



Determination 2013/037

Regarding the issuing of a dangerous building notice under section 124 of the Building Act relating to geotechnical hazards on the property at 4 Awaroa Lane, Sumner

1. The matter to be determined

- 1.1 This is a determination under Part 3 of the Building Act 2004¹ (“the Act”) made under due authorisation by me, John Gardiner, Manager Determinations and Assurance, Ministry of Business, Innovation and Employment (“the Ministry”), for and on behalf of the Chief Executive of the Ministry.
- 1.2 The parties to this determination are
- Christchurch City Council, carrying out its duties and functions as a territorial authority (“the authority”)
 - the owners of the house Mr and Mrs Elmey who are the applicants for this determination (“the applicants”).
- 1.3 The determination arises from the decision made by the authority to issue a section 124(1)(b) notice (“the notice”) in respect of this property because the authority considered that there was a risk that rocks located adjacent to the property could collapse causing death or injury to any person in the house.
- 1.4 The applicants disputed this finding as they considered that the authority’s decision-making was not sufficiently robust and they also considered that, if mitigating factors were taken into account, the danger faced by occupants was insufficient to warrant a notice and they therefore consider that the authority should remove it. As a result of this dispute an application for a determination was made on 9 September 2012.
- 1.5 Therefore the matter to be determined² is whether the authority correctly exercised its powers in issuing the notice under section 124(1)(b). In making this decision I must consider whether the house is dangerous as defined in the Act.³
- 1.6 When considering this matter and arriving at my decision I considered all the information provided to me by the applicants and the authority. I also engaged the services of a chartered professional engineer with a specialisation in geotechnical engineering (“the first expert”), and a professional engineer with experience in the

¹ The Building Act, Building Code, Compliance Documents, past determinations and guidance documents issued by the Ministry are all available at www.dbh.govt.nz or by contacting the Ministry on ph 0800 242 243.

² Under sections 177(1)(b) and 177(2)(a) of the Act

³ The relevant sections of the Act are s 121(1)(d) as modified by Canterbury Earthquake (Building Act) Order 2011 cl7

quantitative modelling of risk (“the second expert”). These experts provided advice and analysis in terms of the technical material provided.

- 1.7 In arriving at my decision I provided a number of drafts to the parties and held a hearing. Reference to these and to the parties’ responses is covered in paragraphs 9.1 to 9.3.1.

2. Context

- 2.1 This determination relates to a property located on Canterbury’s Port Hills, an area already at risk of rockfall which experienced significant rockfall as a result of earthquake activity on 22 February 2011 and subsequent aftershocks. The area is now understood to lie over an earthquake faultline.
- 2.2 This property is one of a number in the Port Hills with notices applied under the definition of ‘dangerous building’ that was modified by the Canterbury Earthquake (Building Act) Order 2010⁴ (“the 2010 Order”). This Order was superseded by the Canterbury Earthquake (Building Act) Order 2011 on 17 September 2011 (“the Order”).
- 2.3 I have appended a description of the Port Hills and associated rockfall hazards, as well as background to the issue of section 124 notices in the Port Hills, including the evolving decision-making process for the issue of these notices, as this information provides significant context to the determination.

3. The property and its location

3.1 The site

- 3.1.1 The site is located in the Sumner section of the Port Hills and is part of a subdivision established in 2008. I understand that the consent notice for the subdivision, issued under the Resource Management Act 1991, stated that all buildings erected in the subdivision must have a rockfall protection structure (RPS) constructed above them and that such protection was a prerequisite of any building consent.
- 3.1.2 The site is a 1,284 m² section sloping to the north and is at the end of a steep lane. The house is sited on an outcrop to the rear of the site.

3.2 Rock sources

- 3.2.1 There are three main rock sources above the site. There is a midslope bluff (shown on Figure 2 of the Port Hills Geotechnical Group (PHGG) memorandum dated 14 January 2013). The other two (upper slope) sources (shown on Figure 1 of the PHGG memorandum dated 14 January 2013) are located on the moderate slope above the main bluff and PHGG considers these to be the main sources of potential boulders.

⁴ Canterbury Earthquake (Building Order) 2010 cl7

3.3 The house

- 3.3.1 The authority issued a building consent for the house in 2009. At this time, the authority was aware of the non-seismic rockfall risk at the site and intended to place a notice on the title under section 72 of the Act. However, it eventually accepted that, as the applicants proposed to mitigate this risk by constructing an RPS across the full width of the site, the section 72 notice would not be required as a condition of the consent.
- 3.3.2 I accept that the three-level house has been specifically designed in accordance with NZS 4210⁵. It has an open deck on the eastern side leading out from the top level. This deck forms the ceiling above the sleeping area, and comprises a 150mm thick tray deck concrete slab supported on concrete block walls.
- 3.3.3 The applicants moved into the semi-finished home in late July 2011 following completion of the construction of the RPS. The house remains incomplete. However, this determination only considers the notice issued in respect of the house and does not consider any other issues relating to the building work that has been undertaken.

3.4 The rockfall protection structure

- 3.4.1 The proposed and consented RPS comprised 2m high gabion baskets stitched together and held in place with steel posts widely spaced, set into concrete.⁶
- 3.4.2 The as-built RPS on this property differs from the consented RPS and, to date, no amendment has been applied for. It was constructed by the applicants between February and June 2011. Its location and details are shown on the Elmac Consulting Engineers drawing SO23 revE dated February 2013, provided by the applicants to the authority and to me on 26 February 2013.
- 3.4.3 The as-built RPS mostly comprises a 1m high x 1m wide gabion wall topped by an approximately 1.6m high double-twist chain link mesh fence. The gabion baskets are in-filled with soil and this is contained by timber planking placed against the inside face of the basket side walls. At approximately 7 m intervals, the gabion wall height increases to 2 m for a length of 1 m at each end and 2 m at the two intermediate points. The wall is buttressed by a 1 m high x 1 m wide basket, located immediately behind (downslope of) the main gabion wall at these locations.
- 3.4.4 The chain link fence is suspended from a 15 mm diameter galvanised wire rope that spans between 115 mm x 5 mm circular hollow-section galvanised steel posts spaced at 3.8 m centres. These posts are anchored into the double-height sections of the gabion wall (described above). The bottom edge of the chain link mesh fence is laced to a second 15 mm galvanised rope. The two wire ropes are then shackled to the galvanised steel posts and anchored to the end of the gabion wall at its eastern end and to the gabion retaining wall located along the uphill edge of the driveway at its western end.
- 3.4.5 The mesh fence has been reinforced with a 400 mm diameter ringnet fabricated from R12 steel hoops.

