November 2014

CG25399

Alberta Transportation
2nd Floor, 803 Manning Road NE
Calgary, AB T2E 7M8

Attention: Mr. Ross Dickson

Dear Ross:

Re: Southern Region Geohazard Assessment
Fall 2014 Instrumentation Monitoring Results
Site S16: Highway 22:08, Chain Lakes

This letter documents the Fall 2014 instrument readings at the above-noted site and can be inserted into Section C of the site binder. The updated site plan, instrument data, and plots are also attached and can be inserted into Section D of the site binder.

1.0 SUMMARY

The site conditions are relatively unchanged from the Fall 2013 inspection. There is ongoing, relatively minor movement measured at both SI's at comparable rates that have been observed since 2009. The rate and magnitudes of movement in the SI upslope of the pile wall have been lower than those measured downslope of the wall, which is interpreted as the stabilizing effect of the wall. The annual readings should continue until movement rates upslope of the pile wall become negligible. If road damage is observed the frequency of readings should be increased and the site should be inspected during the annual tour.

2.0 OBSERVATIONS

2.1 Field Program and Instrumentation Status

Two slope inclinometers (SI's) were read at the S16 – Chain Lakes site on Hwy 22:08, on September 17, 2014 by Nicole Wilder, EIT; of AMEC Environment & Infrastructure (AMEC), a division of AMEC Americas Limited.

The slope inclinometer (SI) probe AMEC used in previous years (serial number 25424) was destroyed in 2013. As a result, DGSI's "Digitilt AT Inclinometer System" (serial number 1339108) was used for this year's readings and will be used going forward. This system was selected for its improved portability and better accuracy. Comparison of the new AT system data to the classic probe system requires manual data interpretation resulting in potentially less accurate readings.

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AMEC performed the interpretation and found good agreement with the previous results. This provides confidence that the readings are directly comparable. The SI data plots will be reset with the 2014 readings as the initial data set for future readings to ensure that no errors are present due to data manipulation. Previously noted movement zones and depths will be marked on the new figures and tracked on the cumulative displacement plots.

The instruments at this site were installed in the spring of 2007 in order to monitor for post-construction landslide movement around a tied-back pile wall that was installed in 2006 in the west slope of the road fill embankment. The pile wall was installed to support the highway embankment as part of the repair for a July 2005 landslide that took the southbound lane of the highway out of service. The pile wall was installed into the clay shale bedrock underlying the site, with the base of the pile wall in the order of 5 m below the elevation of the July 2005 landslide failure surface. Please refer to Figure S16-1 (attached in Section D) for the site layout and instrument locations.

3.0 INTERPRETATION AND RECOMMENDATIONS

3.1 General

Plots of the SI data are presented in Section D and are summarized in the following sections. Where applicable, the resultant movement has also been plotted. Note that all elevations are referenced to a site datum of 100 m.

3.2 Zones of Movement

SI 2007-1 has two previously confirmed zones of movement. The primary movement zone is between 7 to 8 m depth below ground surface and has shown ongoing movement since installation. There is additional movement in the upper 1.5 m; however this displacement has historically been assessed as shallow creep that is part of the same 7 to 8 m depth movement zone. Another movement zone was noted between 9 to 10 m depth from the May 2009 data; however, this zone has shown minor cumulative displacement (approximately 5 mm) since it was identified.

There is one previously confirmed zone of movement in SI 2007-2 at approximately 6 to 7 m depth below ground surface.

No new potential zones of movement were identified in the Fall 2014 data.

3.3 Interpretation of Monitoring Results and Recommendations

3.3.1 Interpretation

SI 2007-1 (Figures S16-2, S16-3 and S16-6)

This SI is located approximately 2 m upslope of the pile wall centerline. The data from this SI shows two active movement zones since May 2007:

- Approximately 12.5 mm of cumulative movement has been measured towards a bearing of 233° at 91.6 m elevation (around 8 m depth) as of the September 2014 readings. The rate of movement has been relatively steady at approximately 1 mm/year since 2009, and was slightly reduced from the 2012 to 2013 rate. This movement is interpreted to be occurring in the native clay soils underlying the fill.

- Approximately 5.2 mm of movement occurred towards a bearing of 230° in a zone at 89.2 m elevation (approximately 9.3 m depth). The incremental movement at the zone since October 2013 was approximately 1 mm. It remains inconclusive that this is an actual movement zone due to the small magnitude of movement and lack of a definitive movement trend.

