ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
NORTH CENTRAL REGION – ATHABASCA
2018 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 17, 2017	8	4	32
Current Inspection:	May 07, 2018	8	4	32
Road AADT:	1000		**Year:**	2016
Inspected By:	Tarek Abdelaziz, José Pineda (Thurber) Rocky Wang, 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
Dimensions:	About 250 m long
Remediation	The Mid-Hill slope section was patched in the summer of 2017
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.

Recent Investigation/Findings	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.	
Observations:	**Description**	**Worse?**
☑ Pavement Distress	5 to 10 mm depression in the SBL of the Mid-Hill slope section	☐
☑ Slope Movement	Mid-Hill slope section: 5 to 25 mm wide reflective cracks in the Mid-Hill slope section with up to 10 mm differential height across crack surfaces; creep movement open cracks to the north and south of Mid-Hill slope section	☐
☐ Erosion		☐
☑ Seepage	▪ **MH#1:** Water level measurement at 1.1 m from top of manhole (0.3 m lower than 2017 measurements) ▪ **MH#2:** Heavily oxidized interior walls. Flow in one of the drains. Water level measurement at 3.1 m from top of manhole (at least 2.2 m higher than 2017 readings). ▪ **Subdrain:** Not observed in 2018	☐
☐ Bridge/Culvert Distress		☐
☑ Other	600 mm long x 300 mm wide 200 mm deep sinkhole in the highway ditch; 2.5 m long x 2.5 m wide x 0.3 m deep drop/settlement near the edge of the road; sag in the guardrail behind the graben feature located downslope of the highway to the north of the Mid-Hill section; dormant small backslope slump (3.5 m long vegetated scarp crack with up to 500 mm drop)	☐

Instrumentation: (2SIs and 11 SPs)

SI06-16 was sheared off at 7.8 m between the 2009 fall and the 2010 spring readings. 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 Spring 2018 groundwater levels in most of the standpipes piezometers showed increase of groundwater levels ranging between 0.02 m to 0.13 m. SP06-3 showed an increases of groundwater levels of 0.94 m

Assessment:
The site observations and historical instrument readings indicate that the slopes outside the Mid-Hill section of the hill continued to experience slow creep movements due to seasonal fluctuations in ground water levels. At the Mid-Hill slope section, the movement is more pronounced due to fill placement at this location to establish the highway profile.

The re-appearance of reflective cracks within the Mid-Hill slope section shortly after ACP patch placement indicates that the landslide continued to be very active. It is anticipated that the landslide will continue to be active, resulting in further deterioration to the highway condition.

The local landslide located downslope of the highway to the north of the Mill-Hill slope section appears to be dormant. The existing dip in the highway SBL and the noted sag in the guardrail 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 presence of clear water in MH#1 indicates the effectiveness of the maintenance work completed in 2014. It is likely that the rock filled channel running downslope of MH#1 has been partially filled with silt, and hence slightly impeding free flow of water out of the manhole.

Flow was noted from one of the sub-horizontal drains inside MH#2. The remaining sub-horizontal drains connected to MH#2 may have become completely plugged. MH#2 has no outflow pipe and the collected flow from the flowing sub-horizontal sub-drain is likely percolating into the ground.

Recommendations:

In the short term, it is recommended to seal all open cracks in the pavement to prevent surface water infiltration into the landslide cracks. The Mid-Hill slope section should be monitored, and the highway should be patched as needed to provide a smooth ride to motorists.

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 slope section. As mentioned earlier, the recommended drainage scheme proved to be ineffective and hence consideration should be given to either of the following options: (a) continue to monitor the highway surface, seal open cracks frequently, patch highway surface at the Mid-Hill slope section location every few years, and undertake a periodic maintenance program to clean and flush existing manholes, sub-horizontal drains and subdrain pipe, or (b) install a pile wall to stabilize the Mid-Hill slope section if the highway conditions start to deteriorate significantly in the future. Option (a) could be attractive in the short-term since this road is classified as low speed low volume roadway.

As recommended in the past, the manhole located at the bottom of the hill (MH#2) will need to be replaced with a proper manhole to allow the flushing of the sub-horizontal drains.

The existing sink hole in the ditch and the drop by the edge of the roadway should be backfilled with either gravel or clay.