

To: Minister for Canterbury Earthquake Recovery



Canterbury Earthquake Recovery Authority

IN CONFIDENCE

Rock Roll in the Port Hills

Date	1 June 2012	Priority	High
Report No	M/12/0410	File Reference	

Action Sought

		Deadline
Hon Gerry Brownlee <i>Minister for Canterbury Earthquake Recovery</i>	Direct officials to work with your office to prepare material for a meeting between yourself, Mayor Bob Parker and senior officials from CERA and Christchurch City Council.	8 June 2012

Contact for Telephone Discussion (if required)

Name	Position	Telephone	1st Contact
Diane Turner	General Manager - Strategy, Planning & Policy	Withheld under section 9(2)(a)	<input checked="" type="checkbox"/>
John WA Scott	Senior Advisor - Strategy, Planning & Policy		

Minister's office comments

Noted
 Seen
 Approved
 Needs change
 Withdrawn
 Not seen by Minister
 Overtaken by events
 Referred to

Comments

Rock Roll in the Port Hills

Executive summary

- 1 The geotechnical work relating to rock roll is not yet complete, so it is not possible to draw any firm conclusions on either the extent of the issues or the most appropriate mix of available policy options. Officials (along with the Christchurch City Council (Council)) are urgently seeking an update of the analysis undertaken by GNS. It is suspected that the number of properties in the higher life-risk bands will be lower than has previously been thought. Updated (and finalised) geotechnical information should be available shortly.
- 2 Regardless of this, it is possible to start considering the policy options that are available to manage the risks associated with rock roll. These risks are likely to decrease over time, so one option is to "buy time," given that rock roll risks reduce as seismicity decreases. Such an approach could augment either retreat or protection through building protective structures.
- 3 It is critical that central government and the Council have a joined up approach to managing rock roll-related issues. Senior Council representatives have expressed a desire to meet with you at an appropriate time to discuss the relevant issues, and we concur with this view. If you agree, we will prepare materials to support such a meeting.

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Recommendations

4 It is recommended that you:

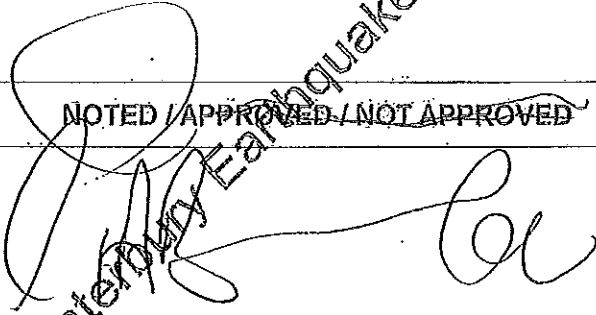
1. Note that officials are still working through important issues with the rock roll protection fences, including how effective they are and the level of maintenance, repair and replacement they need.
2. Note that further material will be available shortly and advice will be firmed up.
3. Direct officials to work with your office to prepare material for a meeting between yourself, Mayor Bob Parker and senior officials from CERA and Christchurch City Council

YES / NO

Provis as per memo paper



Diane Turner
General Manager – Strategy, Planning and Policy

NOTED / APPROVED / NOT APPROVED

Hon Garry Brownlee Minister for Canterbury Earthquake Recovery
Date: 6/6/2011

Attachment A: Roles of Central and Local Government

Attachment B: Indicative Results of Cost-Benefit Analysis of Building Protective Fences

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Purpose

- 5 This report provides you with information pertaining to properties affected by rock roll, and identifies some options for managing these properties. Policy decisions are not sought at this stage because (1) the geotechnical work underpinning the analysis is not yet complete, and (2) it is recommended that you – at the very minimum – consult with the Christchurch City Council (Council) at a senior level prior to decisions being made.

