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

THURBER ENGINEERING LTD.

| Site Number | Location | Name | Hwy | km |
|---|---|---|---|---|
| NC 010-1 | N. of Gunn& S. of Hwy 651 | **Willow Bend** | 33:04 | 25 |
| **Legal Description** | | **UTM Co-ordinates (NAD 83)** | | |
| SE-28-57-3-W5M | | 11 N 5981184 E 672265 | | |

| | Date | PF | CF | Total |
|---|---|---|---|---|
| **Previous Inspection:** | May 7, 2018 | 11 | 4 | 44 |
| **Current Inspection:** | June 10, 2019 | 11 | 4 | 44 |
| **Road AADT:** | 2470 | | **Year:** | 2018 |
| **Inspected By:** | Tarek Abdelaziz, José Pineda (Thurber)<br>Rishi Adhikari, Arthur Kavulok (TRANS) | | | |
| **Report Attachments:** | ☑ Photographs ☑ Plans ☐ Maintenance Items | | | |

| | | |
|---|---|---|
| **Primary Site Issue:** | Landslide affecting a sidehill section of the highway | |
| **Dimensions:** | About 70 m long | |
| **Date of any remediation:** | N/A | |
| **Maintenance:** | The highway surface was chip sealed in 2010 after the 2010 site visit; patched in fall 2013. Cracks were sealed, and spray patched in 2016; highway surface was patched twice in 2017; west side slope improvements completed by AT in 2019 and included the placement of a clay wedge along the slope to eliminate previous sharp drop off | |
| **Observations:** | **Description** | **Worse?** |
| ☑ Pavement Distress | Sharp drop off (approximately 400 mm high) near the edge of the shoulders on the east side of the highway; 5 to 10 mm dip on the highway SBL | ☐ |
| ☑ Slope Movement | 5 to 20 mm landslide scarp cracks have reflected up through the highway pavement surface; deadfall and tilting fence posts at the toe of the highway side slope; toe roll downslope of tree line near the beaver pond | ☐ |
| ☑ Erosion | Erosion at the inlet and outlet of existing 900 mm Diameter CSP culvert; subsidence along the alignment of the culvert on the inlet side (8 m long x 0.9 m deep x 0.6 m deep) | ☐ |
| ☐ Seepage | | ☐ |
| ☑ Bridge/Culvert Distress | Culvert separated at 0.5 m for the inlet and 4 m from the outlet; water flows under the culvert from the inlet and outlet; localized slump above the culvert outlet (3 m wide x 5 m long); water ponding at the culvert outlet | ☐ |
| ☑ Other | Backslope slump 3 continues to push into the ditch | ☐ |

**Instrumentation: (3SIs, 6SPs)**
SI97-1 and 2 sheared off since Spring 2007. Monitoring of SI97-3 readings was discontinued since fall 2007 as it was located outside the landslide limit. Current groundwater levels below ground surface in the standpipe piezometers range from 2.39 m in SP14-3 to 5.25 m in SP14-1. The groundwater level increased in SP14-1, SP14-3, and SP14-6 by 0.15 m, 0.23m and 0.35 m, respectively since the fall of 2018 readings. The remaining standpipes were buried under the clay wedge placed for the side slope improvement work.

**Assessment** (Refer to attached Drawing)**:**

The site observations indicate that the landslide continued to be active as evidenced from the presence of reflective open cracks on the highway surface. It is anticipated that the landslide will continue to move and cause further deterioration to the highway condition until a suitable long-term remedial measured is implemented.

It is likely that the landslide was triggered due to fill placement to construct the highway and continued rise in ground water levels in the slope. Based on the slope inclinometers installed at this site, the slip surface of the landslide is about 7 m deep below the highway surface. The landslide is bounded by the scarp cracks on the highway surface and is probably toeing out near the beaver pond area.

The west side slope improvements completed by AT eliminated previous sharp drop off along the edge of the road and safety hazard concern for runaway vehicles. However, the existing sharp shoulder along the NBL edge of pavement still constitutes a safety hazard to motorists.

Backslope slump No. 2 appears to active and is partially blocking the highway east ditch. However, it is not currently affecting the highway condition.

Erosion is the likely cause of the separation developed at the inlet and outlet of the 900 mm culvert. The presence of a local slump above the outlet of the pipe may have been caused by the saturation of embankment fill, where the pipe got separated. The slump may continue to get bigger with time and could eventually retrogress to the highway surface.

**Recommendations:**

The local MCI should continue to monitor the highway condition for the development of new cracks, further opening or drop along the surfaces of existing crack, or pavement distress in response to further movement. As a minimum, crack sealing of open cracks should take place to reduce surface water infiltration into the landslide mass. ACP patch should be placed, as needed, to smoothen the roadway surface.

