December 5, 2016 File: 13351

Alberta Transportation
3rd Floor, Provincial Building
9621 – 96 Avenue
Peace River, Alberta
T8S 1T4

Attention: Mr. Ed Szmata

**GEOHAZARD ASSESSMENT PROGRAM**
**CALL-OUT INSPECTION**
**HWY 58:14 km 18 to km 19.5 – WEST OF GARDEN RIVER**

Dear Sir:

In early May 2016, Alberta Transportation (AT) noticed that a 1.5 km section of Highway 58:14 had developed severe rutting. Under the GeoHazard Assessment Program, Thurber was requested by Ed Szmata of AT on July 25, 2016, to conduct a call-out inspection. The inspection was completed on July 27, 2016, by Mr. Ken Froese, P.Eng., Thurber in the presence of Mr. Szmata and AT's Maintenance Contract Inspector (MCI), Paul Catt.

## 1. SITE CONDITIONS

The site encompasses about 1.5 km of the gravel-surfaced Highway 58:14 between km 18 and km 19.5. The site is located about 18 km east of the Wentzel River and about 160 km east of High Level, Alberta. At the time the distress was noted (see attached May 2016 photos), the rutting was about 300 mm to 400 mm deep and had occurred during the spring melt. Mr. Catt had observed that the rutting commenced from the east end of the distressed area and moved to the west as the road deteriorated. At the time, there was significant fuel truck hauling occuring to the Little Red River Cree Nation settlement of Garden River located to the east beyond the end of Highway 58 (which is coincident with the western boundary of Wood Buffalo National Park, WBNP).

It is understood from Mr. Catt that Highway 58 from the west side of the Wentzel River to the border of WBNP was constructed in 2008 or 2009 to replace the winter road that had been the previous access to Garden River. The initial portion of the embankment was placed in winter and consisted of 300 mm of native borrow material over a geogrid over 400 mm to 600 mm of native material placed on a nonwoven geotextile laid directly on the muskeg. It is understood that the muskeg surface was already heavily disturbed due to use as an access trail for all-terrain vehicles and equipment. The fill utilized locally-available borrow which likely consisted of silt or fine sand. It is understood that acceptable clay borrow is relatively scarce in this area. The surfacing gravel was placed the following spring.

Deep rutting was first observed in 2012 starting at about km 18 and extending 200 m to 300 m to the east. This section was repaired by a significant subcut into the subgrade (about 1.2 m deep) and replacement with compacted pitrun gravel. Following that time, traffic volumes were relatively small and consisted primarily of light-weight passenger vehicles. However, over time, the amount of heavy truck traffic has increased due to logging, industrial activity, and a growing population in Garden Creek.

At the time of the site visit in July 2016, the road had already been repaired by the maintenance contractor under the direction of the MCI. According to Mr. Catt, they bridged the soft, rutted area by placing significant quantities of pitrun gravel over the existing surface (after grading out the ruts; however, there was no subexcavation undertaken). The thickness of gravel material placed was up to 0.9 m at the west end and 0.6 m at the east. Mr. Catt observed that the subgrade soils exposed during excavation were typically either very dry or saturated. He also noted that it did not appear that the muskeg had come up into the fill suggesting that the depth of failure did not extend into the sugrade (the native peat). Most of the highway surface through the distressed area appeared to be in good condition at the time of the site visit with some soft areas noted between km 18.34 and km 18.43 and at km 18.70.

In general, the highway embankment was approximately 0.8 m in height, 8 m in width, with 3H:1V sideslopes. Where present, the ditches were shallow and with no distinguishable drainage path. There were numerous areas of ponded water adjacent to the highway. The surrounding terrain was predomintantly peat (muskeg) with low spruce and willow vegetation with a few local areas of slightly higher ground. The terrain to the west of km 18 consists of similar organic desposits and vegetation while east of km 19.5 the ground rises a few metres in elevation and is predominantly tall pine and aspen. There were three centerline culverts identified through the 1.5 km section. The culverts were partially filled with ponded water and no flow was observed. Based on overall topography, the general flow patterns are from the Caribou Mountains to the north toward the Peace River in the south.

Selected photographs taken during the July 2016 site reconnaissance are attached to this letter. Hand probing with a small diameter steel rod was undertaken at a few selected locations to determine the approxmate thickness of organic soils (depth at which a noticeable increase in resistance was encountered). These measurements are summarized in the Table 1.1 along with other related observations. Note that these observations are discussed moving west to east (order of increasing chainage) and the terms “left” and “right” assuming facing in that direction. The highway centerline, stationing, and satellite imagery are shown on Figure 1. Selected photographs taken during the reconnaissance and provided by AT at the time of initial distress are attached to this letter.