⁵ New Zealand Standard NZS4210:2001 Masonry construction: materials and workmanship

⁶ Refer to building consent documentation Elmac Consulting Engineer drawing SO6 Rev E

- 3.4.6 To the west of the dwelling, the RPS does not include a gabion wall but generally comprises a 2.6 m high chainlink fence. This is suspended from the upper wire rope which is in turn supported by 150 mm x 75 mm hollow steel posts.
- 3.4.7 The applicants have provided calculations for the as-built RPS and assert that the likely capacity of the 1 m high gabion wall is 345 kJ and the mesh fence above provides the a capacity of 80 kJ.

4. Assessments of this property

- 4.1 On 11 July 2011, a notice issued under section 124(1)(b) was affixed to this property by the authority. This notice said it was a dangerous building under sections 121 and 124 of the Act due to risk from rockfall and/or other hazards.
- 4.2 On 7 September 2011 another notice was affixed to this property. Both this notice and the earlier notice relied on the definition of a dangerous building as modified by the 2010 Order (refer paragraph 2.2).
- 4.3 On 26 October 2011, this was replaced by another notice which also said the property was a dangerous building under the Order (refer paragraph 2.2) due to risk from rockfall, cliff collapse and/or other hazards.
- 4.4 On 8 December 2011, PHGG assessed the property using the process described in Appendix A (refer paragraph A4.3). PHGG commented:
- Rockfall fence above house constructed by [the applicants] after 22 Feb aftershock. Construction completed after 13 Jun aftershock. Design energy rating of fence is not known. Effectiveness of fence is not known. [sic]
- 4.5 At this time, the determining factors for the notice became the presence of obvious rock sources and PHGG's judgement that there was no effective protection from these.
- 4.6 On 16 February 2012, PHGG carried out a site assessment as part of the suburb-wide field testing of GNS Science's⁷ rockfall risk model. As noted in the Appendix, (paragraph A3.4.5), such assessments were carried out at all Port Hills properties and were not s124 assessments. This assessment concluded:
- boulder(s) did not pass within 10m but did pass within 20m of the house
 - the "F" angle at the dwelling was not less than the GNS shadow angle
 - the rockfall source did not vary significantly from the suburb average
 - there were no significant topographic features (ridges, gullies or flat surfaces) that influenced the risk to the dwelling
 - there were no other known mass movement issues (debris flow, landslide or cliff collapse) that could increase the risk to the dwelling.

⁷ GNS Science is a New Zealand Government owned research institute that specialises in earth, geoscience and isotope research and consultancy

- 4.7 On 17 August 2012, the authority wrote to the applicants to say that, with CERA rezoning this property red⁸, the existing notice would remain.
- 4.8 On 15 January 2013 and as a result of the determination application, PHGG completed a complete reassessment of the notice on this property using the process described in the Appendix, paragraphs A4.6.1 to A4.6.6. The results of this review were provided to the applicants and to me (dated 25 January 2013). It concluded:

Currently, the most significant of the potential rockfall source areas are outcrops remote (well upslope) from the dwelling

Unstable rock blocks are present in all of the potential rockfall source areas

There are strong topographic controls (gullies) that can be expected to influence (but not necessarily control) the path of any rocks falling from the source areas

Vegetation on the slope between the source areas and the dwelling has captured many but not all rocks that fell in this area; it thus reduces the probability of rocks reaching the dwelling and also influences the total kinetic energy of falling rocks

3D Hy-Stone rockfall models confirm a very strong topographic control on roll paths and that rocks (on a bare slope) can generally be expected to pass the dwelling

The 3D Hy-Stone models also confirm that the dwelling is situated in the most favourable location on the property

New 2D rockfall modelling, including vegetation effects, indicates that a proportion of falling rocks can be expected to reach the dwelling with total kinetic energies of less than 1500kJ (based on the 95th percentile site-specific boulder)

The existing rockfall projection structure behind the house differs from that proposed with the Building Consent. To our knowledge, the current structure has not been subject to design review and has not been approved by CCC.

An existing 'non-engineered' rockfall fence upslope from the dwelling was damaged by rockfalls caused by the earthquakes and no longer provides the limited protection previously offered.

4.9 The authority's conclusion

- 4.9.1 In January 2013, the authority concluded on the basis of this review that the notice should remain in force. The authority also noted that a further review would be undertaken in the event that the applicants installed rockfall protection that met the authority's Infrastructure Design Standard requirements.
- 4.9.2 Whilst the authority's decision has not changed with respect to the currency of the notice, it does appear to have modified some of its view in response to questions posed by the applicants. I refer to this correspondence in paragraph 6.5.

⁸ CERA Red Zone: Port Hills - affected by cliff collapse and there are immediate risks to life, land remediation is not considered viable and infrastructure would be difficult and costly to maintain, or affected by rock roll and the risk to life is considered unacceptable, is unlikely to reach an acceptable level in a reasonable timeframe, and protective works to mitigate the life safety risk are not considered practicable.

5. Decision under section 183 decision for the section 124 notice to remain in force

- 5.1 Pursuant to section 183 of the Act, the authority's decision to issue a notice in respect of this property was suspended when the applicant applied for the determination. However, that provision also gives me the power to direct otherwise.
- 5.2 On 24 September 2012, the authority requested that I make a final direction in respect of this property that the notice should remain. On 19 September 2012 I issued an interim direction that the notice should remain in force until the final determination was made.

6. The applicants' views

- 6.1 Since the issue of the notice, the applicants' view is unchanged that this notice should be lifted. Their primary concerns relate to
- the assessment of risk; in particular, the probability of an event where boulders would reach their home
 - the refusal of the authority to take into account any mitigation that arises from the RPS that they constructed
 - the protection afforded by their home, and
 - lack of consultation and collaboration.
- 6.2 The applicants' comments in ongoing communications to the authority and to me in support of the determination application and since it was made include the following:
- No rockfalls occurred as a result of the 22 February 2011 aftershock and only two rocks less than 0.5m³ passed the property and travelled down the gully on the southern boundary as a result of the 13 June 2011 aftershock. A car parked in the lane was struck by one of the rocks, but was able to be driven away after the incident.
 - A complete assessment of their property or the rockfall projection had not been undertaken, and all that was provided to them initially was a flowchart and report, which (in their view) did not appear to support the ongoing notice.
 - The authority had yet to address their specific concerns, and they requested that the results of the latest 2D rockfall mapping and modelling results be provided to the Ministry to review. They also highlighted what they perceived to be errors in the calculations. These were addressed by PHGG in January 2013. (In its letter to me of 19 April 2013, the authority said these errors were not in the calculations but in the summary information shown on some of the modelled sections and, in one case, on the labelling of the sections.)
 - The applicants' expectation was that this 2D modelling would include modelling of hazardous rock sizes, positions of those rock sizes and slope vegetation (where it existed) as it relates to their property only. They did not consider including information that fell outside of these parameters to be relevant. They also felt that insufficient account had been taken of site-specific

conditions including the potential rock sources, vegetation, topographical channelling and, in particular the RPS they had constructed.