Consideration should be given for placing the least amount of fill off the highway surface to smoothen the existing east side slope sharp drop off and eliminate the existing hazard. Otherwise, sharp shoulders warning signs should be erected to warn the motorists of the existing hazard.

The local MCI should visually inspect and retouch the bottom of the east ditch (i.e. remove the least amount of dirt), if blocked due to backslope slump movements, to enhance the drainage characteristics of the ditch.

Consideration should also be given for repairing the culvert at the inlet and the outlet locations so that it conveys the flow from the pond in a controlled manner below the highway. As a minimum, the separated section of the pipe at the outlet should be excavated and replaced along with repairing the localized slump above the outlet location. Prior to undertaking any repairs, it is also recommended that a CCTV inspection be undertaken from the outlet location of the pipe to check whether it is separated below the highway.

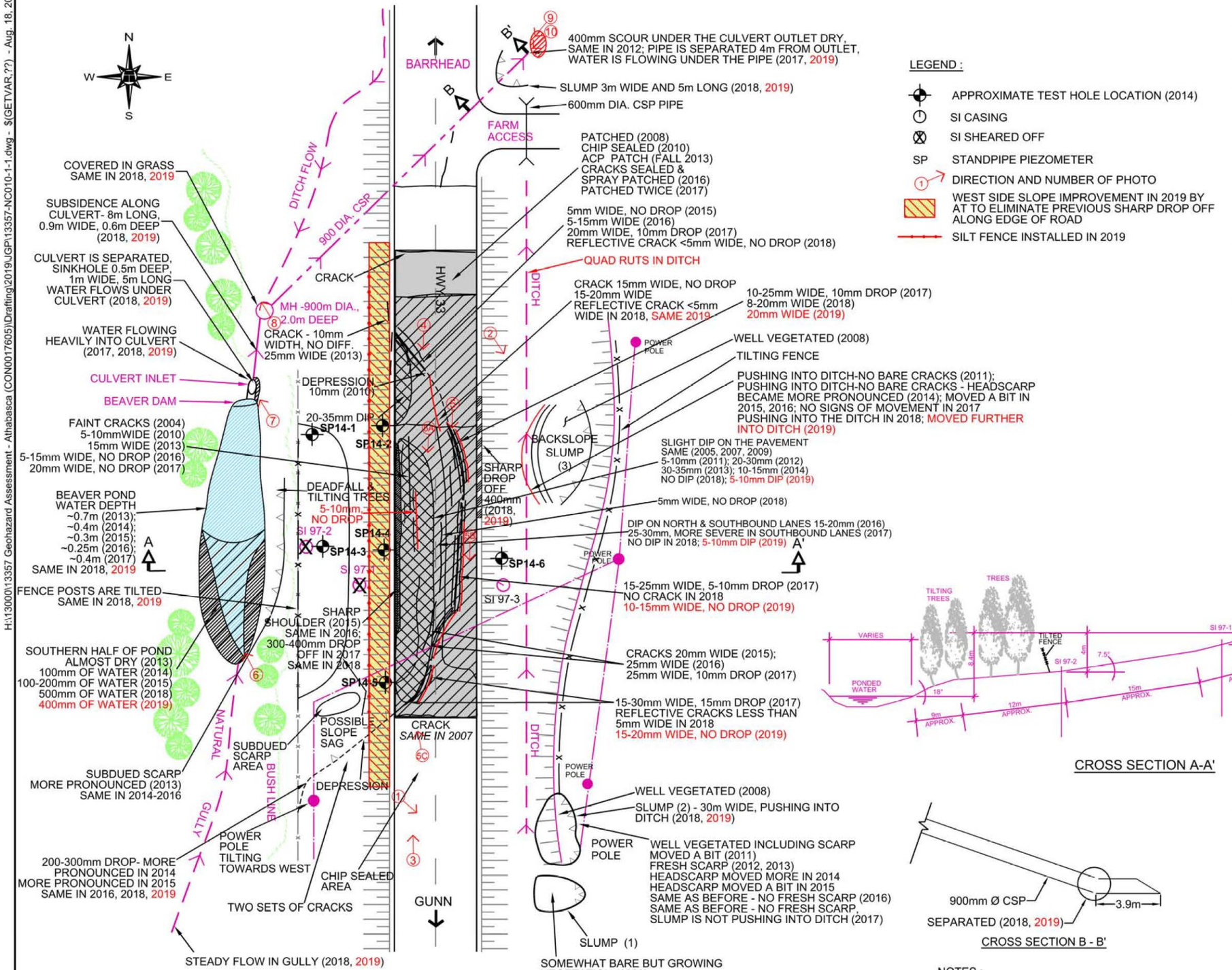
Existing grass and leaves around the drop structure, connected to the inlet of the pipe, should be cleared to enhance surface drainage.

