Determination 2015/002

Regarding the issue of a section 124 Building Act notice (relating to geotechnical hazards) on a property at 47 Ocean View Terrace, Christchurch

1. The matter to be determined

1.1 This is a determination under Part 3 of the Building Act 2004[1] ("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

- 47 Ocean View Terrace Ltd, the owner of 47 Ocean View Terrace, Christchurch, represented by the company director ("the applicant")
- Christchurch City Council, carrying out its duties and functions as a territorial authority ("the authority").

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

1.3 The applicant has applied for a determination regarding the authority's decision to issue a dangerous building notice on the property under section 124(1)(b) of the Act ("a section 124 notice").

1.4 The applicant's property is located in the Port Hills area of Christchurch in an area affected by rock fall following the 2010-2011 Canterbury earthquakes and aftershocks ("the Canterbury earthquakes").

1.5 In June 2012 the authority removed a section 124 notice on the house when the property was "green zoned"[2] by the Canterbury Earthquake Recovery Authority ("CERA"). However, the authority reapplied a section 124 notice in December 2012. In December 2013 CERA revised the property's status to "red zone"[3].

1.6 I consider the matter to be determined[4] is whether the authority correctly exercised its powers in issuing a section 124 notice for the applicant's house.

1.7 When considering this matter and arriving at my decision I have considered all the information provided to me by the applicant and the authority. I also engaged the services of a chartered professional engineer with a specialisation in geotechnical engineering ("the expert"), who provided advice and analysis in terms of the technical material provided.

2. Context

2.1 This determination relates to a property in Christchurch's Port Hills. The Port Hills area was already at risk of rock fall and experienced significant damage as a result of the Canterbury earthquakes. The area is now understood to lie over an earthquake fault line.

2.2 A number of the dwellings in this area had section 124 notices applied under the definition of dangerous building modified by the Canterbury Earthquake (Building Act) Order 2010[5] ("the modified definition"[6]). That Order was superseded on 17 September 2011 by the Canterbury Earthquake (Building Act) Order 2011 ("the 2011 Order"), and the 2011 Order was superseded on 17 September 2013 by the Canterbury Earthquake (Building Act) Order 2013 ("the 2013 Order").

2.3 The modified definition and relevant legislation are described further in the discussion section. A more detailed description of the Port Hills and associated rock fall hazards, as well as background to the issue of section 124 notices under the modified definition is included in previous determinations[7].

3. The house and site

3.1 The house was built in the early 1960s in the Sumner Valley, in Christchurch's Port Hills. The property backs onto La Mar Lane, with a vacant section (at number 8)

[2] CERA Green Zone: Port Hills – considered to have a sufficiently low risk to life and the land can be remediated independently of surrounding properties

[3] 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

[4] Under sections 177(1)(b) and 177(3)(f) of the Act

[5] Canterbury Earthquake (Building Order) 2010 clause 7

[6] 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] For example Determinations 2013/33 and 2013/37 – available at www.dbh.govt.nz

immediately across the road and other houses in that lane (6, 7 and 9 La Mar Lane) nearby and upslope.

3.2 A plantation of trees and a non-engineered rock fence ("the fence") is located above these houses and below a series of bluffs. This fence was hit and damaged by a number of rocks during the Canterbury earthquakes. No rocks reached within 20m of the applicant's property, but Number 9 La Mar Lane was by struck by a boulder.

3.3 The rock sources upslope have been described[8] as having multiple fractured outcrops and bluffs, and with a maximum observed rock size of $3.4m^3$.

4. Background

4.1 As noted earlier, the property is in an area affected by rock fall during the Canterbury earthquakes. It was green zoned by CERA on 29 June 2012, but later red zoned as part of the CERA zoning review published 5 December 2013.

4.2 Section 124 notice confirmed November 2011

4.2.1 On 29 November 2011 the Port Hills Geotechnical Group (PHGG)[9] completed a section 124 notice review (flowchart assessment) at the property and concluded that a section 124 notice was required.