Background

- 6 On 27 June 2011, Cabinet noted the issues on the Port Hills are of a different nature to the low-lying areas [CAB Min (11) 24/15 refers]. On the residential flat land, land damage is largely a result of thin crust, liquefaction and lateral spreading. In the Port Hills, in addition to the physical land damage in some areas, the increased instability of cliffs, land and rocks means that there is an increased risk to life on some properties and infrastructure.
- 7 On 1 July 2011, the Port Hills was zoned white whilst assessments were undertaken. Three studies on life-safety risks associated with rock roll and cliff collapse were undertaken by the Institute of Geological and Nuclear Sciences (GNS) for the Council, "ground truthing" of this GNS model by the Port Hills Geotechnical Group (PHGG), and a 3D study by Geovert for CERA.
- 8 Between 5 September 2011 and 18 May 2012, approximately 11,700 properties were zoned from white to green, leaving approximately 1,700 properties in the Port Hills White Zone.
- 9 The Council has applied notices to restrict access to properties under section 124 of the Building Act. These have been applied to properties where the Council considers there is a potential danger from falling rocks, cliff collapse, debris inundation and land movement. Approximately 532 s124 notices have been issued in the Port Hills.
- 10 This paper provides options to deal with rock roll-related areas, and has been sent to you alongside a second, companion paper providing options for managing cliff collapse, debris inundation and land cracking in the Port Hills. A third paper is being developed on landslips, which will be provided to you in due course.

Geotechnical information – the extent of the issues

- 11 The Council commissioned a report from New Zealand's Institute of Geological and Nuclear Science (GNS) in regards to rock roll in the Port Hills. This report suggests that there is a relatively high annual individual fatality risk (AIFR) associated with a number of properties in the Port Hills due to rock roll.
- 12 The current estimates of the number and value of properties that have an AIFR of greater than 1 in 1,000 ($>10^{-3}$) and 1 in 10,000 ($>10^{-4}$) associated with them are set out in Table 1 below (note that the geotechnical work is not completed and these figures will change):

Table 1: Number and Value of Port Hills Properties at risk from rock roll with an AIFR of greater than 1 in 10,000 (Indicative only)

AIFR level	Number of Properties	Value of Properties (\$m) ¹
AIFR of greater than 1 in 1,000 (>10 ⁻³)	298	162
AIFR of greater than 1 in 10,000 (>10 ⁻⁴)	633	335

- 13 Although estimating these risks to life is very difficult, and there are significant uncertainties involved, these figures may be an over-estimate of the scale of the issue at hand. Related to this, and in informal communication with officials, GNS has suggested the risk associated with rock roll will diminish over time – as seismicity decreases. This reduction in risk may be quite significant. This is an important point and is in clear contrast to the cliff collapse situation (in significant cliff collapse areas, cliffs are expected to recede, placing new properties at risk over time).
- 14 CERA and the Council are working with GNS to attempt to get confirmation (and ideally quantification) of any over-estimate of the scale of the risk. This is a very important issue, as the scale of the risks associated with rock roll is a key determinant of the nature of the appropriate response. The implication of this is that there is a great deal of uncertainty about the figures presented in this briefing note. Once revised figures are available, **it is likely that costs and the number of properties affected will be lower – perhaps significantly so –** than the numbers presented in this note.
- 15 The nature of the risks associated with rock roll means that mitigation through the use of protective structures (e.g. specially designed fences) may be an option. To this end, CERA commissioned a series of reports from Geovert. These reports look at possible locations for protective structures to reduce risks associated with rock roll. Geovert considered fences to be the most appropriate protection structure, should protective structures be employed, and provided price estimates for the construction of these fences.

Comment

- 16 The policy response to rock roll is complicated (more complicated than cliff collapse) in that there are a significant number of variables in play, and there are a significant number of options available to decision-makers. Further, there are a number of different geographical locations in the Port Hills to consider, and these different locations all have specific characteristics. What is an ideal policy response to deal with rock roll in one location might be completely inappropriate in another.
- 17 The major factors that should be considered in making rock roll-related decisions include the following:

¹ This is the value as per the most recent pre-earthquake ratings valuation.

² There is also a risk to property associated with rock roll. The consequence of this risk is less significant than the risk to life, as a boulder could only partially damage the house. It is also a small risk when compared to the risks to property associated with cliff collapse.

