

Appendix 29 – Review of hazards at coastal baches

Memorandum

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To: Peter Doolin, Port Hills Programme Manager

Copy: Sarah Oliver

From: Don Macfarlane & Ian Wright

Subject: Review of hazard at coastal baches

This memorandum summarises our review of existing data and assessments of rockfall hazard sources that may affect coastal baches around Christchurch, specifically at Boulder Bay, Taylors Mistake, Hobson Bay and the area known as Maori Gardens near Governors Bay. The review was undertaken specifically to determine whether proposed hazard zones in these areas are justified and defensible.

It is important to understand that the area at risk from a hazard (for example from a cliff collapse) does not change with time even if the probability of a trigger event (such as earthquake) does change. Hence, for the purposes of this memorandum, we define hazardous locations (that could be zoned as Hazard Management Areas) as locations where naturally occurring upslope rock outcrops or cliffs might, by their nature, present a condition whereby downslope areas are or could become dangerous if the elements for failure are present. In this context, the elements for failure could be earthquake or other natural events (such as climatic incidents) but we also recognise that failures could occur with no known trigger event. Failure may be in the form of individual rockfall, cliff collapse (a rock debris avalanche) or soil slip (debris flow) or any combination of these. A hazardous location is thus any area that could be subject to rock or debris impacts as a result of individual rockfall, cliff collapse (a rock debris avalanche) or soil slip (debris flow) or any combination of these. Precise definition of such areas is difficult.

Methodology

In undertaking this review we have considered the following information:

S124 Notices

S124 Notices were placed on dwellings deemed to be dangerous after the earthquakes, based on whether or not the dwelling met the criteria to be classed as a dangerous building under Section 121 of the Building Act 2004. These notices were placed in mid-2011, following the end of the Civil Defence Emergency.

The decision to place (or not place) a Section 124 (1)(b) notice prohibiting occupation of the building was based on recommendations made to Council by the Port Hills Geotechnical Group (PHGG), whose recommendations were based on a set of simple criteria. For boulder roll these included but were not limited to:

1. Did rocks fall on this or an adjacent property?
2. Did rocks reach or pass the dwelling?
3. Was the dwelling hit by rocks?
4. Is the slope above the dwelling steep enough for rocks to roll down it?
5. Are there obvious sources for further rockfall?

6. Is there effective¹ natural or man-made protection for the dwelling? This may be one or more of vegetation (eg. shelter belts, plantations, dense scrub), house(s), rock fences, bunds or topographic controls.

The criteria for cliff collapse were:

1. Is there loose material (soil or rock) on a cliff above or adjacent to the property?
2. Are there tension cracks behind the cliff crest?
3. Is the house within the runout zone²?

The dwelling was required to meet condition No.3 to be recommended for an s124 Notice.

Hazard Verification Reports

Brief 'Hazard Verification' reports were requested by Council in late 2011-early 2012. These resulted in a summary review of the nature of the hazard and photographs to show the dwelling in relation to the hazard source(s).

Ground Truthing Reports

In early 2012, PHGG undertook ground truthing as a field check of the preliminary GNS life risk models. These checks involved measurements of S angle and/or F angle at each dwelling within the life risk model zones, assessment of the rockfall source and topography, proposed setback lines, ground cracking and any other factors that could affect the risk at a dwelling. These reviews were used to determine whether the model seemed reasonable or should be adjusted. The final decision was, in all cases, made by GNS considering all data, modelling results and any other factors they deemed relevant.

GNS Science Life-risk Model

We have reviewed the GNS life risk models for each location and site. We note that these models are area-wide, not site specific, but were ground truthed by PHGG (in effect sanity checked). The PHGG assessment may differ from the GNS model as final decisions were based on all factors deemed relevant by GNS and, in addition to the nature of the hazard, the life-risk model incorporates other factors such as the probability of a person being present and the probability that the person will be hit by a rock.

