

**Management of Earthquake Risk by
Canterbury Regional Council
and
Christchurch City Council**

Obligations and Responses under the RMA

Enfocus Ltd, November 2011



Contents

1	Introduction	1
1.1	Matters not in scope	1
2	Natural hazards planning obligations under the Resource Management Act	
3	Best practice in natural hazards planning	2
4	Environment Canterbury planning response	2
4.1	Regional Policy: The Regional Policy Statement.....	2
4.2	Related regional council work	3
4.3	Environment Canterbury’s characterisation of its role and response	4
5	Christchurch City Council planning response	5
5.1	The City Plan.....	5
6	Risk management	6
6.1	Revised probability analysis.....	6
6.2	Liquefaction risk information limitations	7
6.3	Risk assessment	8
7	Overview and Analysis	9
7.1	Managing urban growth and zoning.....	10
7.1.1	Urban Growth decisions of Environment Canterbury.....	10
7.1.2	Zoning decisions of the City Council.....	11
7.1.3	Managing risk at time of subdivision	12
7.1.4	Managing risk through the Building Act	13
8	Conclusions	14
	Appendix 1 – Hazard planning responsibilities under the RMA	16
	Appendix 2 – Hazards Planning Best Practice Guidance	19
	Appendix 3 - Planning response of Environment Canterbury	22
	Appendix 3a – The 2011 Proposed RPS	25
	Appendix 4 - Planning Response of Christchurch City Council	26
	Appendix 5 – GNS advice on liquefaction risk	31
	Appendix 6 – Plan Change 28	33
	Appendix 7 – Urban Growth Plan Change or Variation Proposals from 2002	36

1 Introduction

This report has been commissioned by the Royal Commission of Inquiry into Building Failure Caused by the Canterbury Earthquakes (“the Canterbury Earthquakes Royal Commission”).

The purpose of the report is to investigate the manner in which issues of earthquake risk have been dealt with in the relevant planning documents of the Canterbury Regional Council (“Environment Canterbury”) and the Christchurch City Council (“the City Council”). This includes an analysis of the councils’ obligations under the Resource Management Act 1991 (“the RMA”), and the various steps that the councils have taken in carrying out those obligations.

The information and analysis presented in this report is based on written material gathered from Environment Canterbury and Christchurch City Council and on meetings with council staff held in Christchurch during October 2011. Information is also drawn from a letter from Environment Canterbury to the Canterbury Earthquakes Royal Commission dated 31 August 2011 (“the 31 August letter”). Further specific information was sought from the City Council during this project and was received in a letter dated 10 November (“the 10 November letter”).

1.1 Matters not in scope

Environment Canterbury and the City Council have responsibilities in relation to natural hazards under the Resource Management Act, the Civil Defence and Emergency Management Act (“the CDEMA”) and the Building Act. They also have general responsibilities under the Local Government Acts that are relevant.

This report focuses only on the obligations under the RMA (although in practice it is difficult to disentangle these from the those under the Building Act). It is also important to note it is not within scope to consider the technical aspects of hazard risk assessment.

2 Natural hazards planning obligations under the Resource Management Act

The RMA does not refer specifically to earthquake risk but rather regards earthquakes as one of several *natural hazards*. (See definition of natural hazard in section 2 RMA).

Appendix 1 sets out in some detail the obligations of the councils under the RMA for hazards management. In simple terms, the RMA gives both regional councils and territorial authorities (i.e. the City Council) the function of the control of the use of land for the purpose of the avoidance or mitigation of natural hazards. Environment Canterbury’s regional policy statement (RPS) must define how that responsibility is to be shared. In the absence of the RPS clarifying roles relating to natural hazards responsibility defaults to the regional council.

The RMA also requires local authorities to keep records of natural hazards.

Regional councils also have more general functions to address “regionally significant issues” and issues requiring “integrated management” (delivering this is one of the primary roles of the RPS (see section 4.1).

Also of significance is Section 106, which states that territorial authorities may decline applications for subdivision consent where the land in question is “likely” to be subject to certain natural hazards.

3 Best practice in natural hazards planning

While the RMA sets out the functions and duties in framework terms, how these are implemented is a matter of policy and professional practice.

Central government can influence these matters through either:

- the statutory instruments of national policy statements (NPSs) or national environmental standards (NESs); and/or
- non-statutory guidance – generally developed with professional associations, practitioners and expert groups drawing on experience around the country.

There are no NPSs or NESs relevant to managing earthquake risk.

Central government has, however, produced two non-statutory best practice guidelines aimed at assisting councils to exercise the RMA hazard management functions. These are:

- Planning for Development of Land on or Close to Active Faults (Ministry for the Environment 2003); and
- A Quality Planning (QP) Guide on Natural Hazards (First prepared for the Ministry for the Environment in 2008 and updated in 2010).

These guides are of limited value to this study. The first only addresses planning issues in relation to known active fault lines (not liquefaction and lateral spreading risk). The second is generic to all hazards. While general principles are espoused which are of some help, there is no advice directed specifically at the management of liquefaction and lateral spreading risk. These guides are discussed in greater detail in **Appendix 2** and in relation to Environment Canterbury’s planning approach in section 7.1.1.

4 Environment Canterbury planning response

4.1 Regional Policy: The Regional Policy Statement

One key planning document relevant to this study is the Canterbury RPS. The specific natural hazard related provisions of the RPS are set out and discussed in some detail in **Appendix 3**.

The theory of RPSs is that they set the broad policy framework for regional plans and district plans - which must give effect to the RPS - thus integrating management. The RPS can, and arguably should, address hazard management that requires

integrated resource management across a region, notwithstanding that the specific function of land use control may rest with the City Council.

The Operative RPS does this in broad terms by recognising earthquake risk as the key regional hazard and setting out policies to guide management including a policy defining respective functions of Environment Canterbury and the territorial authorities.

Those policies are, however, somewhat obtuse and role definition lacks clarity. The policies do not specifically address earthquake risk management (notwithstanding that it is identified as the most significant risk) but focus on hazards generally. It is difficult to understand how some of the policies could, or should, be applied to managing earthquake risk.

