

20 December 2018

Reference No. 1773474_7407-001-LR-Rev0-1023_0002

2016 Kaikoura Earthquake Recovery Manager

Kaikoura District Council
PO Box 6
Kaikoura 7340

93 WAITANE ROAD, OARO – DANGEROUS BUILDING RISK ASSESSMENT

Dear Recovery Manager

1.0 INTRODUCTION

This letter report¹ documents a dangerous building risk re-assessment for the residential dwelling located at 93 Waitane Road, Oaro, undertaken by Golder Associates (NZ) Limited (Golder). Golder completed a previous assessment of the site in 2017².

The dwelling was issued with a Section 124 notice in August 2017 because of slope instability hazard following the 14 November 2016 Kaikoura earthquake. This letter report builds on that previous knowledge considering 20 months of observed performance since the earthquake.

The current report:

- Draws together dangerous building risk assessment criteria
- Re-assesses the likelihood and consequences of slope instability hazard, accounting for uncertainty
- Compares dangerous building risk criteria to the assessed likelihood and consequences
- Identifies potential slope instability risk mitigation options

This report does not make a recommendation on whether the dwelling on this property should or should not be considered a dangerous building, but rather provides the information to assist Kaikoura District Council when making their assessment.

This work has been undertaken under the existing agreement between Kaikoura District Council and Golder. This report does not assess all possible natural hazards that may affect the site – only those that have been identified on the Civil Defence Emergency Management placards placed on the buildings following the November 2016 earthquake. The scope for the assessment of hazards in this report is focused on providing Kaikoura District Council with information so that they can make an informed dangerous building assessment. A more detailed analysis may result in alternative recommendations.

¹ This letter report is provided subject to the attached Report Limitations.

² Golder (2017a): 93 Waitane Road, Oaro, Kaikoura – CDEM Placard Reassessment and Section 124 Notice: Report 1773474_7407-001-LR-Rev1-1018_0097 to Kaikoura District Council, dated August 2017.

2.0 OBSERVATIONS OF ROCKFALL AFFECTING THE PROPERTY

Rockfall affecting the occupied dwelling on the property, as a result of the 2016 Kaikoura earthquake was described in Golder 2017a. The key observations were:

- The dwelling is located at the base of a steep slope and adjacent to the Hundalee Fault that ruptured during the 2016 Kaikoura earthquake.
- Collapse of the slope during the earthquake resulted in significant rockfall including some boulders that hit the veranda of the dwelling.
- No occupant was injured or killed because of this rockfall.

Observations from new site visit

An engineering geologist from Golder visited the site on 27 August 2018. The objective of the site visit was to observe and record any evidence of ongoing slope instability that has affected the site since the last site visit in August 2017.

The following observations were made during the site visit:

- The dwelling at the site has a red notice taped to the window indicating that it is a dangerous building in accordance with Section 124 of the Building Act 2004 due to being in a '*debris avalanche runout*' zone.
- The dwelling was unoccupied at the time of the visit.
- No evidence was observed of new rockfall boulders having hit or travelled past the dwelling. However, there are several large boulders in the vicinity of the dwelling and some may have resulted from rockfall since the earthquake.
- Many boulders were observed on the slope above the dwelling and, along with the heavily dilated rock outcropping in the upper part of the slope, and a significant tension crack at the crest of the slope represent a significant source area for ongoing slope instability.

During the period of nearly two years since the 2016 Kaikoura earthquake several factors relevant to rockfall hazard at the site are evident:

- **Aftershock sequence:** Kaikoura has moved through a period of heightened earthquake aftershock activity immediately following the 2016 Kaikoura earthquake and earthquake likelihood is now approaching the background level³. Earthquakes are a common trigger for slope instability.
- **Heavy rainfall events:** Several heavy rainfall events have affected the Kaikoura Coast since the 2016 Kaikoura earthquake. The nearest rain fall gauge is located at Rosy Morn⁴, about 7 km from the site. Several significant rainfall events have been recorded since November 2016, including ex-tropical cyclone Gita (20 February 2018) which resulted in about 300 mm of rainfall in 24 hours at the Rosy Morn rain gauge. This is estimated to have a return period in excess of 100 years. We note that this is useful information but that there is likely a high degree of spatial variation in rainfall events due to the geography of the region and the nature of the storms.

