



29 March 2017

Government of Yukon
Energy, Mines and Resources
Assessment and Abandoned Mines
#2C, 4114-4th Avenue
P.O. Box 2703 (K-419)
Whitehorse, YT Y1A 2C6

Attn: Mr. Erik Pit, Senior Project Manager

RE: CLINTON CREEK - ASSESSMENT OF RECENT EARTHQUAKE EFFECTS AND ANY IMPLICATIONS FOR THE STABILITY OF THE WASTE ROCK AND TAILINGS DUMPS

1 Introduction

WorleyParsons Canada Services Ltd, operating as Advisian, was retained to assess the impact of a recent earthquake (February 20, 2017, with a magnitude of 3.8), on the waste and tailings dumps and infrastructure at the abandoned Clinton Creek mine site. The earthquake occurred approximately 230 km south of the Clinton Creek mine site.

The scope of work of this letter includes a prediction of peak ground motions at the mine site, from the above-mentioned earthquake. This prediction provides a benchmark to evaluate the likelihood of any damage occurring on the tailing and water ponds and associated structures.

2 Ground Motion Assessment

Ground motion prediction equations (GMPE) for application to the National Building Code of Canada have been elaborated by Atkinson and Adams, 2013 [Ref. 1]. This paper refers to two major studies performed by Atkinson and Boore, 2011 [Ref. 2] and Boore and Atkinson, 2008 [Ref. 3] that provide ground motion prediction equations for Eastern and Western (North America) earthquakes.

The ground motion prediction equations, as noted above, are quite complex and contain multiple terms and functions. In general, these equations include earthquake magnitude scaling, an earthquake distance function and a site amplification term.

For the study site, the GMPE of Boore and Atkinson was applied to estimate the peak ground motion. At the site, for an earthquake magnitude of 3.8 and epicentral distance of 230 km, the Peak Ground Acceleration (PGA) was assessed. A PGA of 0.001 g (0.1 percent of gravitational acceleration) was estimated. This ground acceleration lies within a "weak motion" range and is small. This low PGA indicates that potential damage on the site facilities at Clinton Creek resulting from the recent earthquake is unlikely.



For context, it is noted that in a 250 km radius around the mine, since its closure in 1978, until now there have been 231 earthquakes of magnitude 3.8 or higher, the highest being magnitude 5.5 in 2006 and more recently magnitude 5.3 on February 13, 2017 on the Alaska side of the border, both of which were at a similar distance from the site. For these 5.3 and 5.5 magnitude events, a PGA of approximately 0.008 g (0.8 percent of gravitational acceleration) was assessed. This acceleration is also within a weak motion range and potential damages are unlikely from these events.

Based on the above assessment, we do not recommend any further action arising from the recent earthquake; however inspections of the site should be continued as per usual schedule and practice for ongoing monitoring as per the Clinton Creek Long Term Monitoring Plan.

3 References

1. Ground motion prediction equations for application to the 2015 Canadian National Seismic Hazard maps, 2013, Atkinson, G M A; Adams, J, Canadian Journal of Civil Engineering vol. 40, 2013; p. 988-998, [DOI:10.1139/cjce-2012-0544](https://doi.org/10.1139/cjce-2012-0544)
2. Modifications to existing ground-motion prediction equations in light of new data, 2011, G.M. Atkinson and D.M. Boore , Bulletin of the Seismological Society of America, DOI:[10.1785/0120100270](https://doi.org/10.1785/0120100270)
3. Ground-motion prediction equations for the average horizontal component of PGA, PGV, and 5%-damped PSA at spectral periods between 0.01 s and 10.0 s, 2008, D.M. Boore and G.M. Atkinson, Earthquake Spectra, DOI:[10.1193/1.2830434](https://doi.org/10.1193/1.2830434)
4. US Geological Survey (USGS), USGS Earthquake Hazards Program earthquake database and map: <https://earthquake.usgs.gov/earthquakes/map>



4 Closure

We trust that this letter satisfies your current requirements and provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned at any time.

Report Prepared by:

A handwritten signature in blue ink, appearing to read 'K. BANAB' with a stylized flourish above it.

Kasgin K. Banab, Ph.D., P.Eng.
Geotechnical Engineer

Senior Review by:

A handwritten signature in black ink, appearing to read 'Fred Claridge'.

Fred Claridge, M.S., P.Eng.
Senior Technical Director (Geotechnical)