That said it is important to record that the shortcomings of the 1998 RPS do seem to have been acknowledged by the Proposed RPS notified in June 2011. That document contains far clearer policies (See **Appendix 3a**). It is also important to recognise that many provisions of first generation RPSs around the country have proved to be of limited value. That reflects the context in which they were developed (the early stages of RMA implementation and bedding in of regional council and territorial authority relationships).

While the 1998 Canterbury RPS may be criticised for lack of clear policy direction, that is unlikely (on the basis of discussions with regional and city council staff and for reasons set out later) to have had a material affect on the quality of hazard planning in the region over the past decade.

4.2 Related regional council work

RPS sets out methods to implement policies but it in no way limits what the regional council can do. It is not uncommon for other initiatives to prove, over the course of the life of an RPS, necessary or even preferable to those listed in the statutory document.

It is clear from Environment Canterbury's 31 August letter that, insofar as earthquake hazard risk is concerned, it has been heavily involved in:

- *commissioning research* (risk identification and assessment – as discussed in Section 6); and
- *information dissemination* (by way of the land information request (LIR) tool and provision of public information resources). This is consistent with Method 4 of its RPS.

The 31 August letter also indicated that at least some *earthquake risk mitigation advocacy* has been undertaken. This is a potentially important role of the regional council and consistent with statutory obligations to ensure that the RPS is given effect to. The scope of this work is difficult to determine. Certainly Environment Canterbury raised this matter in relation to its appeal against the Pegasus Bay development (although that was very much secondary to the primary issues of transport and growth management). It is less clear how much advocacy has occurred through other development consenting processes. Of course, Environment Canterbury only gets a formal opportunity to advocate on land use control at the

territorial council level in the context of plan changes and notified consents. Subdivision applications on land already zoned are rarely publicly notified. This will have limited the opportunity available to Environment Canterbury.

Of some note, Environment Canterbury was a submitter on Change 28 (to the Christchurch City District Plan) but does not appear to have raised concerns about liquefaction risk even though this has proven to be an important issue. (See Section **Appendix 6**~~Error! Reference source not found.~~).

Advice received from the City Council in its 10 November letter suggests that Environment Canterbury has not been active in this role. Acknowledging that there may have been examples not identified by staff responding to the request for information, the 10 November letter notes:

Council officers consulted for the purposes of preparing this letter have not identified any cases in which ECan have played a formal role on a Plan Change or resource consent application in relation to assessment of earthquake risk.

4.3 Environment Canterbury's characterisation of its role and response

It is clear from both the operative RPS and the 31 August letter (see in particular, paragraph 1.2) that, in terms of land use, Environment Canterbury characterises its role in earthquake risk mitigation as *information provider*. As noted above there is no question that Environment Canterbury has invested heavily in that role.

Aside from the specification of objectives and policies in the RPS (which as discussed above, is high level and of limited utility in regulatory decision-making), Environment Canterbury sees its *regulatory role* in earthquake risk mitigation limited to:

- control of land use in circumstances where the impact of the activity or land use results in effects such as on water quality; and
- in the context of processing resource consent applications that fall within regional council functions (i.e. to control the take, use, damming or diversion of water, the discharge of discharge contaminants etc).

The regulatory role Environment Canterbury describes is clearly significantly narrowed from the very broad function set out in section 30 (c) (iv). Of course, given that land use control for hazard mitigation is a shared function, the regional council is entitled to narrow its role provided it is clear that the territorial authorities will assume responsibility for those dimensions not to be assumed by the regional council.

In that context it is noteworthy that the demarcation of functions/ responsibilities (as articulated in the 13 August letter), is not clear on the face of the 1998 RPS. It is accepted, however, the practice in this area was still evolving when the operative RPS was developed and the 2011 RPS is much clearer on this point.

Also important to note is that best management practice guidance is clear that a regional council ought to continue to have a role in land use control issues (in terms of providing policy guidance) even where primary control is exercised by the territorial authority. This is achieved by having clear policy on where and how risk ought to be avoided or mitigated and *advocating* that policy in district plan preparation and individual resource consent applications.

While the 31 August letter claims to have been active in that role, on the basis of advice received from the City Council, and as discussed above, that does not appear to have been the case in Christchurch City.

5 Christchurch City Council planning response

The responsibilities of the City Council for natural hazards management under the RMA are described in **Appendix 1**. Essentially the responsibility is to control land use for the purpose of avoiding or mitigating natural hazards. There is also the specific obligation (under section 106 of the RMA) to consider declining land subdivision applications where it considers land is *likely* to be subject to a natural hazard. (Again, that is discussed more fully in **Appendix 1**).

The response of the City Council in terms of its planning document (the “City Plan”) is set out in **Appendix 4**.

5.1 The City Plan

The key conclusion of the review of the City Plan is that it certainly recognises seismic risk but does so at a relatively high level. That is typical of district plans and in that sense it is unremarkable. In terms of natural hazards generally, it is relatively strong at the level of objectives and policies. However it is not clear whether all the policies apply to all hazards and, insofar as seismic risk is concerned, there is little direct link between policies and regulation. Rather, there seems to be a focus on provision of information and an expectation that earthquake risk issues will be addressed predominantly via the Building Act process (see in particular Policy 2.5.3 which is the only policy specifically directed at management earthquake risk)¹.

While the City Plan does not preclude taking a “hard line” against subdivision of land subject to liquefaction and lateral spreading risk at the time of subdivision consent application, there is no real presumption that it will do so. There are rules² in the City Plan that allow earthquake risk to be considered as part of subdivision consenting, however, these rules make no specific mention of earthquake risk while making specific mention of other hazard risks.

The plan’s approach to earthquake risk is best characterised by what it does not include. It does not include identified liquefaction zones nor does it include a risk assessment or risk standards notwithstanding that one policy refers to limiting development in areas of “moderate to high risk”. Having noted those issues it should be pointed out that the author is not aware of any other district plan that contains such matters. This is likely to be due to the stringent evidential basis that would be needed to defend an assessment and mapping of risk given the inevitability of challenges a council would face to taking such an approach.

¹ This approach is confirmed in the City Council’s 10 November letter which states *“In broad terms, Council officers have generally regarded earthquake hazard to be a matter best addressed at the building consent stage, rather than plan stage”*.