- The level of current and probable future life-safety risk, taking account of uncertainties in the geotechnical information, and the way in which these uncertainties are reflected in risk-level calculations;
 - The measures available to respond to that risk, and the effectiveness (in terms of reducing risk, cost and likely community acceptance) of those measures;
 - The potential roles of central and local government in implementing the various measures available, taking account of their different regulatory responsibilities, tools and powers;³
 - Societal and individual risk tolerance – both in the short term and over time;
 - Community expectations of central and local government;
 - The nature of any precedents that would be created with respect to natural hazard identification and management nationwide, and how these could be managed; and
 - The need for any policy response to marry with the regulatory responsibilities and processes of local government through the Building Act and elsewhere.
- 18 Although some consider this to be a slightly difficult area of public policy, it is not possible to ignore the cost of achieving reductions in risks to life safety. Analysis conducted by CERA suggests that the cost of saving a life in the Port Hills (in a statistical sense) is significantly higher than the cost of saving lives through road transport initiatives, especially if one were to protect to a level of AIFR of 1 in 10,000 (10^{-4}).⁴ Put another way, this suggests that New Zealand could save more lives by investing in road transport-related initiatives than in protecting against rock roll in the Port Hills down to a risk level of 10^{-4} .
- 19 The way that society perceives risk and responds to risk is a complicated matter. People's attitude to risk is dependent on their perceptions on a number of things such as their familiarity with the nature of risk, and the extent to which they can control the risk. Further, societies are particularly sensitive when it comes to events which result in multiple fatalities. As such, while the arguments outlined in the paragraph above are important, they are not the only consideration.
- 20 Underpinning much of this is the respective roles for central and local government. Both CERA and the Council are of the view that managing rock roll risks should be a shared responsibility (in the short term at least). The reasons for this are outlined in Attachment A. Clarity in communicating the reasons why this situation is different to other natural hazard situations (primarily the scale of the issues facing Canterbury and central government's consequential involvement in the recovery effort) that New Zealand faces will be important in reducing precedent risk.

Policy responses available

- 21 There are a number of policy options available to decision-makers and we would not expect any one response to be utilised in all locations. The options identified are presented simply to raise to your awareness the range of possibilities available, and some of the implications of these. Officials are not seeking decisions at this stage; further advice will be provided once geotechnical and engineering information is confirmed.

³ There are section 124 notices placed on properties in the Port Hills that are at risk of rock roll.

⁴ Even if the preferred risk level were 1 in 1,000 then the CERA analysis still suggests that more lives would be saved by expenditure on road transport relative to reducing rock roll risks in the Port Hills.

22 Two broad levels of response are outlined below:⁶

Buying Time

- 23 Under this option, financial support to live elsewhere would be offered to residents for an extended period if they chose not to return to their homes in the short term (perhaps up to 3 years). This would allow residents to access and maintain their properties until they reached a level of satisfaction – or further evidence – that seismicity (and associated risks) had sufficiently reduced. This sort of option may well be particularly important immediately after any future major event, should one occur.
- 24 Such an approach would buy some time to allow all parties to better assess the risks. It may reduce overall costs – and reduce the need for stark and (potentially) expensive decisions to be made. Further, it would extend at least a level of choice to affected residents.
- 25 If pursued across the board, this option would have significant downsides. Firstly, it would place affected residents at risk, and many would not find that acceptable. Residents, particularly those who had boulders hit their houses in previous earthquakes, may not feel at all comfortable reoccupying their homes.
- 26 Further, almost certainly, there would be a misalignment between the arms of government that are involved (the precedent issues would also need to be thought through). A large number of homes have section 124 notices placed on them due to the rock roll hazard, and the Council are unlikely to feel comfortable with removing those notices at this time. As such, this option would not allow all residents to return to their homes, thus defeating the purpose of this measure to some extent.

Retreat and Mitigate

- 27 Under a retreat and mitigate model, a combination of retreat and mitigation, depending on site-specific factors, would be employed. Retreat would be favoured where risks were deemed to be unacceptably high, and/or mitigation was not appropriate or cost effective. A cost-benefit model has been developed in conjunction with the Council to help determine the most cost-effective areas for protection. This work is still in the very early stages, and results are highly preliminary (Attachment B shows these results for the 9 sectors of the Port Hills analysed by Geovert).
- 28 The key results of this cost-benefit analysis are that the economics of protecting depends very much on what the counter-factual is. If, in the absence of building protective fences, there is retreat from properties with an AIFR of 1 in 1,000 (10^{-3}) or greater, then only one area would be protected by fences. If however, in the absence of building protective fences, there is retreat from properties with an AIFR of 1 in 10,000 (10^{-4}) or greater, then six areas would be protected by fences (according to this very initial analysis).⁶
- 29 Table 2 shows the cost of either protecting or retreating (whichever is most cost-effective) in two scenarios: providing protection up to a risk level of 1 in 1,000; and providing protection up to 1 in 10,000. It is built on the results from the table in Attachment B and, as such, is no more than a broad estimation of the costs involved:

⁶ In addition to these, some properties will be rezoned from white to green - with no other policy response required.