- The applicants had provided as-built information for their RPS and would forward calculations to the authority in due course (these were provided to the authority and me on 26 February 2013).
- Acceptance that movement to safe areas after extreme events (ie seismic events around ULS⁹ level and above) did not, in their view, prove risk as defined in section 121(1)(d) of the Act.
- The applicants did not accept that the authority had consulted or collaborated with them to resolve the issue of the notice; they would like to be able to live in their home and, when the authority's RPS design guidelines were made available, would then affect the necessary repairs.
- The applicants were not satisfied that an independent peer review of the decisions had been undertaken.

6.3 Latterly, the applicants have questioned the categorisation of their home as being dangerous, when compared to other "dangerous" houses in New Zealand.

6.4 They have also questioned the authority's analytical process for calculating "there is a risk", the test required by the legislation, as well as its subsequent approach and reasoning that would apply when the risk was no longer considered to exist. In the applicants' view, a fairer assessment of risk would be based on the AIFR with adjustments made to the AIFR¹⁰ for the site-specific mitigating features of vegetation, the RPS and the structure of the house.

6.5 The authority's response

6.5.1 The authority responded to this email and now appears to accept that the RPS has some capacity for mitigating the risk of rockfall at the property. However, in its letter of 8 March 2013, it has indicated that it will require clear calculations and a number of producer statements for this to be properly considered.

6.5.2 In response to the calculations provided by the applicants, the authority noted that

- there was little information to support the validity of the calculations
- there appeared to be mistakes in the calculations
- the design boulder that the applicants had used was the average boulder size of 0.5m³ rather than the design boulder (95th percentile) which the authority now considered likely to be at least 1m³ at this site.

6.5.3 The authority also noted that, since the earthquakes and aftershocks, its thinking and knowledge had changed relating to life safety risk on the Port Hills. As a result, the RPS that was consented in 2009 would no longer be considered adequate.

⁹ Ultimate Limit State

¹⁰ Annual Individual Fatality Risk (refer Appendix, paragraph A3.4.2)

- 6.5.4 The authority further noted that, while it had carried out some risk mitigation work in the Port Hills, this generally only related to high risk areas above tracks and could not be relied upon as a reliable mitigation strategy for dwellings below.

7. Discussion

- 7.1 In order to arrive at a view of whether this house is dangerous in terms of the Act and whether the authority correctly exercised its powers in issuing the notice, I need to consider:

- the meaning of a dangerous building, and
- whether a risk exists at this property for the purposes of section 121.

7.2 Meaning of dangerous building

- 7.2.1 The relevant sections of the Act are

- section 121 Meaning of dangerous building, and
- section 124 Powers of territorial authorities in respect of dangerous, earthquake-prone or insanitary buildings.

- 7.2.2 The relevant clauses of the Order are:

- clause 7 Modification of meaning of dangerous building and extent to which territorial authority can apply modified provision
- clause 9 Modification of powers of territorial authorities in respect of dangerous, earthquake-prone, or insanitary buildings under section 124 of Act.

- 7.2.3 The s124 “rockfall” notice was issued under section 124(1)(b), which provides:

124 Powers of territorial authorities in respect of dangerous, earthquake-prone, or insanitary buildings

- (1) if a territorial authority is satisfied that a building is dangerous, earthquake-prone, or insanitary, the territorial authority may— ...
- (b) attach in a prominent place on, or adjacent to, the building a notice that warns people not to approach the building; ...

- 7.2.4 The authority issued the notice based on the definition of dangerous building as modified by clause 7 of the Order, which provides:

121 Meaning of dangerous building

- (1) a building is dangerous for the purposes of this Act if, – ...
- (d) there is a risk that adjacent, adjoining, or nearby buildings or land could collapse (including collapse by way of rock fall, landslip, cliff collapse, or subsidence) or otherwise cause injury or death to any person in the building

- 7.2.5 The expanded definition establishes a very low threshold before a building will be considered dangerous. In respect of the rockfall risk at this property, the only requirement is that ‘there is a risk’ that adjacent land could collapse by way of rockfall and cause injury or death to any person in the building.

- 7.2.6 A “risk” that something could happen is simply a possibility of that event occurring. This is in contrast to the definition of a dangerous building in section 121(a) where a building must be “likely”, in the ordinary course of events, to cause injury or death.
- 7.2.7 The modified definition also requires that the risk of injury or death must be ‘to any person in the building’. This means that rocks (or other defined hazard) must reach the building itself, not just the property boundary, with sufficient force to injure the occupants. I note further that the term “building” is defined in section 8 of the Act and includes the house, any decks connected to it, and any outbuildings on the property.
- 7.2.8 The extent to which the authority can apply this modified definition is as follows:
- 7 Modification of meaning of dangerous building and extent to which the authority can apply modified provision**
- (3) Section 121(1)(d) or (e) of the Act as modified by this clause applies only for the purposes of a territorial authority exercising its powers under section 124(1)(a), (b) or (d) of the Act as modified by clause 9.
- 7.2.9 The Order expires on 16 September 2013, at which time the notices issued under the provisions covered by the Order can no longer be amended by applying the expanded definition of a dangerous building under section 121(1)(d) as that provision will no longer exist.

7.3 Whether there is a “risk”

- 7.3.1 To arrive at my decision on whether or not this house is a dangerous building under the Act I have to consider whether there is a “risk” for the purposes of section 121.
- 7.3.2 In particular I need to consider whether there is
- a credible risk of a triggering event that would generate a rockfall
 - a source of rocks above the property
 - a risk that rocks from these sources will reach the building with sufficient energy to injure an occupant
 - sufficient mitigation that would offset this risk.
- 7.3.3 In considering each of these points, I have drawn on expert advice (as described in paragraph 1.6).

7.4 Triggering events that will generate rockfall

- 7.4.1 A seismic event is in part described by the resulting peak ground acceleration (“PGA”). This is a measure of earthquake acceleration on the ground and its units are the gravitational constant, “g”.¹¹
- 7.4.2 In order for a seismic event to be likely to generate a hazardous rockfall, a minimum PGA is required. I use the term hazardous to describe a boulder that would be of a sufficient size to potentially cause death or injury.