² Volume 3: Part 14 Subdivision Clause 2.11 (Assessing resource consents); Subdivision Rule 7.1 and Subdivision 126.13 (Building locations)

That is not to say that significant risk assessment has not been undertaken. Just that it is not evident on the face of the plan. Risk assessment is discussed in the following section.

6 Risk management

The key issue in all hazards planning is risk management. Risk management is the key dimension that underpins all the planning functions and responsibilities discussed above (i.e. what and when certain interventions ought to be considered justifiable).

Risk management requires developing an understanding of the risk. Council must do this not just to make information available to the public to allow informed private choices to be made, but also to inform their own planning responses (i.e. plan making and consent decision-making).

Risk identification means identifying the nature of the risk and where it might occur. In the case of liquefaction, for example, this involves assessment of ground conditions and soils. Of itself, that is of limited value in hazard management. To make real sense of risk we need risk *assessment*. That involves looking at:

- *likelihood* – how frequent an event of a prescribed magnitude/intensity is likely to occur based on past recurrence patterns (probabilistic analysis); and
- *consequence* - what the impacts of an event of a prescribed magnitude/intensity would be on people and property.

As noted earlier, considerable risk identification and risk assessment has been undertaken in Canterbury. Most relates to risk identification and probabilistic analysis. It has been undertaken not just for planning responses but in order for councils to deliver on their wider Civil Defence and Emergency Management (CDEM) responsibilities.

I need to qualify the following comments by making clear that I am not a technical expert in earthquake risk assessment. The conclusions I have reached on these matters come from reviewing written material and discussions with Council staff.

6.1 Revised probability analysis

One of the very earliest studies of earthquake risk in Christchurch was the 1992 GNS report *Geology of the Christchurch Urban Area* (LJ Brown & JH Weeber). This was in turn reproduced, in part, as a journal article entitled *Geology of Christchurch, New Zealand*³. Both reports included a table of calculated return periods as indicated in Table 1.

It is my understanding that those studies were superseded by work commissioned by Environment Canterbury in 1999 revised in 2007⁴. The regional data is consistent

³ *Geology of Christchurch New Zealand*, LJ Brown, RD Beetham, BR Paterson, and JH Weeber, Environment & Engineering Geoscience, Vol I, No.4, Winter 1995, pp 427-488

⁴ *Earthquake hazard and risk assessment: probabilistic seismic hazards assessment*, GNS 1999

with the National Seismic Hazard Model developed by GNS (used for the Building Code hazard values).

Using those models, an MMVIII event has a probability of at least 500 as opposed to the 55 years as suggested by the 1992 and 1995 reports.

A 2005 GNS report⁵ prepared for the City Council makes a similar point when it notes:

Early studies of the seismic hazards affecting Christchurch indicated a relatively high seismic hazards level, only marginally lower than that of Wellington. More recent studies, however, indicate a lower level of hazard which is more in keeping with the location and activity of all earthquake sources (i.e. both close-in distributed seismicity source and known fault sources).

That report based its findings on the return periods set out in Table 1 (columns 2 and 3. Column 4 (shaded blue) is the data used in the early reports.

Table 1 – Comparative return periods

MM Intensity	Return Period (years without microzonation)	Return Period (years without microzonation)	Return Period (As reported in the 1995 report)
>6	24	10	7
>7	140	50	20
>8	1,800	600	55
>9	74,000	20,000	300

As I understand it, the microzonation distinction relates to the nature of the ground conditions. “Without microzonation” assumes average ground. “With microzonation” assumes soft ground as was known to exist, for example, in the Christchurch CBD.

This difference is important because a 55 or even 300 year return period is a level of probability which planners might reasonably be expect to manage through planning and building control. If probability was indeed based on a 55 year return period then failure to address that risk would seem imprudent.

As noted, however, planning decision-making was not based on those early probability models but on the more recent GNS advice. The secondary issue, on which there seems to have been varying advice, was which MMI level should be regarded as representing a potential widespread liquefaction risk.

6.2 Liquefaction risk information limitations

More recent and more specific advice has also been available on liquefaction risk. A report on liquefaction risk by Beca in 2004⁶ superseded and improved the information set out in the 1995 GNS report.

⁵ Estimated damage and casualties from earthquakes affecting Christchurch, GNS 2005

⁶ Christchurch Liquefaction Study – Stage IV Ecan report No. U04/25, Beca Carter Hollings and Ferner Ltd May 2004

One key question to answer is why, if the councils had specific information on liquefaction risk, was that information not more directly included in planning documents?

Although designed to improve knowledge of the spatial extent of possible liquefaction, the Beca report too had limitations. Christchurch City Council commissioned a peer review of the report by consultants URS to determine the extent to which it should be used as a basis for information to be placed on LIMs. That URS review highlighted the many caveats and qualifications noted in the Beca report and the limited information on which the liquefaction maps were prepared (essentially liquefaction zones were modelled using a limited number of data points). That peer review (with which Environment Canterbury – who had commissioned the Beca report – agreed) led to an approach to the provision of data on LIMs that communicated the *indicative* nature of liquefaction zones. My understanding is that, due to high variability of soil types, precise and definitive information on liquefaction risk could only be derived by property-by-property geotechnical investigation.

That may explain why liquefaction zones were not included in the Christchurch City Plan and why the indicative zones of the Beca Report were applied by the City Council as a trigger for requiring detailed geotechnical site investigation at the time of significant new development.

6.3 Risk assessment

The further issue relates to the issue of risk assessment. As noted above, knowing how likely an event might be is only part of the issue. To effectively exercise their hazard management planning functions councils need to know the likely consequences of events. That requires development and application of a risk assessment methodology. A risk assessment methodology simply means how the council would go about collecting, assembling and integrating information to quantify the over risk of an event, or range of possible events (scenarios).

In 2005 Canterbury Regional Council commissioned Opus Consultants to develop such a methodology⁷.

The Opus report did provide a high level proposal for a risk assessment model but it was by no means fully developed. Much work was identified as needing to be done before there was a usable tool. That work was the subject of recommendations.