³ <https://www.geonet.org.nz/earthquake/forecast/>.

⁴ <https://ecan.govt.nz/data/rainfall-data/>.

It is unclear whether any of the rockfall boulders that are present around the dwelling have occurred since the earthquake or as the result of any of the heavy rainfall events. Potential additional trigger mechanisms that could have generated rockfall during the period or could generate future rockfall include:

- Livestock on the slope
- Scour of supporting material
- Impact from a smaller boulder
- Fire
- Earthworks or other human activities on the slope.

3.0 EVALUATION CRITERIA FOR *DANGEROUS* BUILDINGS

Under the Building Act 2004:

- Section 121, a building is dangerous if... “*in the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death (whether by collapse or otherwise) to any persons in it or to persons on other property or damage to other property.*”
- If a territorial authority is satisfied that a building is dangerous it may issue a Section 124 notice to prevent people from occupying or approaching the building.
- In the context of the Building Act, ‘*in the ordinary course of events*’ has been interpreted as ‘*...likely to be encountered in the course of a year... but would exclude incidents not normally occurring, such as, for example, 50-year floods and cyclones.*’ (Judge McGuire, DC Rotorua NP966/97). Likely in the context of the Building Act has been interpreted as: ‘*likely does not mean probable, as that puts the test too high. On the other hand, a mere possibility is not enough. What is required is “a reasonable consequence or [something which] could well happen”.*’ (Judge Boshier, DC Auckland NP2627/95, [196] DCR 635).
- Golder refers to the test for “likely”, as per the 2012 High Court judgement of *The Wanaka Gym Limited v Queenstown Lake District Council*⁵, which upholds an earlier judgement by the District Court.

“In *Weldon Properties Ltd v Auckland City Council* this Court upheld a District Court judgement in which it was stated that “likely” for the purposes of the predecessor section to s 121 does not mean “probably”, as that puts the test too high. On the other hand, a mere possibility is not enough, so it has to be a reasonable consequence or something that could well happen”.

While we are unable to provide advice on the legal interpretation of the test, from a geotechnical perspective we interpret that a reasonable definition of probability of injury or death consistent with the legal interpretations above of ‘likely in the ordinary course of events’ is between 10 % and 50 % probability in 50 years, which equates to annual probability of 1/475 and 1/73 respectively.

These criteria are shown graphically on Figure 1 using the likelihood and consequence tables in Attachment B that have been developed for this study.

- The guidance is unequivocal that the consequence must exceed minor injuries, so risk of minor injuries and lesser consequences are not considered as slope instability risk for dangerous building assessment.

⁵ High Court of New Zealand, Invercargill Registry. *The Wanaka Gym Limited v Queenstown Lakes District Council*. CRI-2011-425-00002, CRI-2011-425-00003 [2012] NZHC 284, dated 27 February 2012.

The heavy black vertical line on Figure 1 represents the boundary between where the consequence exceeds a minor injury and where hospitalisation may be required. Therefore, the area to the right of that line can be considered to exceed the consequence criteria.

- The two heavy black horizontal lines represent annual probabilities of 1/475 (dashed line) and 1/73 (solid line) likelihood criteria. The area of the graph above each of these criteria can be considered to exceed each likelihood criteria.
- The dashed and solid red lines are lines of constant slope instability risk derived using the intersection of the two likelihood acceptance criteria and the consequence acceptance criterion.

4.0 SLOPE INSTABILITY RISK ASSESSMENT

For this study, the risk to the dwelling occupants from slope instability, has been estimated by presenting a judgement-based assessment of the likelihood and consequences of slope instability. Slope instability at this site is dominated by rock and debris slide mechanisms and associated rockfall. The uncertainty in the likelihood and consequence estimates is accounted for by assigning a range of values for each parameter as per the likelihood and consequence tables in Attachment B.