¹¹ For example, a PGA of 2 g is acceleration twice that of gravity.

7.4.3 The GNS pilot study includes frequency data (per annum) at which different PGA values are exceeded. It is noted that there are also non-earthquake mechanisms that could release boulders, discussed in the Appendix, paragraph A1.3, that would mean that the exceedance rate for all events is slightly higher.

7.4.4 On the basis of the GNS data, I accept that there is a risk that a triggering event could occur that would result in hazardous rockfall.

7.5 Rock source

7.5.1 PHGG has identified rock sources above the property, described in paragraph 3.2.1. My geotechnical expert concurs with the PHGG assessment, namely that there is a risk that these areas could release rocks in a triggering event. He also noted the following:

- With respect to the mid-bluff source: the bluff appears to comprise a thinly banded lava sequence and therefore appears unlikely that boulders of greater than 1.0m in diameter (approximately 0.5m³ in volume) would be generated from this source
- With respect to the other two sources: the sources comprise blocky rock outcrops which PHGG assert could potentially generate boulders with a 95% size of about 1m³.

7.5.2 On the basis of this advice I conclude that these areas provide a source of hazardous boulders and rocks.

7.6 Rockfall energy calculation

7.6.1 I now need to consider whether there is sufficient evidence that will allow me to conclude that there is a risk that rocks could reach or pass the building and could do so with sufficient energy to cause injury to occupants. I note further that an open deck on the eastern side forms part of the building (refer to paragraph 7.2.7).

7.6.2 The first and second experts have reviewed the rockfall modelling that contributed to and underpinned the authority's most recent decision. Whilst the authority has placed some reliance on the 3D Hy-Stone rockfall modelling, I have not. The advice I have received from the experts was that since the model has not been calibrated against actual boulder roll paths, it may be unreliable. Accordingly, I have given little weight to the Hy-Stone output shown on Map 3 of the PHGG memorandum of 14 January 2013.

7.6.3 PHGG also carried out 2D RocFall rockfall analyses as part of its reassessment of the notice review (refer Appendix paragraph A4.6.1). These analyses indicate that boulders could reach the dwelling and would have sufficient impact energy to cause injury to the occupants. The veracity of a model such as RocFall is dependent on calibration against actual, "real life" rock rolls and the validity of the size of boulder upon which the energy calculation is made. I requested a report on the calibration and sensitivity analyses from the authority which I received on 19 April 2013.

- 7.6.4 I have been assured by the authority that RocFall has been calibrated against actual rock rolls and that the authority's expert adviser (PHGG) considers the RocFall output to be reliable.
- 7.6.5 I note that the resulting energy calculations are dependent on the source of the boulder (upper slopes or mid-bluff), the bounce height as well as the size of the boulder and the topographical features of the pathway (e.g. presence of vegetation). Whilst I accept that at this property there is a risk that rocks will reach or pass the building, I am unclear how these factors will be considered when the authority reviews any proposal to mitigate the risk.
- 7.6.6 However, I accept that there is a risk that rocks will reach or pass the building with sufficient impact energy to cause injury to the occupants.

7.7 Mitigating factors

7.7.1 The site

- 7.7.1.1 PHGG's assessments have considered the mitigating effects of features above the site such as vegetation and topographic channelling. The recent 2D modelling also takes this into account, and I accept that these have been adequately considered.

7.7.2 The RPS

- 7.7.2.1 From a code compliance perspective, it is the applicant's responsibility to ensure that a building consent amendment is obtained for the as-built RPS, and that part of that application would include establishing the capacity of the RPS to absorb impact energy from falling rocks. The application would then be considered by the authority and follow the normal building control processes for engineered structures.
- 7.7.2.2 However the issuing of the section 124 notice is not about code compliance. Rather it is about assessing the mitigation effects of existing features be they naturally occurring or constructed. On this basis, consideration does need to be given in respect of the mitigating effect that the as-built RPS can provide. I accept that the structure was constructed by the applicants and the resulting performance has yet to be validated by an appropriately qualified person who is independent of this property.
- 7.7.2.3 The authority has recently suggested that an unverified RPS will be attributed a value of 50 kJ. This was not explicit during the multiple assessments as indicated in the authority's letter to me of 18 February 2013 where it suggests that:
- Given these circumstances, it is not appropriate for any weight to be placed on the existing rockfall protection structure, when considering this application for a determination.
- 7.7.2.4 I have taken expert advice regarding the applicants' calculated value of the capacity of the existing as-built RPS and the likely capacity requirements for any RPS at this site. Based on this advice I have concluded that the as-built RPS may not have sufficient capacity to mitigate the risk at the property.
- 7.7.2.5 However, I wish to take this opportunity to respond to comments made by the authority. In its submission to the first draft, the authority posed the question as to

who should prove the capacity/mitigating effect of a structure, particularly when that structure has not been subject to the usual consenting processes.

- 7.7.2.6 In my view, in asking this question the authority is mixing the code compliance test with the “dangerous building” test. With respect to its duty associated with notices under section 124, it is the authority’s responsibility to establish the mitigation effects of all structures in the path of falling rocks. Put another way, it is my view that the authority should assess the mitigation effects of any existing RPS in the same way as it considers other topographic features. I do accept that in order to do so they may ask the applicants for information to assist with the assessment but it is for them to make the assessment.
- 7.7.2.7 In March 2013, the authority attributed a default energy capacity of 50kJ to the as-built RPS. I asked the authority to clarify the basis for arriving at this default energy capacity. The response to this request is reflected in paragraph A4.2.4 of the Appendix. However, the as-built RPS at this property clearly does not fall within the authority’s description of ‘rudimentary structure’. It would therefore appear that the authority has not given sufficient consideration to the mitigation effect of the as-built RPS.

7.8 Specific house design

- 7.8.1 The applicants argue that the authority has not considered the specific house design; in particular, that it is specifically engineered, constructed of concrete block walls and has a reinforced concrete roof which provides additional protection to the sleeping areas.
- 7.8.2 Whilst, in general, I accept that the specific house design should be considered, it is the weakest area that should be considered when assessing risk. In this instance, that area is the eastern deck. I consider that the deck is part of the building, since it falls within the definition of a “building” as defined in section 8 of the Act.
- 7.8.3 I have therefore discounted any mitigation effects that result from the design of the building since the only protection afforded someone standing on the deck is the RPS constructed by the applicants.
- 7.8.4 Based on the information I have received I therefore conclude that whilst there is some mitigation arising from the RPS and the vegetation above the site it is not adequate to mitigate the risk.