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**TABLE 1.1**
**HWY 58:14 SUBGRADE FAILURE OBSERVATIONS**

| Chainage | Muskeg Depth* | Other Observations |
|---|---|---|
| 17.94 | | Start of distressed area with 55kph sign for EBL |
| 18.14 | 0.9-1.0m at 6m LT<br>0.5-0.6m at 5m RT and 0.7-0.8m at RT ROW | 1.5-4.5m tall spruce and willow |
| 18.22 | | CL culvert approximately 2/3 full of water, trace flow toward the south |
| 18.34 | | Start of local soft area of hwy at transition to slightly higher ground with vegetation becoming 15m spruce and aspen |
| 18.43 | | End of local soft area |
| 18.52 | | End of of slightly higher ground with vegetation becoming 3 m high willow with sparse spruce |
| 18.58 | | CL culvert approx. 1.5m diameter half-full of ponded water |
| 18.68 | 0.7m LT ditch<br>0.6m RT ditch | 55kph sign for WBL |
| 18.72 | | Local soft spots |
| 18.90 | 0.9m LT ditch<br>0.5m RT ditch | |
| 18.94 | | CL culvert approx. 1.2m diameter ½ to 2/3 full of ponded water<br>Start of few 4.5-6m spruce |
| 18.98 | 0.7m LT ditch, 0.6m at LT ROW<br>0.4m RT ditch, 0.5m at RT ROW | |
| 19.04 | | Start of few 6-10m spruce with spare aspen |
| 19.11 | 0.6m LT ditch (felt sandy below)<br>0.4m RT ditch | Start of predominantly spruce with some willow and aspen to 6m height |
| 19.20 | | CL culvert approx. 1.0m diameter and dry |
| 19.36 | | Higher ground at RT ROW with 15m aspen |
| 19.38 | Cattails and ponded water LT ditch<br>0.3m soft soil in dry RT ditch | Higher ground at LT ROW with 15m aspen |
| 19.52 | | Plastic-coated approx. 2.8m diameter culvert at minor stream crossing |

Notes: * - LT = left side and RT = right side of highway facing in direction of increasing chainage (east)
CL =centerline
ROW = edge of right-of-way

As mentioned by the MCI, there are some areas between the Wentzel River and 5 km west (Hwy 58:12) that have also experienced deep rutting. At that area, the cause appears to be lateral spreading of the embankment rather than failure of the fill material which is in agreement with the observation made by other AT personnel that the culverts are pulling apart.

## 2. ASSESSMENT

Based on the construction methodology and materials, history of distress, and observations of the ground conditions, it is likely that the subgrade strength is marginal for the vehicle loading this highway is experiencing. As the distress has occurred during spring, is likely that higher surface and groundwater levels combined with partially thawed soils increase moisture level resulting in failure when combined with heavy truck traffic. The failures have not occurred every year which may indicate that either the combination of loading and weak subgrade does not occur every year or it is a progressive failure with the subgrade weakening each spring until it fails. The MCI's observations that the fill material exposed tended to be at the low and high extremes of moisture content which are both low strength conditions for the high silt-content and fine sand native material exacerbates the potential for failure given the organic subgrade conditions. It is surmised that under the right conditions of thawing soils and truck loading that the fill material fails in one spot with subsequent traffic increasing the depth of rutting and essentially breaking through the bridging fill to pushing the failure zone further along the road.

The assessed risk level for this site, based on AT's guidelines (established for landslide scenarios and adapted for this subgrade issue) is 64, based on a Probability Factor of 8 (between inactive with high probability of reactivation and active with moderate rate since the rutting will re-occur though seems to have about a four year cycle) and a Consequence Factor of 8 (although a low-height embankment, closure of the road is would be a direct result of failure and there is no detour available). The road will continue to suffer these cycles of deep rutting until the subgrade is strengthened or the highway fill reinforced to be able to bridge the soft areas of subgrade.

## 3. RECOMMENDATIONS

It is understood that AT intends to trial a new product at this location: Tough-Cell (PRS-Neoweb) as distributed by Paradox Access Solutions who will be undertaking the design of the repair. The Tough-Cell product is a high-strength equivalent of a geocell confinement product which uses a polymer cellular product to impart lateral stability to granular soils providing improved bridging strength. It is understood that this product has been successfully used in industrial applications to construct access roads over peat deposits using otherwise-unsuitable native find sand soils.

