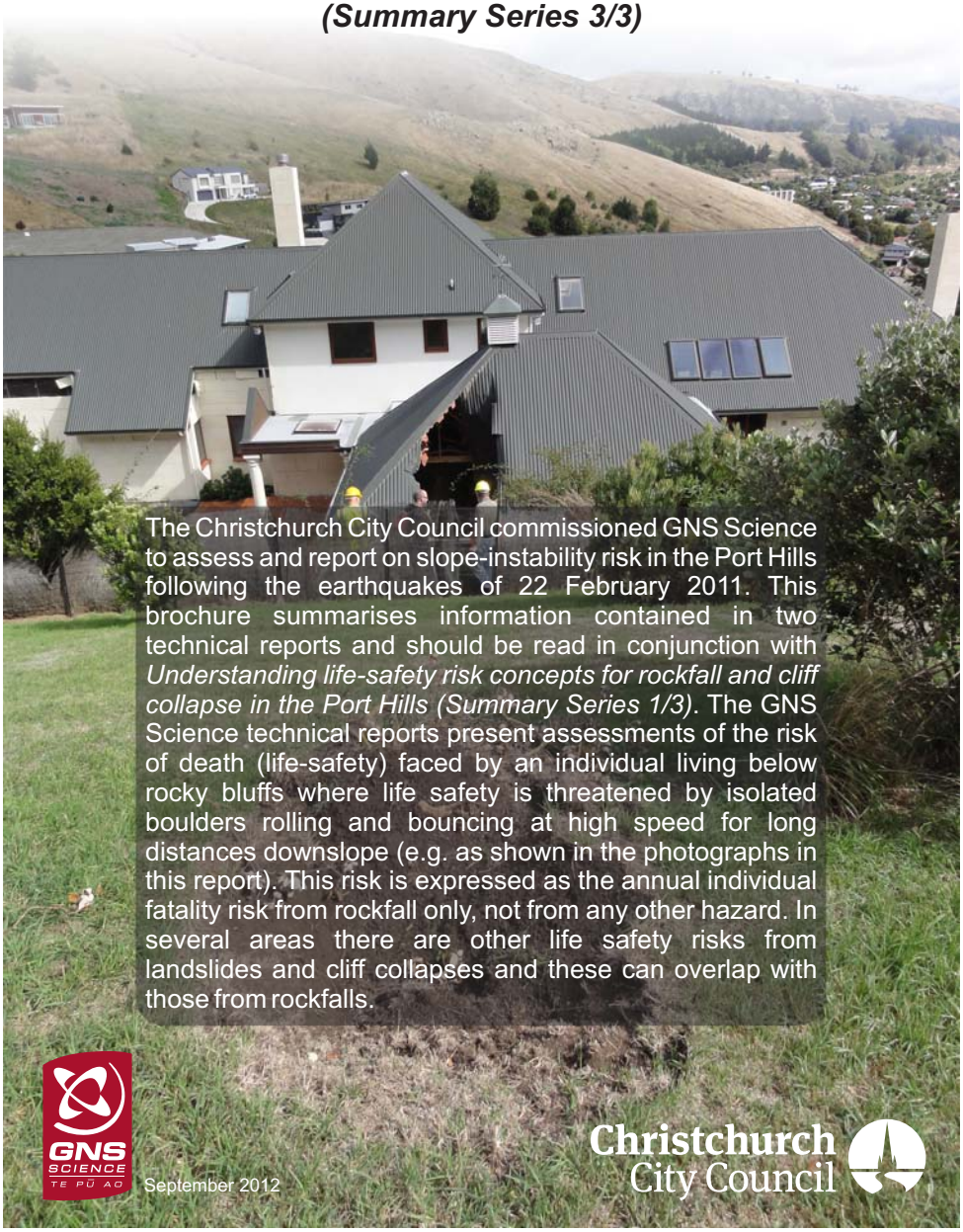
Life-safety risk from rockfall on the Port Hills

(Summary Series 3/3)



The Christchurch City Council commissioned GNS Science to assess and report on slope-instability risk in the Port Hills following the earthquakes of 22 February 2011. This brochure summarises information contained in two technical reports and should be read in conjunction with *Understanding life-safety risk concepts for rockfall and cliff collapse in the Port Hills (Summary Series 1/3)*. The GNS Science technical reports present assessments of the risk of death (life-safety) faced by an individual living below rocky bluffs where life safety is threatened by isolated boulders rolling and bouncing at high speed for long distances downslope (e.g. as shown in the photographs in this report). This risk is expressed as the annual individual fatality risk from rockfall only, not from any other hazard. In several areas there are other life safety risks from landslides and cliff collapses and these can overlap with those from rockfalls.