At around the same time that report was concluded, the government funded a parallel piece of work (the “Riskscape” project) undertaken by GNS and NIWA. That project proposed a national risk assessment model that covered many of the matters addressed by the proposed Opus methodology. As it turned out, Christchurch had been selected as one of the pilots for that project and that negated the need to proceed with the Opus approach. It was not that Environment Canterbury had closed its mind to the need for risk assessment but simply that a different vehicle had come along which enabled council to get access to a risk assessment model at lower cost. This tool is, I understand still in development but an early version is available on the

⁷ Earthquake Risk Assessment Study Part 1 – review of risk Assessment Methodologies and Development of a Draft Assessment Methodology for Christchurch, Opus International Consultants Limited 2005

internet. It is a reasonably sophisticated GIS-based model that allows the user to change input variables and different likely impact outcomes can be calculated.

The other issue of some relevance is how much value an earthquake risk methodology/model would have had for land use planning decision-making had it been available earlier. It is my view that, had a risk assessment model had it been available, it may have been useful but by no means would it have guaranteed better land use planning outcomes. The fact that a model can quantify (or “index”) a risk is helpful to an extent, but there is no accepted risk *standard* for planning such that if the risk is of a certain scale (either on an index or a quantified value in dollars of human lives) certain planning approaches/provisions are to be introduced. Such a standard, though conceivable and potentially valuable, simply does not exist. Thus a value judgement (cost now versus possible cost avoided) would have been required. This contrasts to risk standards that apply in, for example, building or flood management contexts where simple return periods are used.

Finally it should be noted that the 2005 GNS report (commissioned by the City Council), mentioned earlier, was a form of risk assessment and it provided broad scale physical damage and human casualty estimates based on three earthquake scenarios. That indicated a \$1.2 billion damage bill and 16 casualties from a 1000-year return period event.

From the perspective of councils’ obligations to prepare land use plans and consider resource consent applications, Canterbury’s experience with risk assessment appears at least as well advanced as other major centres in New Zealand and well ahead of the smaller regions.

That said, the more critical question is not what risk assessment was done but how information that was available was used by councils at various stages in the development process.

7 Overview and Analysis

In practical terms, there are five means by which local authorities can exercise their earthquake risk management responsibility through land use/development control. These are as follows:

- Ensure hazard risk is factored into *urban growth and zoning decisions* such that risk areas are not zoned for vulnerable (or high capital value) activities and/or mitigation obligations (such as engineering solutions) being required.
- Ensure hazard risk is considered at the time *subdivision consent applications* are determined such that development of high-risk areas is either not approved (notwithstanding zoning) or subject to conditions on consent requiring risk mitigation (i.e. land stabilisation prior to subdivision).
- Require geotechnical information as part of *building consents* and impose construction standards commensurate with risk (foundation engineering, floor levels etc).

- Include relevant information on *land information memoranda* (LIMs) so the owners and prospective purchasers of land are aware of hazard risk and can factor that into investment decisions.
- Provide *information* generally to the community so that people can make business and home ownership investment decisions with some knowledge of risk being taken.

The first four of these is discussed further below. (The last of these has been well delivered by Environment Canterbury as noted in section 4.3).

7.1 Managing urban growth and zoning

7.1.1 Urban Growth decisions of Environment Canterbury

Environment Canterbury takes the view that liquefaction and lateral spreading are not “avoid” issues – meaning the presence of liquefaction risk ought not to constitute a prohibition on development. As Environment Canterbury’s 31 August letter notes *“it [liquefaction] was a natural hazard risk to be mitigated through those appropriate engineering measures controlled by the territorial local authorities at the time of subdivision and building”*.

This is the approach that seems to have been taken in Change 1 to the RPS. That change expanded the urban limits of Christchurch to make available additional land for greenfield urban development. That planning process took into account natural hazards insofar as *flooding* and *sea level rise* were concerned but it did not involve assessment of liquefaction risk.

That does seem to be a dubious approach. Although risk associated with liquefaction may be addressed (in an engineering sense) adequately at time of land subdivision and building, strategic land use planning provides the opportunity to ensure that such mitigation (and associated additional cost) is not required at that time. Identifying areas for development that are known to be at risk of liquefaction seems unnecessary and only serves to add potential for angst and cost in subsequent stages of the development process. In other words, a council should not identify an area of land for actual or potential development that is known to be susceptible to liquefaction unless there are no other/better alternatives⁸. That seems to be the point being made in the good practice (albeit non statutory) guidance that exists (see **Appendix 2**) when it includes, as Principle 2, *“plan to avoid natural hazards before development and subdivision”* [emphasis added].

That criticism should not be read as suggesting that Change 1 (recently made operative under the Canterbury Earthquake Recovery Act) has necessarily identified areas for future development that might be at risk of liquefaction or, that even if it did so, development in those areas would necessarily be approved. It may well be that other criteria applied to site selection have coincidentally steered development away

⁸ There may be instances when, having weighed all the considerations relevant to the suitability of land for urban growth, an area susceptible to liquefaction still rates highly and is subsequently made available for urban development (with caveats regarding remedial works required). However, that decision is reached having transparently identified the risk and considered it against other positive factors that might outweigh the additional cost/uncertainty of developing liquefaction “at-risk” land. That does not seem to be the approach advocated by Environment Canterbury in its 31 August letter.

from higher risk areas. (A detailed assessment of the new greenfield areas has not been undertaken as part of this study). Rather, the point being made is that Environment Canterbury did not, through the exercise of its urban growth management responsibilities, see it necessary or appropriate to consider liquefaction risk as a relevant constraint.

7.1.2 Zoning decisions of the City Council

Insofar as zoning decisions of Christchurch City are concerned it is clear from a recent report commissioned by the Ministry for the Environment (MfE)⁹ that most urban zonings (at least within that report's study area) were confirmed well before there was information available on earthquake hazards risk in the region.

On that basis, the option of managing risk (to those areas that subsequently suffered liquefaction) through zoning was never an option realistically available to the City Council.

In theory, it would also have been possible to "down zone" undeveloped residentially zoned land known to be at some risk of liquefaction. However that was apparently not considered (presumably because of traditional planning reluctance to remove established development rights).

