percolating into the ground. Further silt accumulation at the base of the manhole may impede the percolation rate of collected water into the ground.

Recommendations:

In the short term, it is recommended to get all open cracks sealed to prevent surface water infiltration into the landslide mass. Consideration should also be given for patching the highway at the Mid-Hill and upper slope sections to provide a smooth ride to motorists. In addition, the existing drop by the edge of the roadway should also be backfilled with either gravel or clay.

The preliminary engineering completed at this site recommended the implementation of a drainage improvement scheme or the installation of a pile to stabilize the Mid-Hill and upper slope sections. As mentioned earlier, the recommended drainage scheme proved to be ineffective and hence consideration may be given to either of the following in the future: (a) continue to monitor the highway surface, seal open cracks frequently, patch highway surface at the Mid-Hill and the upper slope sections as needed, and undertake a periodic maintenance program to clean and flush existing manholes, sub-horizontal drains and subdrain pipes, or (b) install a pile wall to stabilize the Mid-Hill and upper slope sections. At present, Option (a) is more attractive since this road is classified as low speed low volume roadway. However, the pile wall option should be considered if the highway condition starts to deteriorate significantly in the future.