8. Conclusion

8.1 Exercise of powers

- 8.1.1 In considering whether or not the authority exercised its powers correctly I have considered its process in terms of whether the process was carried out in accordance with the requirements of the Act and I accept that the notice has been issued in accordance with the relevant legislation.
- 8.1.2 I have also considered whether the authority followed the principles of good administrative process and decision making. In particular I have considered whether:

- the process was robust and replicable; for instance, whether criteria and assumptions were objective and explicit, and
- there was evidence that due consideration had been given to information provided by the applicants.

8.1.3 I accept that it was appropriate for the authority to rely on expert advice. I also accept that it was realistic to expect the process to be dynamic and evolutionary. I also accept that it appears that a logical approach to assessing the rockfall risk at this property has been adopted. However, it appears that the process has been articulated retrospectively. For instance, the criteria applied by the authority have only recently been provided following a number of my requests.

8.1.4 Peer review of a process, methodology and assumptions can be used to strengthen the perception that a process is robust and therefore fair. It appears that the authority's process has not been subject to such a peer review or a structured quality assurance process. As a result the applicants consider that the process is neither robust nor fair as evidenced by their questions asked in February of this year.

8.1.5 In its submission to the first draft of this determination, the authority questioned the need for each decision to be independently peer-reviewed. I concur that an independent peer review of each decision would be unnecessary and that was not my intent. Rather, I was referring to a peer review of the process, assumptions made and methodology for applying these notices generally.

8.1.6 Although the applicants have only belatedly provided information in relation to their RPS, up until 4 March 2013 it appears that the authority excluded consideration of the mitigation effect of this structure (refer paragraph 7.7.2). The authority's letter to me dated 18 February 2013 corroborates this view. Additionally, given the authority's basis for attributing 50 kJ to the structure, it would indicate that little weight been given to the applicants' submissions. Furthermore, at no stage has the authority acknowledged that the building has been specifically engineered or that the "there is a risk" test must be in respect of the risk faced by an occupant when on the exposed deck.

8.1.7 I accept that the authority has exercised its powers correctly. However I would hope that the authority will consider my comments when considering its ongoing review of section 124 notices.

8.2 Issue of the s124 notice

8.2.1 Based on my review of the information provided to me and on the advice provided by my experts, I accept the authority's view that this property is currently a dangerous building as defined by the Act and the notice should remain in force.

9. Comments on the draft determinations and the hearing

9.1 During the course of this determination a number of drafts were issued and a hearing was held. Both parties responded at each stage of the process and I now summarise the various comments and concerns.

9.2 The authority's comments

9.2.1 Throughout the process the authority raised a number of concerns. I have summarised the concerns where my view remains unchanged despite the authority's submissions, as well as incorporating changes requested where I considered them justified.

9.2.2 Consideration of the mitigation capacity of the as-built RPS

9.2.3 The authority considers that it is the applicants' responsibility to establish the capacity of the existing RPS, given that its construction differs from that which had been consented. As a result it does not accept my view that it had given insufficient consideration to this structure; although I do agree with the authority that the RPS does not have sufficient capacity to sufficiently mitigate the risk posed by the upslope rocks.

9.2.4 Exercise of powers

9.2.5 In exercising its powers, the authority's primary concern was ensuring the safety of occupants. Furthermore it considered that given the 'completely new and trying circumstances...the implicit criticism appears to be unfair'.

9.2.6 Furthermore the authority rejected the suggestion that its process had not been subject to peer review. While I accept decisions on individual properties were considered by other members of PHGG, I am still of the view that the process at a methodological level has yet to be peer reviewed, which has limited its robustness.

9.2.7 Suggestions for the way forward

9.2.8 The authority considers the inclusion of advice in respect of resolving the issue faced by the applicants to be 'irrelevant to the primary matter at issue in this determination.'

9.2.9 In its view, the authority considers that such advice would more properly be provided as separate general guidance. The authority has requested an opportunity to discuss this section. My decision to include this section is consistent with all determinations I issue and the comments are offered as advice and help in agreeing the way forward. In particular it would be my hope that the parties can agree a way forward without recourse to another determination.

9.3 The applicants' comments

9.3.1 The applicants supported the inclusion of the discussion and conclusion sections in the final determination. In respect of the section relating to steps for going forward, it was their preference that the section remains as in their view it provided them an approach that would enable engagement with the authority.

10. Suggestions for the way forward

10.1 The comments in this section are provided to assist the applicants and the authority as to the next steps should the applicants propose carrying out some remediation

(building work or not). This information is not part of the matter to be considered for the determination and is only offered in an attempt to assist both parties to agree the way forward.

10.2 There could be two separate tests to be made by the authority under the Act when considering remediation:

- The first test relates to the purpose and whether the proposed mitigation will result in the building no longer being dangerous.
- The second test is, if the proposed mitigation involves building work, whether that work complies with the New Zealand Building Code (“the Building Code”).

10.3 Establishing whether the building remains dangerous

10.3.1 I have not drawn any conclusions as to whether it is possible for the applicants to mitigate the risk to this property with the result that it would no longer be considered dangerous in terms of the modified definition of a dangerous building, as discussed in paragraphs 7.2 to 7.2.9.

10.3.2 I have also limited my comments to the construction of an RPS and, in doing so, have drawn on the comments provided by the authority during this determination as well on as its technical documents. I note that this is not the only means for developing a mitigation proposal and it may be that the applicants elect to pursue alternatives.

10.3.3 The authority has made reference to two of its documents:

- Infrastructure Design Standard (IDS), last reviewed December 2012, which refers to rockfall hazard mitigation at the subdivision level, and
- Technical Guideline for Rockfall Protection Structures (TGRPS), finalised March 2013, which covers private structures.

10.3.4 While I appreciate that there are some relevant design considerations in the TGRPS, it is my view that these are not framed in a way that is meaningful for the applicants or the owners of any other property where a section 124 notice has been issued. In particular, there do not appear to be clear criteria that will be applied for removal of a section 124(1)(a), (b) or (d) notice (as modified by clause 9 of the Order).

10.3.5 The applicants are entitled to expect clear guidance from the authority in respect of the criteria that will be applied when considering any proposal submitted in order that the building would no longer be dangerous as defined by the Order. This is particularly important as the TGRPS leads the reader to conclude that the authority’s decision will hinge on the resulting AIFR at the dwelling. I also note that the TGRPS appears to imply that the size of design boulder to be used will depend on the AIFR order of magnitude reduction that is required (refer section 3.2 note 1 and table 1 note 1 of the TGRPS).