In terms of any zoning that occurred in more recent times and/or not within the MfE report study area, liquefaction/lateral spread has seldom been considered. One instance where those risks were investigated and taken into account in decision-making was in relation to rezoning of land at Ferrymead by way of Plan Change 28. That matter is discussed in **Appendix 6**. These issues were also addressed in the development of Pegasus Bay (in Waimakariri District).

The City Council usefully provided (in its 10 November letter) a summary of relevant plan changes and an assessment of the extent to which liquefaction/lateral spread risk was considered (see **Appendix 7**).

That information shows, that apart from Plan Change 28 already mentioned, very few proposals assessed liquefaction/lateral spread risk. **Appendix 7** shows that in the majority of cases there was simply no assessment. Plan Change 43 (a private plan change request) seems to be another exception where geotechnical information was presented and liquefaction risk was identified. Documentation submitted to council as part of the private plan change request that became Plan Change 45 also identified some liquefaction risk but this does not seem to have been carried through to the section 42A report or decision. Other instances where geotechnical reports have been received seem limited to post 22 February 2011.

City Council officers do not have expertise in risk assessment and therefore must rely on information provided by applicants. The key issue here is what triggers council officers to require applicants to provide the geotechnical/hazard risk information? That is not clear from the information to hand. It does appear that a different approach has been adopted post 22 February from that prevailing before that date.

⁹ Canterbury Fact Finding Project, Hill Young Cooper and Resource Management Group Ltd, August 2011

7.1.3 Managing risk at time of subdivision

The MfE-commissioned “Canterbury Fact Finding Project” reported, in respect of the eastern suburbs of Christchurch along the Avon River that have been impacted more severely by liquefaction and lateral spread:

“no evidence [was] found of the consideration of liquefaction or lateral spreading, either in the documents sourced or the interviews undertaken

Further the same report noted that in respect of section 106 of the RMA 1991, and its predecessor section 274 of the LGA 1974,

No documentary evidence of the use of these sections of the Acts being used for the purpose of declining subdivision consent was discovered and neither was it raised in any of the interviews conducted

This followed from the finding that although zoned before 1977 many parts of the study area were not developed until after 1977 and quite often not until after 1986 and in some case in the 2000s. It is generally held that information on this risk (though incomplete for reasons given earlier) was available to councils from the early 1990s.

This is consistent with the feedback received in meetings conducted as part of this project. It is also consistent with the direction of the Christchurch City Plan, which though not explicit, seemed to emphasise the use of the Building Act as the primary means of managing earthquake risk. The Christchurch City Plan does contain some ability to exercise control at the time of land subdivision but it is not strong in that regard and would require a case-by-case assessment of risk.

The planning reality is that once land is zoned for a specific use it is very difficult for a council to refuse a subdivision that enables that use to establish. There is a presumption that land zoned will be suitable. That was also the view expressed in the Canterbury Fact Finding Project Report and by City Council officers in the meeting conducted as part of this project.

As noted earlier, Section 106 of the RMA refers to refusing subdivision if the land in question is “likely” to be subject to material damage. It seems that Christchurch City did not regard the probability of an earthquake and subsequent liquefaction and lateral spread as “likely”.

The key issue here is “was that a reasonable assessment?” - especially taking into account the liquefaction and lateral spread were not considered at the time the land was zoned. While it is not within the scope of this project to answer that question directly, it is relevant to note that case law on this matter does seem to have set the bar high in determining what is “likely”. Advice received by the City Council on this matter suggested the risk needs to be “real or substantial”.

Case law and practice on this issue seems based around flood risk, for which a 100-year return period has established as something of a benchmark. Should that approach be taken to earthquake risk then it is little wonder the section is never invoked. Earthquake risk is of course of quite a different nature (and comprises both rupture and shaking risk) and the consequences, not just the probability, need to be

integral to the assessment. Whether this is captured in the term “likely” is a moot point.

Further, Christchurch City received much advice over the years which (although not always entirely consistent) would have created a picture of relatively low liquefaction risk. A letter from GNS to Christchurch City’s Building Control Manager of 14 July 2003 is particularly instructive.

That letter commented on an earlier report entitled *Effects of Liquefaction-Induced Differential Settlements on Residential Dwellings in Christchurch*¹⁰. **Appendix 5** quotes extensively from that letter. In short, the advice received was that:

- in the case of a MM7 level earthquake GNS “*would not expect to see major damage to buildings as a result of liquefaction...*”
- the probability of an MM9 or MM10 earthquake “*is sufficiently low that, in our opinion, it would not be reasonable to require ordinary structure, like house, be constructed to withstand all the adverse effects of such strong shaking.*”
- “*the majority of houses in Christchurch will not be affected by liquefaction, even during the strongest shaking (MM8) likely to be experienced*”¹¹

These two factors (i.e. the planning presumption/case law hurdle and GNS advice) together may explain Christchurch City’s approach in continuing to consent subdivision applications but it does not entirely explain why site remediation/stabilisation was seldom required as a condition of consent.

It should be noted that the City Council has advised that every subdivision consent granted contains a note advising that subsequent subdivision or building may be subject to a requirement for site-specific investigation.

7.1.4 Managing risk through the Building Act

I am not in a position to comment in detail about the use or otherwise of the Building Act as a means of managing risk. It is outside the brief of this project.

I do note that following advice from consultants URS in 2005, Christchurch City has been issuing LIMs with broad statements as to whether the site is within a “liquefaction study area” and referring the reader to Environment Canterbury for further information.

It is my understanding that geotechnical reports on liquefaction risk were not required for residential buildings but have been required for commercial/industrial buildings since the mid 1990s. Presumably appropriate foundation engineering solutions were then required to address the risk to those buildings.

City Council staff have confirmed that on the basis of the GNS advice detailed in **Appendix 5**, the risk to domestic buildings was not considered sufficient to warrant a change in the foundation engineering requirements for those buildings and geotechnical reports were not required.

¹⁰ Carr, KM, *Effects of liquefaction-induced differential settlement on residential dwellings in Christchurch*. Department of Civil Engineering, University of Canterbury (October 2001).

¹¹ This advice was originally included as an assumption in an earlier GNS report *Earthquake, volcano and tsunami risks to property for Christchurch City Council* (April 2003) and quoted with agreement in the July 2003 letter.