SI 2007-2 (Figures S16-4, S16-5 and S16-6)

This SI is located approximately 6 m downslope of the pile wall centerline. The data from this SI shows one active movement zone since May 2007:

- Approximately 42.5 mm of cumulative movement towards 221° in a zone at 90.6 m elevation (around 6 m depth). There has been 3.4 mm of incremental movement since the October 2013 readings. The rate of movement has been relatively steady at approximately 3 mm/year since Fall 2009. The rate of movement has decreased significantly from the 2007 readings when the movement rate was measured up to 37 mm/year. This drop in the rate of movement is interpreted as the stabilization effect of the pile wall as it attained the full load of the landslide mass. The soils encountered in Borehole 2007-2 were not logged in detail prior to the installation of the SI. However, based on the subsurface information available from other boreholes at this site it is expected that the movement is within native clay soils above the bedrock.In summary, the September 2014 data shows that:

- The ongoing movement zones in both of the SIs at 90.6 to 91.6 m elevation likely correspond to post-construction movement along the failure surface of the July 2005 landslide. The previous SI 2005-5, which was installed prior to the pile wall repair, showed movement at 91.9 m elevation.

- As shown on Figure S16-6, the post-repair movement upslope of the pile wall is significantly less than the movement measured around the same elevation and downslope

of the pile wall. The movement in SI 2007-2 downslope of the pile wall likely represents continued movement along the July 2005 landslide failure surface at similar movement rates measured in the last several years. The approximately 13 mm of movement measured in SI 2007-1 upslope of the pile wall likely represents similar movement, but limited to the nominal amount required to load the wall.

- The rate of movement at the upper SI since 2009 has been lower than the 2007 and 2008 rates. The reduced rate of movement in SI 2007-1 upslope of the pile wall, and the concurrent reduction (apart from seasonal fluctuations) in movement rate at SI 2007-2 in the area downslope of the pile wall likely indicates that the pile wall is acting to stabilize the embankment.

3.3.2 Recommendations

Based on the monitoring results and observations, AMEC recommends that:

- AMEC recommends that annual readings continue at this site until the movement rates become negligible at SI 2007-1 using the new probe system. The 2015 data plots will be reset with the September 2014 data as the initial set to reduce comparison errors between the probes.

- Additional readings should be taken if the maintenance contractor notes new damage to the road surface or there are other indications that the road embankment may be unstable despite the reinforcement from the pile wall.

- If the monitoring data shows increased movement rates at unexpected locations (upslope of the pile wall) or there is observed damage to the road surface the site should be inspected during the annual tour.

4.0 INSTRUMENTATION REPAIRS AND MAINTENANCE REQUIRED

No repairs or maintenance are required.

TABLE S16-1: FALL 2014 – CHAIN LAKES
Slope Inclinometer Instrumentation
Reading Summary

Date Monitored: September 17, 2014

INSTRUMENT NAME AND COORDINATES (LATITUDE AND LONGITUDE)	DATE INITIALIZED	TOTAL CUMULATIVE RESULTANT MOVEMENT AT DEPTH SINCE INITIAL READING	MAXIMUM RATE OF MOVEMENT	CURRENT STATUS	DATE OF PREVIOUS READING	SINCE PREVIOUS READING		
						INCREMENTAL MOVEMENT	RATE OF MOVEMENT	CHANGE IN RATE OF MOVEMENT
2007-1 (50°10'.146N, 114°11'.001W) Upslope Of Pile Wall	May 15, 2007	12.5 mm at 6.9 m at 233°	6.5mm/yr (March to September 2007)	Operational	10/15/2013	+0.9 mm	+1.0 mm/yr	-0.8 mm/yr
2007-2 (50°10'.146N, 114°11'.011W) Downslope Of Pile Wall	May 15, 2007	42.5 mm at 5.7 m at 221°	37mm/yr (March to September 2007)	Operational	10/15/2013	+3.4 mm	+3.6 mm/yr	-0.1 mm/yr

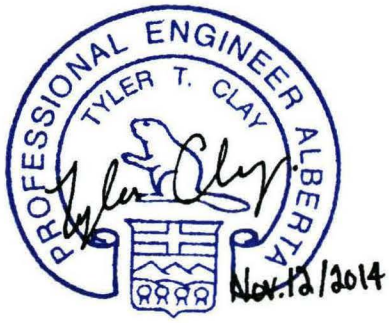
5.0 CLOSURE

This report has been prepared for the exclusive use of Alberta Transportation for the specific project described herein. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it are the responsibility of such third parties. AMEC Environment & Infrastructure, a division of AMEC Americas Limited, cannot accept responsibility for such damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This report has been prepared in accordance with accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

We trust that this meets your needs at this time. Please contact the undersigned if you have any questions or require any further information.

Respectfully Submitted,

AMEC Environment & Infrastructure,
a division of AMEC Americas Limited



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APEGA Permit to Practice No. P-04546

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