Our estimated likelihood of slope instability impacting on the buildings on the properties could be as low as 1/20 per year or as high as 1/2 per year with a most likely probability of 1/5 per year.

The consequences of very minor rockfall affecting the dwelling could be limited property damage (0.31). A large debris slide affecting the dwelling could result in significant damage and possible fatalities (0.8). We think the most likely consequence of slope instability hitting the dwelling is significant damage with injuries possible but without death occurring (0.6).

This assessment is shown on Figure 1 as the coloured map that presents the combined probability distribution of the estimated consequence and likelihood.

- The horizontal axis labelled at the bottom represents the consequences and a green line graph inside that axis shows the assessed distribution of consequence described above.
- The vertical axis labelled on the left represents the likelihood and a green line graph inside that axis shows the assessed distribution of likelihood described above.
- The slope instability risk distribution is defined as the likelihood multiplied by the consequence so at each point in the field presented in Figure 1 the probability is shown as a colour. The risk probability is calculated in a 100x100 bin matrix.

5.0 SLOPE INSTABILITY RISK ASSESSMENT COMPARED TO DANGEROUS BUILDING CRITERIA

By combining the estimates of likelihood and consequence presented in Section 4.0, we calculated a risk distribution that can be compared to the dangerous building criteria (presented in Section 3.0) as illustrated in Figure 1. Based on this assessment we calculate there is a 43 % probability that the slope instability risk exceeds the dangerous building criteria for 93 Waitane Road.

This dangerous building risk assessment is not definitive and accounts for the fact that we have imperfect knowledge of the likelihood and consequences of the slope instability hazard affecting these properties. Further investigations and analysis may reduce the uncertainty. We would expect that the risk would still fall

within the uncertainty range described in this study unless the hazard changes, which could occur over time as our understanding of hazards change or as the slope evolves.