4.2.2 The flowchart noted: rocks did not fall onto this or an adjacent property; the slope below the source was steep enough for boulders to roll; there were obvious sources for further rock fall; and there was not effective natural or man-made protection.

4.2.3 The comments made were: "damaged rock fall fence above house" and "empty section above house".

4.3 Hazard verification report January 2012

4.3.1 On 17 January 2012 PHGG completed a hazard verification report for the property. The report said rock fall had occurred during the February and June 2011 aftershocks and a boulder had struck one of the upslope dwellings (9 La Mar Lane). Unstable boulders and bluffs were observed above the property.

4.4 Site assessment February 2012

4.4.1 On 19 February 2012 PHGG undertook a site assessment as part of the suburb-wide field testing of GNS Science's[10] rock fall risk model[11] that was carried out at all Port Hill properties. This noted:

- the GNS_{LOL} (loss of life) risk at the property was between 10^{-3} and 10^{-4}
- the measured 'F' angle[12] at the dwelling was 33°, greater than the GNS shadow angle[13] of 28°
- the slope above the dwelling was "sloping run-out" and no significant topographic features influenced risk to the dwelling

[8] Port Hills Geotechnical Group review accompanying its memorandum to the authority dated 20 December 2013
[9] A consortium of geotechnical engineers contracted to the Christchurch City Council
[10] A Government-owned research institute specialising in earth, geosciences and isotope research and consultancy
[11] Reported in GNS Science Consultancy Reports; 2011/311 (March 2012) "Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Pilot study for assessing life-safety risk from rock falls (boulder rolls)" and 2012/123 (March 2012) "Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Life-safety risk from rock falls (boulder rolls) in the Port Hills"
[12] F angle, or Fahrboeschung angle: the angle formed between the horizontal and a line drawn from the actual rock fall source location to the stopping point for a given boulder or to a particular given point on the slope below the source
[13] S angle, or shadow angle: the angle between the horizontal and a line drawn from the base of the rock fall source to the stopping point for a given boulder or to a particular given point on the slope below the source

- the site-specific rock fall source did not vary significantly from the suburb average, which was "continuous outcrop"
- boulders did not pass or land within 10m of the house
- the risk at the site was the same as the GNS suburb-scale value
- a section 124 notice was required.

4.5 Section 124 notice removed June 2012

4.5.1 On 29 June 2012 CERA advised the applicant that the property had been green zoned.

4.5.2 The same day, the authority advised the applicant that 'as a result of recent decisions relating to risk to life from geotechnical hazards' the section 124 notice would be removed.

4.6 Section 124 notice reapplied December 2012

4.6.1 On 11 December 2012 the authority wrote to the applicant to confirm that a section 124 notice had been issued for the dwelling since 6 December 2012 and would remain in place until further notice. It said geotechnical hazards in the immediate vicinity made the house 'unsafe for residential purposes'.

4.6.2 The authority's decision was based on a section 124 notice review conducted by PHGG that concluded: 's124 (geo) notice should remain'. This review included a flowchart assessment ("s124 (geo) Notice Review – Boulder Roll") completed between 17 October and 21 November 2012, a site visit and 2D rock fall modelling.

4.6.3 The flowchart stated:

- The condition for which the section 124 notice was attached was still present.
- While the GNS-modelled AIFR[14] at the dwelling was marked as $\geq 10^{-4}$ (2012 and 2012a), and $<10^{-4}$ (2016), an addition to the form noted that this model had been reviewed and the 2016 AIFR was $\geq 1 \times 10^{-4}$.
- The GNS risk model was not consistent with the site-specific field evidence (it underestimated risk) and a review of the GNS model and site-specific risk assessment was required.

4.6.4 Comments below the flowchart were:

> Re-ran 2D model 19/10/12
> No effective protection upslope houses
> Site visit 1/11/12 confirmed that model underestimates risk.

4.6.5 The accompanying form ("Geotechnical Assessment of Property") stated:

- It was unknown whether geomorphic evidence of past rock fall or boulder roll on or around the property directly affected the house, buildings, or building platform.
- There was no rock fall or boulder roll within 20m of the dwelling, the dwelling or other buildings were not hit, and rocks did not fall onto adjacent properties ('all nearby fallen rocks stopped further upslope').