The long-term remedial measure may include any of the following options:

**Option #1:** A toe berm along with the construction of an armoured swale along the top of the berm to convey surface water flow from the gully to the inlet of existing culvert. This option will require right-of-way negotiations, borrow source assessment, and regulatory authorities' approvals (to remove the existing beaver dam, undertake in-stream work and tree clearing), and replacement of the inlet and the outlet of the existing 900 mm diameter culvert. The ballpark cost of this option along with backslope flattening and east ditch grading/armouring would be in the range of $950,000 (Excluding Engineering).

**Option #2:** A pile wall below the west shoulder of the highway to retain the landslide mass. The ballpark cost of this option would be in the range of $1,500,000 (Excluding Engineering). This option will require the re-location of existing Telus lines to the east side of the highway.

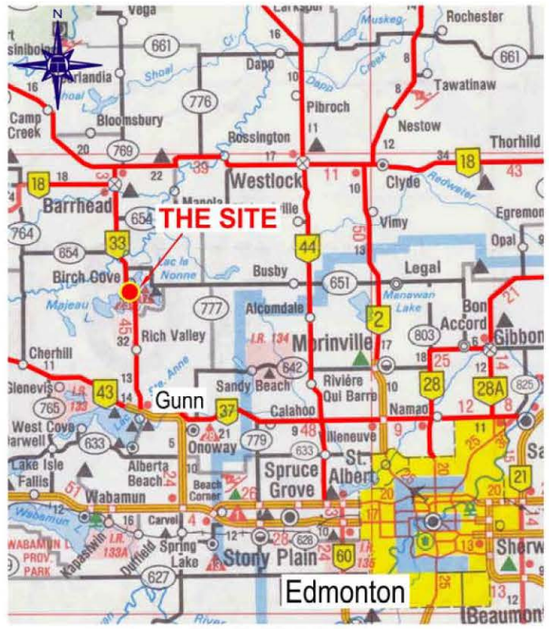
H:\13000\13357 Geohazard Assessment - Athabasca (CON0017605)\Drafting\2019\JGP\13357-NC010-1-1.dwg - $(GETVAR,??) - Aug. 18, 2019




**SITE PLAN**
N.T.S.

LEGEND :

- APPROXIMATE TEST HOLE LOCATION (2014)
- SI CASING
- SI SHEARED OFF
- SP STANDPIPE PIEZOMETER
- (1) DIRECTION AND NUMBER OF PHOTO
- WEST SIDE SLOPE IMPROVEMENT IN 2019 BY AT TO ELIMINATE PREVIOUS SHARP DROP OFF ALONG EDGE OF ROAD
- SILT FENCE INSTALLED IN 2019




**SITE MAP**
NOT TO SCALE




CROSS SECTION A-A'




CROSS SECTION B - B'

NOTES :

1. FEATURE LOCATIONS ARE APPROXIMATE.
2. PREVIOUS OBSERVATIONS SHOWN IN BLACK
3. *JUNE 10, 2019 OBSERVATIONS SHOWN IN RED*

Alberta

**NORTH CENTRAL REGION (ATHABASCA AREA)**
**2019 GEOHAZARD ASSESSMENT**

**NC010-1: HWY 33:04 WILLOW BEND (km 25)**
**SITE PLAN SHOWING SITE FEATURES AND CROSS - SECTION A-A'**

**DWG NO. 13357-NC010-1-1**

| | |
|---|---|
| DRAWN BY | ML |
| DESIGNED BY | JGP |
| APPROVED BY | TSA |
| SCALE | N. T. S. |
| DATE | JULY 2019 |
| FILE No. | 13357 |

Photo No. 1 – Looking southeast at backslope slump No. 1 located to the south of the landslide area

Photo No. 2 – Looking south at slump No.3 located within the limits of the landslide; the toe of the slump is encroaching in the ditch and is partially restraining ditch flow

Photo No. 3 – Clay wedge placed by AT along the west side slope of the highway to eliminate previous sharp drop off (looking north)

Photo No. 4 – Reflective open longitudinal crack near the north flank of the landslide

Photo No. 5 – Looking south at a reflective open longitudinal crack near the north flank of the landslide and a sharp drop off on the east side of the highway (NBL)

Photo No. 5a – Looking south at a reflective open longitudinal crack on the highway SBL near the middle of the landslide

Photo No. 5b – Looking south at a reflective open longitudinal crack on the highway NBL near the middle of the landslide

Photo No. 5c – Looking north at a reflective open diagonal at the southern flank of the landslide

Photo No. 6 – Looking north at the Beaver Pond

Photo No. 7 – Looking north at the separated culvert inlet

Photo No. 8 – Existing manhole, located to the west side of the highway within the bush, is partially covered with grass and leaves; water still flows into the manhole

Photo No. 9 – Water flows under the culvert outlet

Photo No. 10 – Culvert outlet location: culvert is separated at 4 m from outlet.