GNS SCIENCE TE PŪ AO

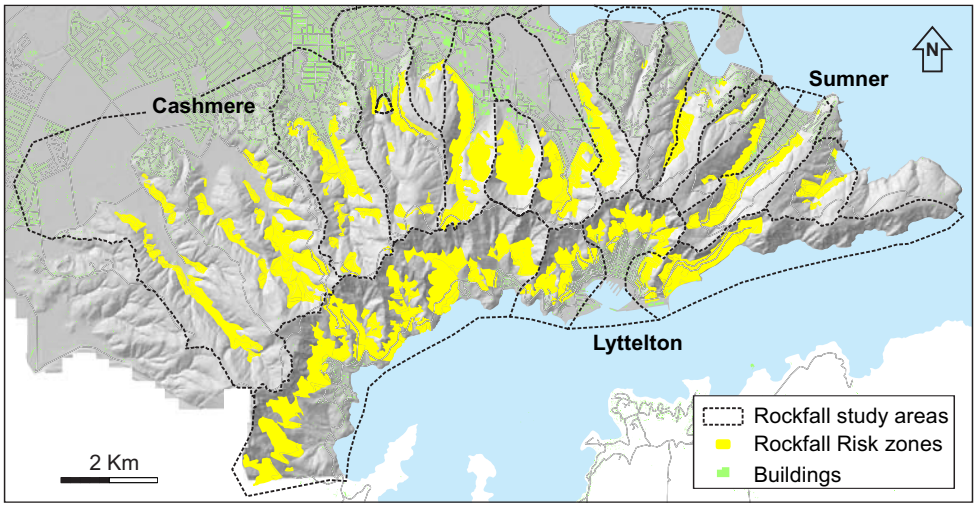
September 2012

Christchurch City Council

What areas do these reports cover?

The entire Port Hills are included in the two GNS Science technical reports. As shown in the map below, this includes the suburban areas of Avoca Valley, Bowenvale, Cashmere, Castle Rock, Heathcote Valley, Hillsborough (Vernon Terrace only), Sumner (Wakefield Avenue and Heberden Avenue areas only), Lyttelton and Rapaki Bay. Some dwellings within these areas are also affected by other types of earthquake-triggered landslides.

Rockfall damage to a residential home in Morgan's Valley, Heathcote. This rockfall damage occurred in the main 22 February 2011 earthquake. ►



▲ Location map showing Ports Hills areas covered by these reports.

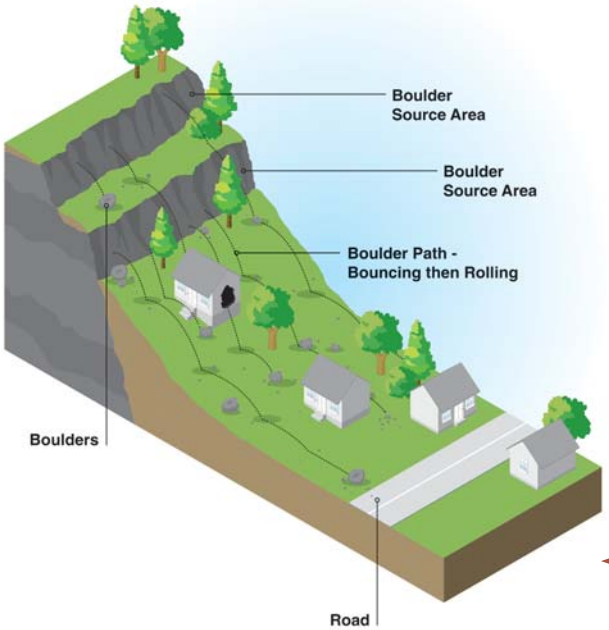
Why were these technical reports needed?