Given this limited use of the Building Act, references in the City Plan tend to overstate (in my opinion) the degree to which risk will be managed by that Act. In fact the approach to risk management, insofar as domestic buildings are concerned seems to be more a question of accepting what was considered to be a very low level of risk.

8 Conclusions

A review of planning documents shows that both Environment Canterbury and the Christchurch City Council recognised the seismic risk, understood their functions and, in broad terms at least, were carrying out those functions. Inevitably some questions may be raised about whether (with the benefit of hindsight) planning responses were adequate and appropriate given known seismic risk.

The research conducted as part of this project suggests that an unclear, evolving and at times conflicting understanding (or perception) of the risk may have led councils to adopt what might now be regarded as an inadequate planning approach.

While Environment Canterbury should get credit for its technical work on risk identification/assessment and information dissemination (which was, apparently, amongst the best in New Zealand) its role in controlling land use was limited.

That role could have been more clearly articulated in the RPS although there is no evidence that any lack of clarity around respective regional city council responsibilities in hazard risk management caused confusion or malpractice. Other issues include the following.

- The operative RPS hazards policies are not particularly helpful – but that is acknowledged and has been rectified in the recently proposed RPS.
- There is a question about whether Environment Canterbury had been advocating for seismic risk management in planning processes. Liquefaction had been raised by Environment Canterbury in its appeal against the Pegasus Bay development but it was very much an “add on”, secondary factor. Environment Canterbury did not raise liquefaction concerns in its submission on the City Council’s Change 28 – even though that was clearly an issue. Information from the City Council indicates that Environmental Canterbury had not been active in formal earthquake risk advocacy (i.e. through submissions on plan changes and notified consents).
- Environment Canterbury has not seen its role as extending to consideration of earthquake hazard risk in its land use policy decisions. Change 1, which extended urban limits, did not take account of earthquake risk on the basis that liquefaction and lateral spread are considered to be issues to be addressed by territorial authorities at the time of subdivision and development. At the very least that seems a highly debatable position for Environment Canterbury to adopt and potentially inconsistent with the (admittedly general) best practice advice. It has become clear from this project that the City Council at least, was not managing risk effectively at those stages of the development process. In that sense Environment Canterbury’s reliance on those processes seems ill-founded. Where there are choices to be made about which land is to be urbanised good

planning practice would suggest the presence of natural hazards would be a factor in weighed in the selection process. Nevertheless, the approach had no bearing on the extent of damage suffered as a result of recent earthquakes as Change 1 did not become operative until after those events.

Christchurch City Council has responsibility for land use control to manage earthquake hazard risk. Given the historic nature (i.e. pre seismic hazard knowledge) of most of its urban land zonings, it has seldom been able to use the zoning process to limit risk. Change 28 (rezoning of land at Ferrymead) was one such example where appropriate hazard mitigation was considered as part of the rezoning proposal. That does, however, seem to be an exception. Other recent urban growth plan change processes do not appear to have considered earthquake risk. The key issue being that the City Council has not routinely sought earthquake risk information as part of private plan change requests¹².

Even though there has been limited ability to manage risk at the time of land zoning, the City Council could, in theory at least, have managed the risk at the time of subdivision consent (either by declining consent or by requiring land consolidation or other risk mitigation). However, based on recent MfE-commissioned research, it seems that has not been the approach adopted by the City Council. That is a matter that has recently led the Minister for the Environment to add hazard management as a matter to be addressed in the current round of reform of sections 6 and 7 of the RMA. A technical advisory group has been appointed to consider this, and other issues, and is scheduled to report back to the Minister by March 2012.

In my opinion, to the extent that there have been issues with seismic hazard management under the RMA in Christchurch, those issues are largely systemic in nature rather than issues related to the competency or commitment of the local authorities concerned. By systemic I mean a lack of clarity about the level of risk that should be planned for, ingrained public expectations about the right to develop suitably zoned land and statutory provisions that are not overly supportive of planning in the absence of perfect information. This may be addressed, in part at least, by the Minister's review of the RMA. There are, in addition, improvements in planning practice that could be introduced. By and large, these seem to have already been recognised by the councils concerned. However, greater central government guidance for local authorities on planning for earthquake risk may be warranted.

¹² The practice in this regard has not been researched as part of this project. It is likely, however, that council officers are guided by the Web-map electronic data system available to all council officers. This does include known indicative liquefaction zones.

Appendix 1 – Hazard planning responsibilities under the RMA

Environment Canterbury

The relevant functions and duties of Environment Canterbury under the RMA stem from sections 30, 62 and 65.

Relevant regional council functions – Section 30

Section 30 (a) and Section 30 (b) set out general obligations. Section 30 (a) requires regional councils to prepare *“objectives, policies and methods to achieve integrated management”*. Section 30 (b) requires regional councils to *prepare objectives and policies in relation to any actual or potential effects of the use, development and protection of land which are of regional significance”*.

These are broad functions which (theoretically at least) allow a regional council to engage in natural hazard management where the risk of regional significance or where management requires an integrated response.

Here “integration” means integrated between the regional council and territorial authorities and integrated in terms of the various functions of the regional council (i.e. control of water takes, river beds disturbance, land use, discharge, occupation of coastal space etc).

While I note these provisions here, I do so largely for completeness. These provisions could, it seems to the author, be used to provide a mandate for hazard/earthquake risk management to my knowledge it is not currently practice for these sections to be relied on for such a purpose (except insofar as RPS policy and associated advocacy).

In addition to those general functions, section 30 (c)(iv) includes the specific function for regional councils requiring:

“the control of the use of land for the purpose of the avoidance or mitigation of natural hazards”.

Regions also have the function under section 30 (1)(g) to control the planting of any plant on the bed of any water body for the purpose of avoidance of natural hazards. That function is not, however, relevant to earthquake hazard management.

Regional policy statements and regional plans

Section 62 (1) (i) (i) provides that the regional council’s (mandatory) regional policy statement must specify:

“the local authority responsible for specifying the objectives, policies and methods for the control of the use of land -... to avoid or mitigate natural hazards or any group of hazards”.