10.3.6 The authority also needs to inform the applicants as to the reliance they might place on the authority's own evaluation findings. For instance, this should include whether the applicants are entitled to use the 95th percentile boulder described as the site

specific boulder and whether they might use the referenced 2D rock fall modelling as the basis for their proposal.

10.3.7 For this property, I note that PHGG appears to have concluded that it could be protected by an RPS (refer its memorandum dated 25 January 2013). The authority needs to provide clear reasons if the applicants are not able to rely on this advice.

10.3.8 I also make the following comments in respect of factors that need to be considered when designing an RPS if this is the mitigation path that the applicants propose.

10.3.9 Design boulder size

10.3.9.1 In its correspondence of 8 March 2013 regarding this property, I note that the authority now considers that a site specific design (95th percentile) boulder of 1m³ would be appropriate.

10.3.10 2D rock fall modelling

10.3.10.1 The authority has provided the outputs from 2D rock fall modelling for a 1m³ design boulder which indicate that the 95th percentile modelled energy would be in the range of 289 kJ to 611kJ.

10.3.10.2 However, I suggest that new modelling for this size of design boulder is undertaken for criteria (such as vegetation and bounce height) agreed between the authority and the applicants (or the applicants' advisors).

10.3.10.3 On the basis of this modelling, the energy level (EL) classification required of an RPS can then be established following the European Guideline ETAG 27¹².

10.3.11 Service energy level versus maximum energy level¹³

10.3.11.1 I note that the authority's TGRPS is clear that, where multiple impacts are likely, the RPS design needs to meet the service energy level (SEL) standard (i.e. the RPS is expected to stop a boulder at the SEL and still be able to stop a subsequent boulder).

10.4 Establishing compliance with the New Zealand Building Code

10.4.1 If the proposed mitigation involves building work, the proposal will need to demonstrate compliance with the Building Code. In particular if the mitigation involves the construction of an RPS, then this building is defined as ancillary under the Act and would need to comply with the structural and safety-related aspects of the Building Code.

10.4.2 Given that the purpose of the RPS is to absorb the energy arising from the impact of boulders then a not less than 50 year intended life may not be appropriate¹⁴. In this instance the authority may consider specifying the intended life by defining by alternative means such as the extent of damage sustained following impact.

¹² Guideline for European Technical Approval of Falling Rock Protection Kits, European Organisation for Technical Approvals, Brussels (2003)

¹³ Service energy level (SEL) and maximum energy level (MEL) are design limits from ETAG 27 and referred to in the authority's TGRPS that relate to the energy absorbing capabilities of an RPS.

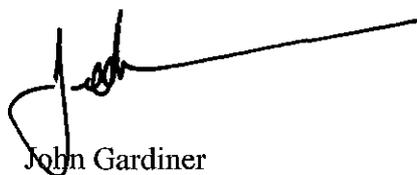
¹⁴ Previous determinations have addressed this issue 2004/08, 2005/28 and 2007/110d

10.4.3 In the event that the structure has a specified intended life it should also be noted that section 113(2)(b) provides for the authority to impose conditions it considers necessary when granting a consent with a specified intended life. Following on from this section 114 of the Act allows an owner to give notice if he or she proposes to extend the life of the building beyond the specified life.

11. Decision

11.1 In accordance with section 188 of the Act, I hereby determine that the authority correctly exercised its powers in issuing the section 124 notice under section 121 of the Act and accordingly I confirm the authority's decisions to issue and to refuse to withdraw the section 124 notice.

Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 2 July 2013.

A handwritten signature in black ink, appearing to be 'John Gardiner', with a long horizontal line extending to the right.

John Gardiner
Manager Determinations and Assurance

Appendix A

A1. The Port Hills and associated rockfall hazards

- A1.1 The Port Hills are the northern part of the eroded and now extinct Lyttelton basalt volcano, which comprises five overlapping volcanic cones. The hills extend from the southeast edge of Christchurch's main urban area to Lyttelton Harbour and from Godley Head in the east to Governors Bay in the west. They range up to about 500m high and include steep coastal cliffs.
- A1.2 The rock forming the hillside slopes and bluffs comprise strong jointed volcanic lava flows. These are composed of basalt and trachyte interbedded with softer breccia (scoria), agglomerate (volcanic gravel), ash and buried soil layers and cut by intruded dykes. The volcanic rocks are generally mantled with loess soils (windblown sand and silt). These are typically about 1m thick but can reach up to 5m thick in places.
- A1.3 From time to time, the jointed rock masses release boulders that roll and bounce downhill and then accumulate as talus or scree at the toe of the slopes. Potential triggers for releasing these boulders include earthquake shaking and a variety of non-earthquake mechanisms such as prolonged heavy rainstorms, shrinkage of soil beneath detached boulders during dry periods, and frosts.
- A1.4 As well as potentially triggering a boulder release, earthquake shaking can also fracture and loosen the jointed rock masses, making them more susceptible to future rockfalls.

A2. Events relating to the issue of section 124 notices in the Port Hills

- A2.1 The magnitude 7.1 earthquake of 4 September 2010 resulted in significant damage to buildings in the Canterbury region. As a result, a Civil Defence emergency was declared. The Canterbury Earthquake (Building Act) Order 2010 ("the 2010 Order") was passed to enable the region's territorial authorities to respond appropriately, and this came into force on 16 September 2010.
- A2.2 The 2010 Order expanded the definition of dangerous building to include:
- 7 Modification of meaning of dangerous building and extent to which territorial authority can apply modified provisions**
- (1) Section 121(1) of the Act is modified by adding...
- (d) there is a risk that other property could collapse or otherwise cause injury or death to any person in the building.
- A2.3 On 22 February 2011 the Canterbury region suffered a major aftershock on the Port Hills. As a result of this event, Civil Defence applied red placards to approximately 500 properties including the house that is the subject of this determination. These placards were issued under part 5 of the Civil Defence Emergency Management Act 2002.