Field Check

On 22 October, we inspected all bach locations in Taylors Mistake and Hobson Bay, and checked the Boulder Bay bach sites from the cliff top. The objective was to reassess the site-specific hazard to determine whether the proposed Hazard Management Areas were appropriate and/or whether any changes had occurred to justify a change to the proposed Management Areas.

A similar inspection of the baches at Maori Gardens was undertaken on 4 November 2014.

Results

In the following tables we summarise the key outcomes for each site area.

NOTE: Our assessment is based on the potential consequences of a cliff collapse or rockfall (or boulder roll), not on the life risk model. It does not consider possible benefits from trees as these are not permanent features, could be 'gone tomorrow' (eg. due to fire) and affect the RISK not presence or otherwise of a hazard.

¹ The protection is not deemed effective if it has been passed or penetrated by rockfall boulders (eg. if some rocks/boulders have passed right through a shelter belt or plantation it is not an effective barrier even if it stopped other rocks)

² The extent of the runout zone was defined by a 30-33 degree Fahrboeschung (F) angle from the cliff crest

Boulder Bay

Bach No.	Assessment	Conclusion and/or Recommendation
1	Significant tension cracking in rock mass above the bach. Generally the rock quality is very poor making it susceptible to failure as a debris avalanche. Rock mass above the property is also prone to debris avalanche as indicated by tension cracks.	Location judged a hazard area for debris avalanche and/or individual boulders.
2	Boulders have fallen within 10m of the property including two immediately to the west that went past the property. Marginal protection provided by mature trees. Rockfall modelling shows that most rocks originating from the slope above the bach will reach or pass the dwelling. If they hit the building, the impact energy will be substantial	Location judged a hazard area for debris avalanche and/or individual boulders.
4	Small cliff immediately behind bach has loose rock	Direct cliff collapse hazard
5 to 7	Not subject to cliff collapse hazard	Need not be included in Hazard Management Area
8, 9	Small cliff behind baches may shed isolated boulders. Not deemed a cliff collapse hazard but subject to hazard from rockfall.	
10	Bach sited in lee of an undercut cliff. Small amounts of debris fell off the cliff during the 2011 earthquakes	Direct cliff collapse hazard

Taylor's Mistake

Bach No.	Assessment	Conclusion and/or Recommendation
28	On top of small cliff. Judged not at risk from cliff collapse. No boulder roll hazard evident. Could be affected by future cliff erosion	Site is judged to be relatively 'safe'
30	Hazard is from collapse of low cliff adjacent the bach that could impact dwelling. Low rockfall (boulder roll) hazard.	Hazard at site is adjacent to rather than directly above bach
31-32	Direct hazard from rockfall, viable source of rocks in outcrops above these baches at the base of a gully that will focus boulders rolling down the slope.	Clear hazard area
33-43	Minor areas of rock outcrop indicate limited hazard from rockfall. A number of boulders have reached the flat area behind these baches during (and before) the earthquakes.	Sites are relatively safe



Overview, Taylor's Mistake baches. No.30 at left of photo; No.45 at right. No's 31-33 are in the trees at the end of the beach.

Hobson Bay

Bach No.	Assessment	Conclusion and/or Recommendation
55-58	Judged not at risk from cliff collapse. No boulder roll hazard evident.	Outside hazardous area
59	Hazard is from collapse of low loess cliff adjacent the bach that previously impacted dwelling. Has been excavated and is currently stable. No rockfall (boulder roll) hazard.	No significant current hazard
60	No hazard from cliff collapse inundation. Failure has affected slope below bach but does not undermine the structure.	Further undermining could affect stability of structure but could be remediated
62	Limited stabilisation work has been completed (shotcrete and ineffective catch fence). Building is located under a cliff which shows evidence for instability.	Site is within hazardous area. Direct cliff collapse hazard.
63, 64, 67, 68	Baches immediately under overhanging cliff which shows signs of instability, full extent of which is hidden by vegetation. Direct hazard from cliff collapse (overhanging) at all 4 sites. No.63 has been hit and badly damaged by debris that has fallen from cliff since mid 2012.	All sites within hazardous area (cliff overhangs dwelling)
69	Not at risk from cliff collapse or rockfall but is located in the mouth of a steep gully which may be susceptible to mass movement or debris flows	No significant current hazard