[14] Annual individual fatality risk, used in GNS work for the authority and CERA to express the likelihood that a particular person occupying a dwelling will be killed by an event such as rock fall in any one year. This is expressed as logarithmic numbers such as 10-4 per year.

- There was natural protection to the property from a low ridge and trees, and it was not exposed to any topographical focus (gullies), but upslope houses did not provide effective protection.
- The rock source type was 'discontinuous major' and there was a moderate probability of the dwelling being struck by a rock.
- The assessment was inconsistent with the GNS model as this model underestimated the risk.

4.6.6 The form also noted that 2D rock fall modelling (95th percentile boulder) was within the run-out zone; bounce height at the dwelling was greater than 1m (ie 4.5m); and total kinetic energy at the dwelling was greater than 100 kJ (ie 2,180 kJ).

4.6.7 A note added to this on 19 October 2012 stated:

> Re-ran 2D model with 95% (suburb) boulder and vegetation (trees)
> At dwelling: bounce = 1.8m. Total [kinetic energy] = 655 kJ.

4.7 Section 124 notice confirmed December 2013

4.7.1 Between 14 October and 19 December 2013, PHGG conducted another section 124 notice review for the authority which included new 2D rock fall modelling. This was prompted by the applicant's original application for a determination, which I received on 10 September 2013 but which the applicant later withdrew (refer to paragraph 5).

4.7.2 PHGG wrote to the authority on 20 December 2013 with details of its review, and concluded:

> … it is our opinion and recommendation that the s124 should remain on this dwelling until such time as properly designed, constructed and approved rock fall protection works have been implemented.

4.7.3 It said it had considered the GNS life risk models and CERA's zoning decision but this did not affect whether or not the dwelling met the criteria to be classed as a dangerous building under the Act. It also noted that risk to access was not a reason for a section 124 notice.

4.7.4 PHGG said its original criteria used to determine whether or not the dwelling was in a location such that it was exposed to a danger (and was therefore a dangerous building under the test that applied at the time the section 124 notice was placed on the building) included but were not limited to:

- Did rocks fall on this or an adjacent property?
- Did rocks reach or pass the dwelling?
- Was the dwelling hit by rocks?
- Is the slope above the dwelling steep enough for rocks to roll down it?
- Are there obvious sources for further rock fall?
- Is there effective natural or man-made protection for the dwelling?

4.7.5 PHGG said this protection might be one or more of vegetation (eg shelter belts, plantations, dense scrub), house(s), rock fences, bunds or topographic controls. It also said the protection was not deemed effective if it had been passed or penetrated by rock fall boulders. For example, if some rocks had passed right through a shelter

belt or plantation it would not be considered an effective barrier even if it had stopped other rocks.

4.7.6 PHGG said it conducted a site inspection of the rock source area(s), the slopes below the rock sources and the area of the applicant's dwelling. Its considerations included:

- All available relevant technical information held by the authority, and 2D rock fall modelling undertaken for PHGG as well as GNS Science.
- 3D rock fall modelling originally undertaken for CERA, but little weight was given to this in light of the uncertainties associated with this modelling.
- Previous reviews and site assessments (as described in paragraph 4).

4.7.7 PHGG said its review specifically considered the effects of topography, vegetation, other buildings, fences and, where appropriate, rock fall protection structures that might have affected the probability of boulders reaching, impacting or passing the dwelling with sufficient momentum to represent a life safety risk. It also considered the likelihood that the dwelling's construction would make it capable of stopping rocks that impacted upon it.

4.7.8 PHGG said it considered the following specific factors:

- the approximate PGA[15] experienced at the site
- the nature/characteristics of the rock fall source area
- the characteristics of the slope between the source and the dwelling
- whether the observed rock trails had been influenced by topography, vegetation or man-made structures
- previous 2D and 3D rock fall modelling (for context)
- new site-specific 2D rock fall models (including effects of topography, vegetation, Rock Protection Structures) undertaken to obtain estimates of energy and bounce height at the rear of the dwelling.