Following the 4 September 2010 Darfield earthquake, the levels of seismic activity in the Christchurch region are considerably higher than the long-term average, and are likely to remain enhanced for several decades. As a result, the risk of death from rockfall is now considerably higher than it was before September 2010. However, the risk from earthquake-induced rockfall is expected to decrease as the seismic hazard decreases.

The 2010–2012 earthquake sequence has caused the rockfall source areas to become more unstable and therefore more susceptible to both earthquake and non-earthquake triggering events (such as rainfall). It is highly likely that future rates of rockfall accumulation from non-earthquake events will be greater than pre-earthquake rates for at least the next 20–30 years.

Terminology

Rockfalls (sometimes referred to as "boulder rolls") have been considered separately from cliff collapse. This is because rockfalls tend to travel further, along less predictable paths, and typically involve individual boulders, where cliff collapse involves many thousand boulders.



◄ Rockfall (boulder roll) features referred to in the technical reports.

What is "annual individual fatality risk"?

The probability (likelihood) that a particular person will be killed by rockfall in any year where they live is referred to as the annual individual fatality risk (or life-safety). This risk is expressed as logarithmic numbers such as 10^{-4} ("10 to the power minus 4") per year. Table 1 shows how some of these numbers translate into more familiar terms. For example, 10^{-4} is the same as one person in every 10,000 at risk of being killed each year.

Table 1. Different ways of expressing risk probabilities.

Probability 1 in... (per year)	Is the same as (per year)	Is the same as (per year)	Is the same as
1,000	10^{-3}	0.001 or 0.1%	8% per lifetime*
10,000	10^{-4}	0.0001 or 0.01%	0.8% per lifetime
100,000	10^{-5}	0.00001 or 0.001%	0.08% per lifetime
1,000,000	10^{-6}	0.000001 or 0.0001%	0.008% per lifetime

*Based on average New Zealand life expectancy of about 80 years, from 2008 mortality and population data

For more information on understanding risk concepts, see *Understanding life-safety risk concepts for rockfall and cliff collapse in the Port Hills (Summary Series 1/3)*.

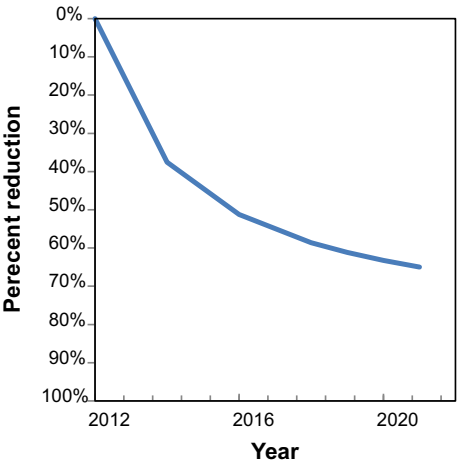
What is the risk to life from rockfalls?

Of the dwellings located in the life-safety risk zones (maps of these areas are provided in the technical GNS Science reports), a number of these houses expose people to risks greater than 10^{-3} under current seismic conditions. Refer to *Summary Series 1/3* for a comparison of risks across New Zealand.

How this risk compares to other risks in New Zealand is provided in *Understanding life-safety risk concepts for rockfall and cliff collapse in the Port Hills (Series 1/3)*.

The probability of a person present being killed in a rockfall is estimated by:

1) calculating the probability that they will be in the path of one or more boulders for a given rockfall event at a given distance downslope, assuming that boulder sources are uniformly distributed along the hill slope in the suburb in question (i.e. boulders can fall from anywhere on the slopes above the suburban dwellings);
2) the proportion of time a person spends in their home (residency); and
3) the probability of the person being killed if hit by a boulder (vulnerability).



▲ Average reduction in rockfall risk from 2012

▲ Rockfall damage to a residential home at Rapaki Bay. This rockfall damage occurred in the main 22 February 2011 earthquake.

The technical GNS Science Reports:
CR2011/311 March 2012 'Canterbury Earthquakes 2010/11Port Hills Slope Stability: Pilot study for assessing life-safety risk from rockfalls (boulder rolls)'
CR2012/123 May 2012 'Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Life-safety risk from rockfalls (boulder rolls) in the Port Hills'
are available for download at: *www.ccc.govt.nz/porthillsgeotech*