

Tauranga City Council
Private bag 12022
Tauranga

7 May 2009

For the attention of [REDACTED] s 7(2)(f)(ii)

Dear [REDACTED] s 7(2)(f)(ii)

Rockfall on Mauao; Risk to proposed campground development

Thanks for your call. I have reviewed our previous work, also taking into account more recent rockfall events. Please find a report set out below:

Introduction

As we know, Mauao's lower slopes are littered with numerous surface boulders. These may represent thousands of years of rockfall but all have clearly fallen from the rock outcrops above.

Much of our previous work included looking at the incremental risks to persons walking on the various tracks on Mauao (many of which are threatened by small and large rocks). When considering the campground in isolation the assessment is somewhat simpler as only large boulders have the energy to travel the distances involved.

The assessment of the risk in the campground might also be made more intuitive by estimating how often a boulder might be expected to enter the camp and subjectively evaluating whether or not this is acceptable. This is the approach taken below.

A brief review of recorded natural boulder falls 2003 to 2009

July 2004; Earthquake

A series of minor earthquakes (10 year return period magnitude) triggered many small rockfalls and slips. 15 slips were greater than 1m³, at least one of which released an easily identifiable boulder, which travelled a few hundred metres and can be seen in the photograph below.



Photo' 1. Boulder travelled 300m on Northern slopes of Mauao.

May 2005; Floods

350mm of rain fell within 24hrs, a predicted 1 in 100 year event. Around thirty significant soil slips were triggered, three of which marginally affected the campground.



Photo' 2. 250m³ slip near campground.

Boulder falls were triggered although none were in the vicinity of the campground.



Photo' 3. Boulders which fell on the south west slopes.

June 2005; The floods ongoing effects

After further intense rain a 20 tonne boulder fell 25m and came to rest against the campground boundary fence.



Photo' 3. Large boulder stopped at camp fence.

September 2005; Boulder kills lambs above campground

An example of the type of movement which could go unnoticed.

A boulder above the campground slid a short distance during rain and killed two sheltering lambs. On steep enough terrain such a boulder could have gained speed and travel much further.



Photo' 4. Boulder movement above campground.

June 2007; Boulders fall from rock outcrop.



Photo' 4. Northern slopes boulder fall; damage to Oruahine track (outcrop inset).

A rock outcrop high on the northern slopes collapsed releasing 7.5 tonnes of boulders. These boulders travelled to the shoreline, narrowly missing a walker on the base track. There was no obvious trigger other than natural erosion to the point of collapse.

Estimate of the frequency of falling boulders

Our last review was in July 2006. At that time we were estimating a boulder frequency into the campground of around 0.013/yr.

We can update this again with reference to the events listed above, in which we recorded around six recorded boulders in the six years on all of Mauao, however, it is likely that some went unrecorded so maybe we should say six to twelve boulders; 1 to 2 per year?

Boulders reaching the campground

Next we need to consider; as these boulders fall over all of Mauao, what might be the probability that one will be on a trajectory towards the campground, and what chance it will actually cross the boundary fence.

As the campsite boundary represents a 55° sector when viewed from the summit, we could approximate that 55/360 or 15% of boulders fall in this zone.

15% of the estimated total 1 to 2 boulders per year = 0.15 to 0.3 boulders per year (one every four years).

We have excellent evidence on travel distances, recorded during blasting work carried out in 2003 to remove boulders on the bluff high above the campground:



Photo' 5. Blasted boulders reaching campground.

May 11, 2009

For boulders of around 1m³ falling from the upper bluff, around 10% made it through the boundary fence. Four can be seen in the photograph above.

If we expect 90% of boulders to come to rest above the campground, this leaves 0.015 to 0.03 per year entering the campground.

So we now have a frequency of one boulder every 33 to 66 years which may enter the campground.

Of course as our six year period included a 1 in 100 year storm event and a one in 10 year earthquake it could be argued that even the 66 year return may be an overestimate, but then again, we do not know how many rocks fall unrecorded.

Boulders certainly don't seem to be entering the campground more frequently than our highest estimate; otherwise there would surely be historical knowledge. This type of estimation is not an absolute science and can only give a feel for the risks involved.

Risk to the proposed development

The boundary of the proposed development covers around 100 linear metres of the 400m boundary of the campground and as such we could say the probability of a boulder landing here is then only every 130 to 260 years.

Possible mitigation

An engineered, energy absorbing, rockfall catch fence could be installed at the campground boundary.

Of course the consequences need to be taken into account and weighed against the practicability and costs of any works to mitigate the risk.

I hope this helps and please contact me if you have any queries. I look forward to hearing from you and will definitely let you know when I will next be over at the mount, hopefully within the next few weeks.

Regards

s 7(2)(a) f Privacy

For Avalon Industrial Services Ltd