4.7.9 It said new 2D rock fall modelling was undertaken along three section lines, or profiles, defined on the basis of the field inspection and data review.

4.7.10 PHGG's key outcomes from its review included:

- Based on effects observed following the 22 February and 13 June 2011 events, earthquake was a credible trigger that could generate future rock fall from the slopes above this site.
- There were rock sources (bluffs and fractured outcrops) at several levels on the slope above this property that could release rock fall debris onto the site, and boulder trajectories resulting in impact of the applicant's dwelling were considered feasible.
- No rocks reached the property as a result of the Canterbury earthquakes but a number were stopped by the pine plantation and non-engineered rock fall fence (now compromised) above La Mar Lane, particularly behind 9 La Mar Lane (PHGG said this dwelling was hit by at least one rock on 13 June 2011).

[15] Peak Ground Acceleration (PGA) is a measure of earthquake acceleration on the ground and it is described in terms of the gravitational constant, "g"

- Site-specific mapping of the *in situ* rocks in the potential rock fall source areas indicated there was the potential for boulders in the order of 4.5m^3 to be generated (maximum of joint set data recorded). The estimated site-specific 95th percentile boulder size was approximately 1.0m^3.
- The dwelling at 9 La Mar Lane provided limited upslope protection to the applicant's dwelling, but there was no house at 8 La Mar Lane to provide protection.
- The non-engineered rock fall fence (about 1.8m high and 45m upslope) was hit and breached in several locations by boulders during the Canterbury earthquakes, and could not be relied upon as effective rock fall mitigation.
- The vegetation (plantation) upslope had slowed or stopped significant numbers of rocks but had not stopped all of them; so the vegetation alone could not be relied upon as effective rock fall mitigation.
- Including vegetation in the 2D rock fall modelling reduced kinetic energies and bounce heights but did not eliminate the potential for rocks to reach the dwelling.

4.7.11 PHGG's key outcomes also included a summary of the site-specific 2D rock fall modelling, noting that:

- The modelling showed that even with the existing forest a small percentage of rocks originating from all sources on the slopes above were able to reach the dwelling with total kinetic energies > 100 kJ.
- For the bare slope modelling (ie if the trees were removed) total kinetic energy at the dwelling was estimated to range from ~100 kJ (rocks originating just above the trees) to ~1400 kJ for rocks originating further upslope.
- Further cross-check modelling showed rocks that just passed through the trees and regained momentum as they continued downslope (ie using a seeder placed at the failed catch fence location) resulted in total kinetic energies at the dwelling of >60 kJ for a 1m^3 boulder and >100 kJ for a 2m^3 boulder.

4.7.12 PHGG said the modelling indicated there was a risk that rocks would penetrate the structure with sufficient energy to injure an occupant (based on the criterion that where the kinetic energy was greater than ~25 kJ, rocks would penetrate a typical house wall).

5. The submissions

5.1 On 17 July 2014 I received an application for determination. This included copies of the section 124 notice reviews, site assessments and correspondence from the authority described in paragraphs 4.2 to 4.6.

5.2 I note that the applicant had filed an application previously, on 10 September 2013. However, this application was withdrawn on 5 December 2013 when the applicant learnt that the property had been red zoned by CERA.

5.3 In response to the original application for determination, the authority noted the site assessments and reviews already provided to me by the applicant. On 8 January 2014 it sent me a copy of the PHGG review and accompanying memorandum described in paragraphs 4.7.1 to 4.7.12.

5.4 On 24 September 2014, in response to a request from me relating to the 2D modelling undertaken for that review[16], the authority supplied copies of reports it said highlighted the rock sources above the property. These related to the applicant's property (as already described in paragraph 4) and to those on either side (45 and 49 Ocean View Terrace), and were:

- the section 124 notice review flowcharts completed 29 November 2011
- hazard verification reports completed on 17 January 2012 for 47 and 49 Ocean View Terrace, and on 20 November 2012 for 45 Ocean View Terrace
- site assessments carried out as part of the field testing of the GNS Science model and completed 14 February 2012.