Overview, Hobson Bay baches, Feb 2011. Pale blue bach at centre left is No.63



Destruction caused by rockfall debris hitting rear of bach at No.63 Hobsons Bay

Maori Gardens

These four baches are located under a cliff face. Where exposed, the rock is weathered and of variable quality. The cliff shed some rocks in the earthquakes and is clearly capable of shedding rocks and debris at other times. One bach appears to have been struck by mud/earth flow debris quite recently.

Bach No.	Assessment	Conclusion and/or Recommendation
A	Exposed to hazard of rockfall from cliff behind the bach; loose rocks/open fractures evident. Some protection from vegetation. Small debris flow/slump immediately to N of dwelling	Clearly hazardous site.
B	Exposed to hazard of rockfall from cliff behind the bach; loose rocks/open fractures evident. Some protection from vegetation.	Clearly hazardous site.
C	Cliff face >15m high immediately behind bach.	Clearly hazardous site (cliff collapse or rockfall).
D	Cliff face is immediately behind bach which has been struck by recent small debris flow (approx. 0.5m deep at rear wall judging from soil marks).	Clearly hazardous site (cliff collapse or rockfall).



Baches at Maori Gardens with cliff behind (Bach A at right, D at left of photo)

Alternative Location

The draft District Plan currently out for public consultation designates an area on the SE side of the valley at Taylors Mistake for relocation of some of the baches in hazard locations. The draft plan shows that approximately half of the designated area is considered to be a Rockfall Hazard Management Area. On 13 November, the designated area was inspected and boulders on the ground surface were mapped. The mapping showed that:

1. A small number of earthquake-induced and older boulders are scattered across the area designated for relocation of baches;

2. These boulders are not restricted to the part of the area indicated to be a Rockfall Hazard Management Area; and
3. There are four unstable areas of outcrop above the designated area that have the potential to release further boulders that could impact relocated baches.

The inspection report recommends that these unstable outcrops be treated prior to relocating baches into the designated area.

Discussion

We believe that Hazard zoning should be based on the potential consequences of failure of the rock sources (cliffs or rock outcrops) rather than on the GNS life risk models. The life risk models provide an estimate of annual probability (risk) of death(s) on an area-wide rather than site-specific basis and changes through time occur as the likelihood of earthquake-induced failures is modelled to decrease. This is a model based on past experience of world-wide earthquakes and does not recognise that:

1. another earthquake large enough to induce cliff collapse or rockfall (boulder roll) could occur at any time and would 'reset the clock' – science cannot reliably predict the location, magnitude nor timing of the next damaging earthquake
2. in the event of failure (for any reason) the rockfall debris or boulders may travel just as far as occurred during the 2010/2011 earthquakes. This is supported by the geological and geomorphological evidence provided by old boulders, debris cones and large wedges of erosion debris containing rocks and boulders that flank slopes in areas such as Sumnervale, Bowenvale and Avoca Valley that show how far rocks have travelled in the past.

Comment on proposed Hazard Zones

This study has indicated that of the 38 baches investigated, 19 are located in clearly hazardous situations and 19 are in a low hazard location. Consequently, we suggest that the hazard zone boundaries be modified as shown on the attached drawings and summarised below:

Boulder Bay - No changes

Taylor's Mistake - Bach 28 should be removed Cliff Hazard Management Area 2

Hobson Bay - Baches 55 to 59 and bach 60 should be removed from Cliff Hazard Management Area 2

Maori Gardens - No changes. Cliff Hazard Management Area 2 is appropriate for all four baches.