This is required because, as noted below, the RMA provides the same function (i.e. the control of land for the purpose of avoiding or mitigating natural hazards) to both regional councils and territorial authorities. The Section 62 (1) (i) (i) responsibility is designed to ensure that the shared responsibility is clearly defined and the function

does not “fall through the cracks” with each authority believing the other is carrying it out.

Section 65 (3) (c) requires a regional council to consider the desirability of preparing a regional plan when there is likely to arise “..any threat from natural hazards ...”

That makes clear that the presence of an actual or potential natural hazards is grounds to prepare a regional plan or to have a regional plan, prepared principally for other reasons, address natural hazards.

Christchurch City Council’s RMA functions and obligations

Christchurch City Council’s RMA functions are defined by Section 31 of the RMA. As noted above, the function in respect of natural hazards largely mirrors that allocated to regional councils. Section 31 (1) (b) states:

The control of any actual or potential effects of the use, development or protection of land, including for the purpose of –

(i) the avoidance or mitigation of natural hazards ...

This mirrors the regional council function except insofar as section 30 refers to the *control of land use* whereas section 31 refers to the control of the *effects* of land use. In practical terms, however, little if any distinction is drawn between these functions.

Section 106 of the RMA is also relevant. It states that:

(1) A consent authority may refuse to grant a subdivision consent, or may grant a consent subject to condition, if it considers that –

a. The land in respect of which a consent is sought, or any structure on the land, is or is likely to be subject to material damage by erosion, falling debris, subsidence, slippage, or inundation from any source; or
...

It may be relevant to note the Section 106 has (arguably) been diluted since first included in the RMA in 1991. Until legislative amendment in 1993, section 106 had read “shall not grant subdivision consent”¹³. This was consistent with section 274 of the Local Government Act that addressed land subdivision prior to the enactment of the RMA in 1991. The section now directs that councils “*may*” refuse consent.

General duties

In addition to the above specific functions and plan-making responsibilities, all local authorities have general duties under the RMA that are relevant to the management of natural hazards.

Duty to gather information

Section 35 (1) requires every local authority to gather information and undertake or commission research necessary to effectively carry out its functions.

¹³ It should be noted that the previous wording was not absolute. Provision was made for consent to be granted provided the local authority was satisfied that the risk could be mitigated by rules, conditions or works.

Section 35 (2) requires every local authority to monitor the environment in its district or region.

Section 35 (3) requires local authorities to keep information available which is relevant to the administration of policy statements and plans to enable the public to be better informed.

More specifically, Section 35 (5) (j) requires local authorities to keep:

“records of natural hazards to the extent that the local authority considers appropriate for the effective discharge of its functions”.

Duty to consider alternatives, benefits, and costs

While not specific to natural hazards, the general duty to consider alternatives, benefits and costs is relevant to the extent that the duty can act as a “governor” on the development and implementation of policies and rules. To avoid unjustified or irrational intervention.

In essence, the section requires councils to consider the appropriateness of objectives and the effectiveness and efficiency of policies and rules or other methods before proposing or adopting them. This is to be done having regard to the benefits and costs of the policies and methods and the risks of acting or not acting.

It is commonplace to refer to the “section 32 test” which is generally regarded as the benefits outweighing the costs and/or risks. Section 32 has an important role in determining what, if anything councils do in response to species issues and risks.

Appendix 2 – Hazards Planning Best Practice Guidance

Planning for Development of Land on or Close to Active Faults

In March 2001, the Parliamentary Commissioner for the Environment released the report *Building on the Edge – The Use and Development of Land On or Close to Fault Lines*¹⁴. The Commissioner's investigation arose following public concern that local authorities were not able to adequately manage the use and development of land on or close to active faults.

The PCE report focused on the Building Act 1991 and the Resource Management Act 1991 (RMA). It reached a number of key conclusions.

- There is no technology to prevent earthquake damage to buildings built across faults.
- Few territorial authorities identify and plan for seismic hazards, despite their responsibilities for subdivision and land use.
- Practical guidelines are urgently needed to reduce the risks associated with fault rupture.

Specifically recommendation 1 (below) of the PCE report proposed that priority be given to:

The Ministry for the Environment working together with the Institute of Geological and Nuclear Sciences and other interested organisations with structural and geotechnical expertise to develop best practice guidelines for territorial authorities in avoiding or mitigating seismic hazard through the district plan process.

An essential first step will be the identification of barriers to incorporating scientific information into the policies, objectives and rules in plans and policy statements under the Resource Management Act 1991; the investigation and evaluation of planning and other options to reduce risk in different situations depending on seismic hazard type and the level of certainty that exists; and establishing a dialogue with local authorities to increase awareness of seismic problems and potential solutions.

The report referred to in the first part of the recommendation was duly prepared in the form of the *Planning for Development of Land on or Close to Active Faults*, 2003 ("the Active Fault Guideline").

The following text describing the scope of the 2003 guideline is taken (with minor amendment for clarity) from its summary.

The first part of this guide focuses on the need for a risk-based approach to planning for land use on and near active faults. It recommends that councils:

- *identify active faults in their district, with maps that are at the right scale for the purpose*

¹⁴ <http://www.pce.parliament.nz/publications/all-publications/building-on-the-edge-the-use-and-development-of-land-on-or-close-to-fault-lines-2>

- *create fault hazard avoidance zones on their district planning maps*
- *evaluate the fault rupture hazard risk within each fault avoidance zone*
- *avoid building within fault hazard avoidance zones where possible*
- *mitigate the fault rupture hazard when building has (already) taken place or will take place within a fault hazard avoidance zone.*

The main elements of the risk-based approach are:

- *the fault recurrence interval, which is an indicator of the likelihood of a fault rupturing in the near future*
- *the fault complexity, which establishes the distribution and deformation of land around a fault line*
- *the Building Importance Category, which indicates the acceptable level of risk of different types of buildings within a fault avoidance zone.*

The second part of the guide discusses the role of regional councils and territorial authorities in planning for fault rupture hazard. Section 11 describes how councils can take a risk-based approach to establishing resource consent categories for buildings within a fault hazard avoidance zone.

The appendices to the guide contain information that councils can use to begin identifying active faults in their districts.

Note that these guidelines are only concerned with the avoidance and mitigation of risk arising from *active fault rupture*. They don't discuss other earthquake-related hazards, such as strong ground shaking, liquefaction, uplift, subsidence, landslide and tsunami.