5.5 A draft determination was sent to the parties for comment on 18 November 2014. In a covering letter I requested further information regarding the fence and clarification of some details in the PHGG memo of 20 December 2013.

5.6 The authority accepted the draft in a response dated 19 November 2014, and provided further information in response to my request.

5.7 On receipt of the draft the applicant engaged a geotechnical engineer to assess the site and an engineering company to design rockfall protection for the site. The applicant provided a submission as follows (in summary):

- The fence was established to address/mitigate a known rockfall hazard and must have been subject to an engineering design to satisfy the authority for consenting requirements. The protection it provides should be considered.
- A probability that a boulder could reach the dwelling may exist, however the question is whether the calculated probability is tolerable. The GNS CR2012/214 Report, current at the time the notice was issued, shows the risk to be an acceptable level (less than 10^-4).
- The applicant's property is in the same life risk zone as others on the same road but is treated differently.
- Clear guidance is needed on the criteria that will be applied when the applicant submits a proposal in order that the dwelling would no longer be dangerous.
- The applicant assumes the determination to be based on the Design and Hazard Based Guidelines, and the guidelines should be disclosed.

  It is unclear why in some cases the Ministry has provided recommendations in determinations[17] but has not done so in this case.

5.8 I have carefully considered the submissions received from the parties and amended the determination as I consider appropriate.

[16] My request was: "with respect to section 7, is there a credible rock source at the top of this section and, if so, what further information can you supply about this rock source?"
[17] For example Determination 2013/037

6. Discussion

6.1 In order to arrive at a view on whether the authority correctly exercised its powers in issuing the section 124 notice, I must consider the meaning of dangerous building and the issuing of section 124 notices in terms of the relevant legislation.

6.2 This legislation includes:

- the Act
- the 2011 Order, which expired on 16 September 2013, and
- the 2013 Order, which took effect from 17 September 2013 and will be revoked on 18 April 2016.

6.3 The relevant sections and clauses are discussed further below.

6.4 Meaning of dangerous building

6.4.1 The relevant sections of the Act are:

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

6.4.2 While section 124 'Meaning of dangerous building' was replaced on 28 November 2013[18] with section 124 'Dangerous, affected, earthquake-prone, or insanitary buildings: powers of territorial authority', I refer to the version noted in paragraph 6.4.1 as this was in force during the period the determination is concerned with and is the version referenced by the 2011 and 2013 Orders.

6.4.3 As the authority reapplied a section 124 notice on the applicant's property in December 2012 – that is, before the 2011 Order expired on 16 September 2013 – the following clauses of that Order are also relevant:

- 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

6.4.4 The authority had the power at that time to issue a section 124 notice by relying on the definition of dangerous building as modified by clause 7 of the 2011 Order. This modified definition is as follows:

> **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

6.4.5 In considering whether the authority should have issued a section 124 notice based on the modified definition, I note that this definition established a very low threshold before a building would be considered dangerous.

[18] By section 30 of the Building Amendment Act 2013

6.4.6 In respect of the risk at the applicant's property, the only requirement is 'there is a risk' that adjacent land could collapse by way of landslip, cliff collapse or subsidence and cause injury or death to any person in the building.

6.4.7 A "risk" that something could happen is simply a possibility of that event happening. 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.

6.4.8 The modified definition also required that the risk of injury or death must be 'to any person in the building'. This meant that the defined hazard must reach the building itself, not just the property boundary, with sufficient force to injure the occupants.

6.4.9 The extent to which the authority could have applied this modified definition was as follows[19]:

> **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.

6.4.10 I note that, as the 2011 Order has expired, the authority no longer has the power to apply new section 124 notices using the modified definition.

6.4.11 Furthermore, the 2013 Order only provides for some of the section 124 notices issued by the authority relying on the modified definition to remain in force[20]; namely, those issued:

- under section 124(1)(b)[21] of the Act (warning a person not to approach a building), and
- before the 2011 Order expired.