As discussed on site with AT representatives, it does appear the deep rutting occuring through this location is the result of the embankment fill material being insufficient, under certain conditions, to bridge the soft underlying peat deposits. One alternative would be to rebuild much of the fill using either higher-quality material or conventional geosynthetics products such as woven geotextiles and geogrids to improve the lateral stability of the embankment. However, given that the local borrow material is of marginal strength, use of a geocell-type product appears to be a reasonable alternative solution.

Based on the distance of distress repaired in Spring 2016, the minimum recommended length of highway to reconstruct is from km 17.9 to the dry culvert just west of the highway ground at km 19.2. The total length is 1.3 km. However, as discussed on site with AT personnel, the embankment is also constructed over muskeg further to the west and consideration should be given to extending the repair to km 17.10 where the higher ground resumes. That would increase the total length to 2.1 km.

It is recommended that consideration be given to using the existing embankment material in the reconstruction. The existing embankment could be excavated one lane at a time (to allow continuous traffic access) and not to the full depth to avoid breaking through into the underlying peat. The base of the subcut would then be smoothed and covered with a woven geotextile and Tough-Cell placed above and filled with the excavated embankment fill material thus limiting the amount of additional borrow required. Alternatively, the depth of the subcut could be reduced with the Tough Cell then placed in the upper half of the embankment and filled with borrow material before using the existing material to restore the driving surface above. It is recommended that the manufacturer/supplier be consulted in this determination. It should be noted that the borrow areas developed during construction of this alignment have been restored and that developing new borrow sources would require authorization from both provincial and federal governments and the Little Red River Cree Nation.

The general fill conditions would be improved with better drainage in the area; however, as the ground is flat-lying, there does not appear to be a practical way to improve ditch grading.

It is recommended that the rutted section immediately west of the Wentzel River could also be improved using Tough Cell to reduce lateral spreading of the embankment. Consideration should be given to repairing this section at the same time or utilizing the current repair location as a test section and repairing Highway 58:12 once the product has been proven.

An estimated cost for this work (reconstructing approximately 1.5 km of highway) is difficult to provide as the selected repair method will be utilizing a trial product with the design undertaken by the supplier. However, it is anticipated to be similar to the $600,000 spent in the spring of 2016 by the MCI to undertake the temporary repair with pitrun gravel. Cost of the aggregate used are not included in this estimate as existing stockpiles were used; however, if the material in the embankment can be re-used, than additional gravel sourcing and hauling will also not be required.

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## 4. CLOSURE

We trust this is the information you require at this time. If you have any questions, or if you require further information or recommendations, please contact us at your convenience.

Yours very truly,
Thurber Engineering Ltd.
Don Proudfoot, M.Eng., P. Eng.
Review Principal


**PERMIT TO PRACTICE**
THURBER ENGINEERING LTD.
Signature ______________
Date December 5, 2016
**PERMIT NUMBER: P 5186**
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Ken Froese, M. Eng., P. Eng.
Project Engineer
/lg

Attachments:
- Photos
- Figure 1

AT Photo 1: Distress in May 2016.

AT Photo 2: Closer view of May 2016 rut.

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AT Photo 3: Distress in May 2016.

TEL Photo 1: Looking east toward start of distressed and note the thickness of pitrun placed in May 2016.

TEL Photo 2: Looking west along highway near west end of distress showing typical muskeg terrain.

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TEL Photo 3: Looking east toward slightly higher ground between km 18.34 and km 18.43.

TEL Photo 4: Looking west at local soft spots between km 18.34 and km 18.43.

TEL Photo 5: Looking west from km 19.0. near east end of distressed area.

TEL Photo 6: Looking west from km 18.1 near west end of distressed area.


SATELLITE IMAGERY FROM ESRI WORLD IMAGERY DOWNLOADED JULY 26, 2016

0 200 400 600 800m

SCALE 1:15000

Alberta
Transportation

**PEACE REGION (PEACE RIVER/HIGH LEVEL)**
**HWY 58:14 km 18.0 TO km 19.5**
**WEST OF GARDEN RIVER**

**JULY 27, 2016 CALLOUT INSPECTION PLAN**

**FIGURE 1**

| | |
|---|---|
| DRAWN BY | KLW |
| DESIGNED BY | KEF |
| APPROVED BY | DWP |
| SCALE | 1:15 000 |
| DATE | JULY 27, 2016 |
| FILE No. | 13351 |

THURBER ENGINEERING LTD.