- A2.4 On 19 April 2011, the Canterbury Earthquake Recovery Act 2011 came into force and provided the power to extend these placards¹⁵ for a further 12 weeks.
- A2.5 The 2010 Order deemed a red placard to be a notice under section 124(1)(b) of the Act¹⁶. Therefore, when the red placards expired in July 2011, the authority was required to formally serve section 124 notices.
- A2.6 In mid 2011, the authority established the Port Hills Geotechnical Group (PHGG), a consortium of specialist engineers, to assess those properties bearing Civil Defence red placards and to recommend whether (or not) a section 124 notice should be served.
- A2.7 The PHGG has continued to review properties on behalf of the authority with regard to issuing, retaining or removing section 124 notices in view of the definition of dangerous building contained in the Canterbury Earthquake (Building Act) Order 2011 (“the Order”). This superseded the 2010 Order referred to in paragraph A2.1 and took effect on 17 September 2011. The 2011 Order further modified the definition of dangerous building:
- 7 Modification of meaning of dangerous building and extent to which territorial authority can apply modified provisions**
- (1) Section 121(1) of the Act is modified by adding...
- (d) there is a risk that adjacent, adjoining, or nearby buildings or land could collapse (including collapse by way of rock fall, landslip, cliff collapse, or subsidence) or otherwise cause injury or death to any person in the building
- A2.8 I note that should the Order expire on 16 September 2013 the amended definition of dangerous building will no longer apply.

A3. Suburb-wide geotechnical assessments

- A3.1 The earthquake and aftershocks of 2010 and 2011 revealed a hitherto unknown earthquake fault in the Port Hills region. This has heightened the awareness of the level of rockfall risk in the area.
- A3.2 A considerable amount of geotechnical assessment has been now undertaken to assess that risk. Work has been commissioned by the authority to help with its assessment of risks from rockfall, cliff collapse and related hazards in the area. Work has also been commissioned by the Canterbury Earthquake Recovery Authority (CERA) to inform its land zoning decisions across all affected regions, including the Port Hills.
- A3.3 As I consider that this work has influenced some of the decision-making relating to the maintenance of notices issued under section 124 on this and other Port Hills properties, I now describe these assessments.

¹⁵ Under s85

¹⁶ cl8(?)

A3.4 Assessments for the authority

- A3.4.1 As a result of the February 2011 aftershock, the authority commissioned GNS Science in mid 2011 to undertake a comprehensive assessment of the life-safety risk in the Port Hills from rock fall.
- A3.4.2 GNS Science's risk model identified areas of different Annual Individual Fatality Risk (AIFR) within the Port Hills.
- A3.4.3 GNS Science's Port Hills rockfall risk assessments were derived from three independent components:
- the behaviour of people (where and how they lived relative to the Port Hills)
 - the nature of the surroundings relative to where people live (where boulders could fall from, the number of boulders available to fall and the paths they could follow), and
 - the frequency and magnitude of rockfall triggers such as earthquakes, rain and human disturbance.
- A3.4.4 I understand that GNS Science combined the frequencies, probabilities and consequences of these to estimate the different AIFR areas. However, GNS Science noted that this assessment was based on limited data that was subject to uncertainties and therefore had to be generalised as average values.
- A3.4.5 This model was further calibrated for GNS Science by PHGG between February and May 2012. PHGG assessed each Port Hills property against the model to calibrate the risk contour maps (it termed this field testing work "ground-truthing"). The finalised model and associated research was made public in September 2012.

A3.5 Assessments for CERA

- A3.5.1 At a similar time, the Government recognised that there was land in the Canterbury region that may no longer be able to be built on and wanted to provide options for residents. Accordingly, CERA also commissioned geotechnical and life risk modelling research from GNS Science and others, including 3D rock fall modelling. I understand from the authority that this modelling was not independent but a rerun of the modelling GNS Science had previously carried out for the authority, but with different parameters. This research was used as a basis for CERA's land zoning decisions, in what it deemed to be red zones, since property owners in those zones would become eligible for a Crown purchase offer.
- A3.5.2 In late 2012 CERA announced its decisions relating to red zones in the Port Hills. It said red zoned properties were those:
- affected by cliff collapse and with immediate risks to life, or
 - where land remediation was not considered viable and infrastructure would be difficult and costly to maintain, or
 - affected by rock roll and where the risk to life was considered unacceptable or was unlikely to reach an acceptable level in a reasonable timeframe, or
 - where protective works to mitigate the life safety risk were not considered practicable.

A3.6 The section 124 notices and CERA's zoning process

- A3.6.1 There is potential for confusion in the understanding of the CERA zoning process and the authority's decisions to issue section 124 notices; both can have significant impact on the living choices of building owners. Both decisions have drawn on similar data and investigative reports, which makes sense given the technical challenges of assessing the increased risk of rockfall and the limited resources of both CERA and the authority. However, it is important to keep in mind that the authority, unlike CERA, must comply with specific statutory requirements before issuing a notice.
- A3.6.2 The notices issued by the authority make use of significant powers intended to ensure that a minimum standard of safety is maintained for all buildings and that people's health and safety is not placed at risk by buildings that are dangerous, earthquake-prone or insanitary.
- A3.6.3 The powers provided for under section 124 can have a very severe outcome as they can prevent a person from accessing their own home. Accordingly, the authority is required to provide a clear articulation of when these powers will be exercised and appropriate evidence in support of any specific decision to issue a notice.
- A3.6.4 While the GNS Science methodology was initially commissioned by the authority, it is a suburb-scale tool which the authority advises me was not applied directly to its decisions to issue or retain section 124 notices relating to rockfall in the Port Hills. The methodology was subsequently applied by CERA, although using a different set of initial assumptions.

A4. The authority's process in respect of section 124 notices in the Port Hills

- A4.1 The authority has acknowledged that the decision-making process relating to the application or removal of notices on this and other Port Hills properties has been an evolutionary process. Based on the documentation provided to me in the context of this and similar determinations, I describe this process as I understand it:
- first, by focussing on the authority's decision making criteria (paragraphs A4.2 to A4.2.4), and
 - second, by summarising the types of assessment carried out, in chronological order (paragraphs A4.3 to A4.6.7).

A4.2 The authority's decision making criteria

- A4.2.1 The authority has applied criteria related to
- whether the building had actually been hit by a boulder or rock
 - whether a boulder or rock had landed at or passed the building
 - whether there was a rockfall source and how that source compared to the suburb average
 - whether any topographic or other mitigation features influenced the risk to the dwelling

- how the site compared with the GNS Science' suburb-scale risk assessment, and
- whether the F angle¹⁷ was less than the GNS shadow angle¹⁸.

A4.2.2 Latterly, additional criteria have been specified. These are as follows:

- whether a boulder or rock will pass or reach the building with sufficient energy to damage the building, with sufficient energy now being specified as 'in the region of, or greater than 25 kJ at the dwelling' for an external wall of the type described within NZS 3604, and
- where any interceptors (e.g. a rock protection structure or vegetation) were present, the mitigation effect of those interceptors being limited to 50 kJ unless those interceptors have mitigation effects certified as otherwise.