6.4.12 All other section 124 notices relying on the modified definition expired with the 2011 Order[22].

6.5 Whether there was a risk

6.5.1 To arrive at my decision on whether or not this house was a dangerous building under the Act while the modified definition applied, I have to consider whether there was a "risk" for the purposes of section 121.

6.5.2 In previous determinations relating to the application of section 124 notices for rockroll[23] where such notices have been applied by the authority and their issue or removal has been challenged by the homeowner, I have set out the decision-making approach.

6.5.3 In particular, I need to consider whether there is:

- a credible risk of a triggering event that would generate a rock fall
- a source of rocks above the property

[19] Clause 7 of the 2011 Order
[20] Under clause 5(1)(a) of the 2013 Order
[21] The 2013 Order refers to section 124(1)(b) of the Act but these provisions are currently contained in section 124(2)(b) following the enactment of the Building Amendment Act 2013.
[22] Under clause 6 of the 2013 Order
[23] Eg determination 2013/074, available at www.dbh.govt.nz

- a risk that rocks from these sources would reach the building
- 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.

6.5.4 In considering each of these points, I have drawn on expert advice (as described in paragraph 1.7).

6.5.5 Following this approach, and based on the evidence supplied and the expert's advice, I accept there was:

- a credible risk of a triggering event that would generate a rock fall, and
- sources of rocks above the property.

6.5.6 I now need to consider whether there is sufficient evidence to allow me to conclude there was:

- a risk that rocks from these sources would reach the building
- a risk that they would do so with sufficient energy to injure an occupant
- sufficient mitigation that would offset this risk.

6.5.7 The expert has reviewed the technical evidence made available in this determination. He notes that while no boulders reached or passed within 30m of the applicant's dwelling during the Canterbury earthquakes, six boulders passed the same 28° shadow angle contour between about 75m and 150m to the southwest (at 65 Ocean View Terrace). Another boulder passed about 120m to the northeast (at 29 Ocean View Terrace).

6.5.8 The expert notes that the vegetation belt above these houses is wider than, and of similar density to, the vegetation above the applicant's property. He also notes PHGG's conclusion (in its memorandum of 20 December 2013) that the non-engineered rock fence upslope from the applicant's property has been breached in several locations and cannot be relied on for effective mitigation, and that there is no house immediately upslope to provide protection.

6.5.9 In the expert's view, the shadow angle of 28°at the applicant's dwelling indicates that there is a significant chance that boulders could reach this. He says that Table 17 of the GNS Pilot Study Report indicates that approximately 8% of the fallen boulders that were generated by the February 2011 aftershock passed the 28° shadow angle on the Heberden Avenue side of the Sumner Valley[24].

6.5.10 The expert has considered the 3D rock fall modelling noted in PHGG's December 2013 review. However, as he understands this has not been validated against actual boulder roll paths, he concludes that little weight should be given to this output.

6.5.11 He has also reviewed the 2D rock fall modelling carried out by PHGG, noting its previously stated criteria[25] for considering that "there is a risk". Based on this, a rock would need to reach the dwelling with kinetic energy of about 25 kJ or greater to be considered capable of penetrating a wall and injuring an occupant.

6.5.12 In reviewing this modelling, the expert noted that:

[24] The location of the applicant's property
[25] As stated in an email from the authority to me on March 4 2013 regarding the assessment for similar section 124(geo) notices