⁶ This analysis covers entire sectors. Analysis at a sub-sector level (e.g. the Avoca Valley, as opposed to the entire Avoca valley and Hillsborough area combined), increases the cost-effectiveness of protecting properties with fences.

Table 2: Indicative costs involved with either retreating or protecting properties

Protection level (AIFR)	Cost (capital only) of either retreat or providing protection (\$m)	Number of Properties retreated from	Number of Properties protected by fences	Value of Properties either retreated from or protected (\$m) ⁷
Protect or retreat to an AIFR of greater than 1 in 1,000 (>10 ⁻³)	132	231	67	162
Protect or retreat to an AIFR of greater than 1 in 10,000 (>10 ⁻⁴)	141	102	531	335

- 30 There are several specific issues that need working through. In terms of retreat, the nature and funding of any financial assistance to affected parties needs to be considered – parallels with the offer in the Residential Red Zone will be drawn. Consideration also needs to be given to the extent to which the costs are shared between the Crown, the Council, and property owners (the earthquakes have exacerbated a rock roll risk that was present pre-earthquakes).
- 31 In terms of mitigation, there are a large range of issues yet to be worked through. Most important amongst those is the extent to which protective fences are effective. Clearly there is no point in investing in protective structures that are ineffective.
- 32 There are a number of more practical – but real – issues to consider. The time required to build fences, funding, ownership and maintenance of the fences all need to be considered.⁸ Further, the acceptance of the Council of the effectiveness of fences within its regulatory framework will be critical when deciding whether to proceed with reducing risk through the use of protective fences.
- 33 A significant number of issues are raised by this approach. In particular, unless the community is involved in decision-making, it places decision-makers with a series of difficult and expensive choices. Given both the risks of conservatism in the GNS model, and the possible reduction in risks over time, it is very possible that New Zealand expends a significant amount of resource in this area for relatively little improvement in overall life safety.

Potential Policy Packages

- 34 There is no perfect package to take the rock roll issues forward, but two potential packages have been developed for consideration. (It is very important to note is that these options have not yet been fully worked through with the Council in terms of their likelihood of removing s124 notices and the like). The options are as follows:
- Option A: Protect / retreat to a level of 10⁻³, and (potentially) provide choice thereafter; and
 - Option B: Protect / retreat to a level of 10⁻⁴.

⁷ This is the value as per the most recent pre-earthquake ratings valuation.

⁸ Especially in the case of protective fences, there is a strong case to seek a level of funding for those who benefit from the fences (ie, affected residents).

- 35 Under the first of these options, a decision would be made to protect or retreat (whichever is most cost-effective) up to a risk level of 1 in 1,000 (10^{-3}). This would provide (based on current data) protection for / retreat from approximately 298 properties – at a capital cost of \$162m.
- 36 A risk line drawn at 1 in 1,000 may appear to be relatively low. Such an approach could be augmented by allowing residents whose properties fall between the 10^{-3} and 10^{-4} risk lines to buy time. Under such a model, accommodation support could be extended for up to three years for residents who have properties in this risk zone if they chose not to return to their homes immediately. This may assist with the building of confidence amongst affected residents.
- 37 A different way to augment such an approach would be to make clear that affected residents could approach CERA and the Council with a proposal to build protective fences (this would require some form of contribution from affected residents). This would somewhat complicate matters, but would provide affected residents with a chance of reducing risks to life, should they wish to do so.
- 38 The alternative option identified of protecting / retreating to a risk level of 10^{-4} clearly reduces risks in the Port Hills – and brings the construction of fences into the policy frame far more significantly. Protecting / retreating to a higher risk level reduces the need for additional measures to augment the basic policy response.

Next Steps

- 39 As with cliff collapse, the geotechnical work that underpins this analysis needs to be completed – and we expect that more granular analysis (i.e., at a sub-sector as opposed to a sector level) will be possible shortly. Related to this, engineering work such as assessing the effectiveness of fences also needs to be finalised. Again, as with cliff collapse, officials are working on a number of issues such as the availability of insurance in the future, the maintenance costs of any protective structure, and legal issues such as how best to gain access to land to construct protective fences.
- 40 It is critical that central government and the Council have a joined up approach to managing rock roll-related issues. With this in mind, senior Council representatives have expressed a desire to meet with you at an appropriate time to discuss the relevant issues. CERA concurs with this view. We propose that you direct CERA officials to work with your office to prepare materials to support a meeting between yourself, the Mayor of Christchurch and senior CERA and Council representatives in order to advance these issues.