A4.2.3 The authority has advised me that the energy capacity attributed to a NZS 3604 type external wall (25 kJ) was established as a result of discussion with its engineers and then cross checked by 'basic back calculation' of the energy levels of rocks reaching, impacting or penetrating some of the dwellings directly affected by rocks in Morgans Valley and Sumner.

A4.2.4 The authority advised that it had allocated an energy capacity of 50 kJ to rock protection structures constructed before the 2010/2011 earthquake sequence that had 'typically been installed across the Port Hills, generally comprised of chain-link fence or double-twist mesh' because the performance of these structures was highly dependent on the mode of travel of the boulder, type of construction and quality of workmanship, and that:

After considering supplier product information, anecdotal evidence, and some limited back analyses, the indication is that these rudimentary structures generally have rockfall stopping capacities no greater than 50kJ.

A4.3 Assessments from mid-2011

A4.3.1 From mid-2011, PHGG assessed all properties for section 124 notices on behalf of the authority. I refer to any house that had a red placard from this time as having a notice. The authority said these notices were placed and reviewed on the basis of site-specific conditions and observations and that PHGG considered topography, vegetation, actual boulder locations in relation to houses, upslope houses and potential rock sources for future boulders. In a letter to me of 26 November 2012, the authority advised that:

In the expert opinion of the PHGG consultants, where a s124 notice has been issued, the level of risk is very high or extreme.

A4.3.2 This assessment process included a flowchart and considered

- whether rocks fell on this or an adjacent property and, if so, whether they reached or passed the house and whether the house was hit by rocks

¹⁷ F angle, or Fahrboeschung angle: the angle formed between the horizontal and a line drawn from the actual rockfall source location to the stopping point for a given boulder or to a particular given point on the slope below the source.

¹⁸ S angle, or shadow angle: the angle between the horizontal and a line drawn from the base of the rockfall source to the stopping point for a given boulder or to a particular given point on the slope below the source.

- if the slope below the source was steep enough for boulders to roll
- whether there were obvious sources for further rockfall, and
- if there was effective man-made or natural protection such as rock fences, houses, bund or trees.

A4.4 Assessments from mid-2012

A4.4.1 PHGG continued its assessments for the authority from mid-2012 using a revised flow chart that represented its process.

A4.4.2 At this time the process considered

- whether a boulder had passed within 10 m of the house
- if the F angle was less than the GNS shadow angle
- whether the rock fall source varied significantly from the suburb average
- whether topographic features influenced the risk to the dwelling
- whether there were any other known mass movement issues that could increase the risk to the dwelling, and
- whether the risk at the site was the same, less or greater than the GNS suburb-scale value.

A4.4.3 The authority said the GNS Science modelling information was used for context. However, from the documentation, it appears that it used the GNS Science model as a filter as the decision-making process did not allow for an existing notice to be lifted unless the AIFR¹⁹ at the property (as assessed by the model) was less than 1×10^{-6} .

A4.5 Assessments from late 2012

A4.5.1 CERA made several zoning announcements for the Port Hills during 2012, and these triggered further assessments. Properties with existing notices that were zoned red were sent letters by the authority saying that the section 124 notice would continue. I also note that the assessment template changed around that time to reflect CERA's adaptation of the GNS Science life safety risk model. From then on, the decision-making process did not allow for an existing notice to be lifted unless the AIFR at the property was less than 1×10^{-4} as assessed by the GNS Science model for the authority and by CERA's own modelling.

A4.5.2 The authority has recently advised me that it also completed 2D rock fall energy modelling for approximately 130 properties at this time. These properties were those where:

...the s124 notice was uplifted following the zoning announcement by CERA in June 2012, but where the [authority] subsequently decided a review was needed to verify the decisions that had been made.

¹⁹ Annual individual fatality risk, which is used in the GNS work for the authority and CERA to express the probability (likelihood) that a particular person occupying a dwelling will be killed by an event such as rockfall in any one year. This risk is expressed as logarithmic numbers such as 10^{-4} (10 to the power of minus 4) per year.

A4.5.3 Around this time, some owners (including the applicants) applied to the Ministry for determinations with the objective of overturning the notices for their properties.

A4.6 Assessments from early 2013

A4.6.1 Where a determination application had been made, a complete reassessment of the rockfall risk for the property was undertaken by PHGG. The review included completion of a two-page checklist, an office review of existing data, further field testing and 2D rockfall modelling.

A4.6.2 I understand that the rockfall model has been calibrated against actual, observed roll/bounce trails of boulders that fell during the Canterbury earthquake sequence. The rockfall model also takes into account the topography, geomorphology, vegetative cover and other barriers along any particular rock-roll path that has been selected.

A4.6.3 I note that in the accompanying memoranda to the authority for all reassessments of this type that I have seen, PHGG says the criteria used to determine whether or not a dwelling was in a location such that it was exposed to a 'clear and present danger' include, but are not limited to, whether (in recent earthquake events)

- rocks fell on this or an adjacent property
- rocks reached or passed the dwelling
- the dwelling was hit by rocks
- the slope above the dwelling was steep enough for rocks to roll down it
- there were obvious sources for further rockfall, and
- the rocks could reach the dwelling with sufficient energy to penetrate the exterior cladding (of the dwelling), and
- there was effective natural or man-made protection for the dwelling.

A4.6.4 In order to undertake the 2D Rock fall modelling and arrive at a calculated potential energy, a 95th percentile boulder size was calculated and the 95th percentile energy value of that boulder at the dwelling was recorded. I understand from PHGG that for many properties the site specific 95th percentile rock was assumed to be the same as the suburb wide 95th percentile boulder size.

A4.6.5 I note further that the review checklist provides for consideration of rockfall mitigation measures, but only if these are approved or consented by the authority:

Non [authority] approved engineering mitigation works cannot be used to change the risk.

A4.6.6 The checklist also gives PHGG three options for its recommendations to the authority:

- Retain the notice on the property.
- Retain the notice but reassess this once approved rockfall protection measures have been installed.
- Remove the notice.

A4.6.7 The authority has advised that, except for one additional property, this complete reassessment has been limited to:

- (a) properties with existing section 124 notices where a determination application had been made; and
- (b) properties that are exposed to increased risk of rock fall due to the demolition of an upslope dwelling that currently provides protection and which may need a section 124 notice to be applied.

The reason given for limiting this reassessment was because of the time and cost associated with the reassessment work.