- Rocks could reach the dwelling along all three sections where bare slopes are modelled but only along section 007 for the vegetated slope models.
- Outputs relate to boulders of $1m^3$ and $2m^3$ size, which compare to the site-specific 95% design size of $1m^3$ indicated in the PHGG review (under Key Outcomes) and the 95% design sizes of $1m^3$ and $2m^3$ indicated for *in situ* and fallen boulders respectively (under Rockfall Modelling Parameters).
- A 95% bounce height of up to 1m at the dwelling for bare slope and up to 0.2m for the vegetated slope runs indicates that, as the slope is vegetated, any boulders are likely to be rolling rather than bouncing to any significant extent at the dwelling.
- Results for bare slope modelling indicate that boulders would penetrate the rear (upslope) wall of the applicant's dwelling, as 95% kinetic impact energy values of ≤246 kJ for the $1m^3$ (95% design) boulder size and ≤534 kJ for the $2m^3$ boulder size are greater than 25 kJ.
- Results for vegetated slope modelling indicate that a $1m^3$ boulder may not penetrate the rear wall of the dwelling, as the 95% kinetic impact energy value (<5 kJ) is less than 25 kJ. However the kinetic impact energy value increases to 66 kJ for boulders that just pass through the forest and regain momentum (using a seeder placed at the failed catch fence) and the number of boulders reaching the dwelling increases from ≤0.1% to 2.6% (and to 79.6% for the $2m^3$ boulder size).
- The results also indicate that a $2m^3$ boulder would penetrate the rear wall as the 95% kinetic impact energy value (110 kJ) is greater than 25 kJ.

6.5.13 The expert's view is that although this modelling indicates that the vegetation substantially reduces the percentage of boulders reaching the dwelling from about 80% to ≤0.1%, Table 17 of the GNS Pilot Study Report (referred to in paragraph 6.5.9) indicates that about 8% of the falling boulders generated by the February 2011 aftershock reached the same shadow angle.

6.5.14 In the expert's opinion, given that the 2D rock fall model results are highly dependent on the vegetation parameters used and the uncertainties inherent in those parameters and the modelling process, the results of the rock fall modelling of the vegetated slope should be considered in conjunction with:

- Table 17 of the GNS Pilot Study Report, which indicates that 8% of the boulders could reach the dwelling; and
- the observation that several boulders passed through the forest belt and non-engineered rock fence on nearby properties and reached the 28° shadow angle contour.

6.5.15 Based on this, it is the expert's opinion that the life safety risk to occupants of the applicant's dwelling is high enough to warrant the section 124 notice that has been placed on the dwelling, and he agrees with the key outcomes of the PHGG memorandum of 20 December 2013, which states: 'the modelling indicates that there is a risk that rocks will penetrate the structure with sufficient energy to injure an occupant.'

6.5.16 In the expert's opinion, the risk is not sufficiently mitigated by the existing site features (vegetation, non-engineered rock fence and topography).

6.5.17 Accordingly, in reviewing the available evidence and based on my expert's advice, I consider that, at the time the modified definition of dangerous building could be considered, there was sufficient evidence to conclude there was a risk rocks could arrive at the applicant's dwelling with sufficient energy to cause injury to an occupant. Furthermore, I consider that this risk has continued to exist and that the authority acted appropriately in reviewing, and deciding not to uplift, the section 124 notice in December 2013 after the 2011 Order expired.

6.5.18 Notwithstanding this conclusion, I note that it is the expert's view as well as that of PHGG[26] that it should be possible to mitigate this risk by constructing an appropriate rock fall protection structure above the property.

6.5.19 The Ministry is currently developing guidelines to assist building owners who are intending to install rock protection structures to mitigate rock roll risks. This should be completed by mid 2015.

6.6 The authority's section 124 review process

6.6.1 I have also considered whether the authority's decision-making process and assessment methodology was adequate.

6.6.2 I appreciate that these section 124 notice reviews have been based on an evolving methodology, given the accumulation and refinement of technical information following the Canterbury earthquakes.

6.6.3 I am of the view that in this case the authority's ongoing reviews and actions in relation to the applicant's property have been sufficient and that it has made appropriate use of the tools and methodologies available to it.

7. Conclusion

7.1 In considering whether or not the authority exercised its powers correctly I have considered its process in terms of whether this was carried out in accordance with the requirements of the Act.

7.2 For the reasons above, I consider that the authority did exercise its powers correctly in deciding to issue a section 124 notice.

[26] Assessment Section of PHGG s124 (geo) Review Checklist

8. The decision

8.1 In accordance with section 188 of the Act, I hereby determine that the authority correctly exercised its powers of decision by issuing a notice under section 124 of the Act; and accordingly I confirm that decision.

Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 17 February 2015.

John Gardiner
Manager Determinations and Assurance