Consultation

- 41 Treasury, the Department of Building and Housing, the Ministry for the Environment, the New Zealand Transport Agency, the Department of Internal Affairs and the Christchurch City Council have been consulted in the preparation of this paper. The Department of Prime Minister and Cabinet have been informed.

Financial implications

- 42 This paper has no direct financial implications.

Attachment A: Roles of Central and Local Government

- 1 Local government has responsibility for managing natural hazard risks and, in general, local government is best placed to determine local solutions to local issues. Reflecting this, there are strong reasons for the Christchurch City Council's (Council) involvement in determining the future of currently white zoned properties. Notwithstanding this, there are advantages in having central government very heavily involved in the process – working as closely as it can with the Council (ideally central government and the Council would be in agreement on the way forward).
- 2 Central government (DoC) and the Council own a large portion of the land from which rock roll could stem. withheld under section 9(2)(h)
Reflecting this, both parties have incentives, as well as relevant information, to assess the trade-off between the cost of undertaking mitigation works and the benefits in terms of reduced risk to lives and properties. Both parties should, therefore, be involved in the decision making process regarding options and mitigation works.
- 3 Other reasons for central government involvement are as follows:
 - There are concerns that the Council is not well placed to expedite decisions on rock roll. The additional resources available within central government means that the process can be completed more swiftly, thus bringing a more timely resolution for property owners; and
 - Assuming that some form of financial assistance is provided, funded partly or wholly by central government, it is highly desirable that central government be involved in the process so as to manage the fiscal risks involved.
- 4 The desirability of a strong level of local government involvement also reflects that once completed, any mitigation works will create assets (protective fences) that – for a range of practical reasons – may well be owned and maintained by the Council. Assuming this to be the case, then the Council is best placed to consider the whole-of-life costs associated with mitigation structures (including the impact of diverting financial and other resources away from competing community priorities).
- 5 The Council also has responsibility for its normal regulatory functions, such as district planning and the implementation of its functions under the Building Act. Alignment of policies at a central and local level would be very difficult to achieve without a high degree of joint involvement in policy development and decision-making processes.

Attachment B : Indicative Results of the Cost-Benefit Analysis of Building Protective Fences

Sector	1 - Eastern Sumner, Godley Head	2 - Western Sumner, Clifton and Moutons Bay	3 - North Redcliffs	4 - Mount Pleasant	5 - Heathcote, Morgans and Horotane Valleys and Tunnel Rd	6 - Lyttelton	7 - Hillsborough, Avoca Valley	8 - Rapaki Bay and Cass Bay	9 - Cashmere, Bowenvale, Huntsbury	All Sectors
Number of properties with risk greater than 1 in 1,000 (10^{-3})	31	2	21	25	71	43	26	12	298	
Value of properties with risk greater than 1 in 1,000 (\$M)	18	38	10	19	47	118	51	7	633	
Number of properties with risk greater than 1 in 10,000 (10^{-4})	91	82	40	32	52	55	29	49	335	
Value of properties with risk greater than 1 in 10,000 (\$M)	50	46	3	7	24	22	21	8	127	
Cost of installation (\$M)	14	8	6	16	43	40	46	17	282	
NPV of Mitigation costs (\$M)	0.6	2.1	0.1	0.6	0.7	0.5	0.3	0.4	0.6	
BCR - buy out those > 10^{-3}	1.6	2.6	0.2	1.1	0.6	1.4	0.6	2.9	1.2	

This table provides indicative benefit-cost ratios of building protective fences for the 9 sectors in the Port Hills affected by rockfall. It covers entire sectors; at a sub-sector level (eg. the Avoca Valley, as opposed to Hillsborough and the Avoca Valley); more protective fences are likely to be beneficial in a cost-benefit sense. The key points are:

- 1) That this analysis is not complete and the results will change
- 2) That only one area (sector 2) meets a benefit-cost ratio of 1.0 if the counter-factual to building a fence is that properties with an AIFR of more than 1 in 1,000 are retreated from; and
- 3) That 6 sectors meet a benefit-cost ratio of 1.0 if the counter-factual to building a fence is that properties with an AIFR of more than 1 in 10,000 are retreated from.