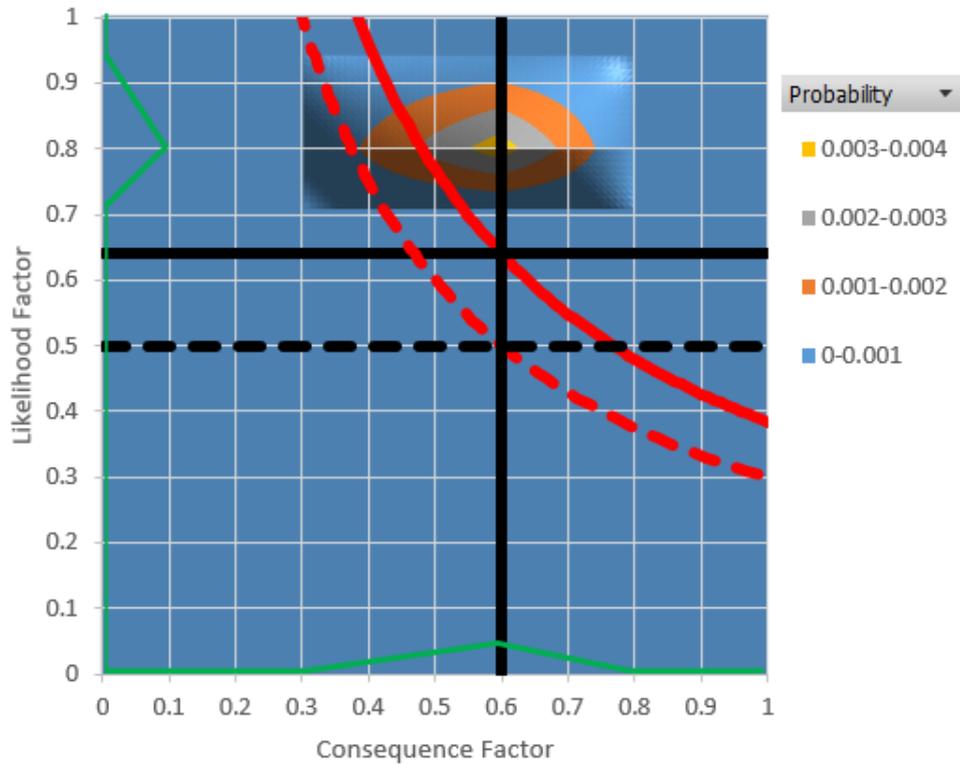


Figure 1: Criteria and assessment for dangerous building assessment. Likelihood and consequence factors are defined in Attachment B. Criteria are shown as black and red lines. The assessed range of likelihood- and consequence- factors are shown as green lines on the left and bottom axes, the combined probability of the assessed likelihood and consequence is shown as probability by colour bands.

6.0 MITIGATION OPTIONS

Given the layout of the property with the dwelling located on a narrow strip of land between the toe of the slope and the railway lines, we believe that mitigation of the slope instability hazard would be difficult to significantly reduce the risk for occupants. We believe that moving the dwelling to an alternative site is the most effective way to mitigate the hazard.

7.0 CLOSURE

We trust this meets your current requirements. Should you have any queries, or require further clarification, please do not hesitate to contact the undersigned.

Yours sincerely

GOLDER ASSOCIATES (NZ) LIMITED



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Attachments: Attachment A – Report Limitations
Attachment B – Dangerous Building Assessment Criteria

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Attachment A – Report Limitations

This Report/Document has been provided by Golder Associates (NZ) Limited (“Golder”) subject to the following limitations:

- i) This Report/Document has been prepared for the particular purpose outlined in Golder’s proposal and no responsibility is accepted for the use of this Report/Document, in whole or in part, in other contexts or for any other purpose.
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- iv) The passage of time affects the information and assessment provided in this Report/Document. Golder’s opinions are based upon information that existed at the time of the production of the Report/Document. The Services provided allowed Golder to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.
- v) Any assessments, designs and advice made in this Report/Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Report/Document.
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- vii) The Client acknowledges that Golder may have retained subconsultants affiliated with Golder to provide Services for the benefit of Golder. Golder will be fully responsible to the Client for the Services and work done by all of its subconsultants and subcontractors. The Client agrees that it will only assert claims against and seek to recover losses, damages or other liabilities from Golder and not Golder’s affiliated companies. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any legal recourse, and waives any expense, loss, claim, demand, or cause of action, against Golder’s affiliated companies, and their employees, officers and directors.
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Attachment B – Dangerous Building Assessment Criteria

Table 1: Likelihood criteria.

Likelihood	Probability of occurring in each year		Probability of occurring in 50 years	Likelihood Factor
Almost certain	100%	1/1	100%	0.9-1.0
	20%	1/5	99.999%	
Very likely	5%	1/20	92%	0.8-0.9
Likely	1%	1/100	39%	0.7-0.8
Possible	0.4%	1/250	18%	0.6-0.7
Unlikely	0.2%	1/500	10%	0.5-0.6
Very unlikely	0.1%	1/1000	5%	0.4-0.5
Rare	0.04%	1/2500	2%	0.3-0.4
Very rare	0.02%	1/5000	1%	0.2-0.3
Extremely rare	0.01%	1/10000	0.5%	0.1-0.2
Almost impossible				0.0-0.1

Table 2: Consequence criteria.

General descriptor	Example consequence to persons	Consequence Factor
Cataclysmic	Loss of hundreds of lives	0.9-1.0
	Loss of tens of lives or 100 serious injuries	
Catastrophic	Loss of 1 life or 10 serious injuries	0.8-0.9
Disastrous	1 Serious injury requiring hospitalization or 10 minor injuries	0.7-0.8
Major	Minor injury to person	0.6-0.7
Moderate	Highly inconvenient	0.5-0.6
Low-Moderate	Inconvenient	0.4-0.5
Low	Slightly inconvenient	0.3-0.4
Minor	Noticed	0.2-0.3
Very Minor	Unnoticeable	0.1-0.2
Negligible		0-0.1