Nevertheless, they do contain principles for hazards planning that can be applied more widely (see below).

Natural Hazards (QP) guidance note

The QP Guide prepared in 2008, takes the "principles for planning approaches" used in the 2003 Active Fault guidelines and applies them to hazards more generally¹⁵.

These principles are:

Principle 1: Gather accurate natural hazard information

This involves identifying and accurately locating hazards on planning maps

Principle 2: Plan to avoid natural hazards before development and subdivision

This involves preventing building and development in known hazard areas (Alternatively it can involve requiring mitigation measures to reduce risk to an acceptable level)

¹⁵ The RMA defines natural hazards to include earthquake risk.

Principle 3: Take a risk-based approach in areas already developed or subdivided

This acknowledges the need to take a different approach to areas where there is an established expectation of building entitlement. The risk management approach recommended is the 2004 Australian/New Zealand Risk Management Standard 4360.

Principle 4: Communicate risk of hazards in built up areas.

To the extent that existing development may exist in hazard risk areas a level of risk needs to be expected. However, any further development and use of building needs to be consistent with the level of risk faced and district planning maps should clearly show hazard zones (allowing people to make informed choices). Non-regulatory education and community engagement process will also be important to raise awareness.

The QP Guidance note gives particular guidance on:

- Techniques for the identification of risks
- The role of RPSs, regional and district plans, iwi management plans and resource consents

Specific guidance is also given on individual hazard risks. In relation to earthquake risks the QP guideline repeats the advice the 2003 guideline by recommending mapping active faults, using buffer zones and excluding development, and requiring structures to be designed to minimise risk. It also cites examples including Wellington City's rules dealing with liquefaction zones.

Appendix 3 - Planning response of Environment Canterbury

Canterbury regional policy statement

Environment Canterbury notified a new (Proposed) RPS in June 2011 but for purposes of this report the RPS considered in the Canterbury RPS made operative in 1998.

Natural hazards are addressed in Chapter 16 of the RPS. It is clear from the introduction to that chapter that earthquake risk was well recognised. The opening paragraph notes “*twice after its completion the masonry of the spire of the Christchurch Cathedral was felled by quakes*”. Later in the same section it identifies a “*large scale earthquake affecting Christchurch*” as the most severe regionally significant natural hazard in the region.

It then identifies a single relevant objective being:

Avoid or mitigate the actual or potential costs of loss or damage to life, property, or other parts of the environment from natural hazards.

Five policies are identified to give effect to the objective. With due respect, these are very high level and some might be described as esoteric. They are as follows.

Policy 1

In managing natural hazards, highest priority should be given to the combination of measures which delivers the greatest net benefit.

This seems to be directing the regional council and territorial authorities (who must not act inconsistent with the policy¹⁶) to prioritise their management of natural hazards towards those hazards that had the lowest cost relative to the benefit gained (or the highest benefit relative to the cost). This seems focused on/most applicable to council-funded hazard mitigation works (flood protection, coastal protection etc) rather than having direct application to land use control (i.e. the policy and regulatory context).

Policy 2

For the Canterbury region, or any part of the region, which local authority shall have responsibility within its own area for developing objectives, policies, and rules relating to the control of the use of land for the avoidance or mitigation of natural hazards shall be determined in the following manner:

- (a) Particular responsibility for any particular hazard or group of hazards shall initially remain with the local authority or local authorities managing that hazard or group of hazards as at 1 January 1994. Where this responsibility is not clear, the Regional Council shall retain primary responsibility.*
- (b) The Regional Council in consultation with territorial authorities in the region will review responsibilities to ascertain any need for changes to which local authority or local authorities shall have responsibility for managing particular natural hazards or groups of natural hazards.*

¹⁶ The statutory test has now changed to “give effect to” but when the policy was drafted the test for territorial authorities was that they be “not inconsistent” with it).

This policy seeks to meet the Section 62 requirement to sort out respective natural hazards responsibilities in the RPS. In the absence of this policy the Act sets a default position that the regional councils is responsible.

The policy is far from clear however. Which local authority was responsible for what prior to 1 January 1994 is not stated. More critically, Method 16.3 of the same RPS suggests that there may have been doubt about where those responsibilities lay. That methods proposed consultation in the with territorial authorities to confirm which authority had been responsible for what as at the 1 January date. The results of this confirmation exercise were to be included in the RPS presumably to provide the clarity that was obviously absent. That does not, however, appear to have occurred.

Policy 3

Where there is no provision for natural hazard in a plan relevant to an area in which an application for a resource consent has been received, the consent authority should, when having regard to this Regional Policy Statement, take a precautionary approach to the potential for a natural hazard to be created or increased as it relates to the applicant or any other person or property. This may be achieved by giving priority to the principle of avoidance.

This policy is designed to apply in the resource consenting context. I take it to mean that where the assessment of environmental effects (AEE) submitted with an application (or the councils assessment of the application) identifies a hazards risk but the plan does not identify the risk or the appropriate means of managing it, then a precautionary approach is to be applied and that may in turn mean that applications should be declined or the risk otherwise avoided (through, for example, conditions requiring location of the activity on a part of the site that avoids the risk). This acknowledges that plans may not have dealt with natural hazards comprehensively.

Policy 4

In discharging their responsibilities for natural hazard management, the Regional Council, and territorial authorities in the Canterbury region should adopt a precautionary approach and ensure that an appropriate combination of measures is used to modify occurrences, modify susceptibility to damage, and deal with the consequences of disaster.

This simply encourages a “precautionary approach” to be adopted and an “appropriate combination of measures”. It provides little guidance of what this might mean in practical terms.

Policy 5

Responsibility for costs associated with management of natural hazards, as well as these can be determined, should fall on those who benefit in proportion to that benefit.

As with Policy 1, Policy 5 appears to be focused on management of hazards by way of physical works (stopbanks, seawalls etc) and the principle that the beneficiaries of that management ought to bear the cost. It is not clear that the policy has application in influencing or directing land use planning decisions although it might support conditions being placed on consent ensuring that make developers responsible for hazard mitigation work at the time of land subdivision and development. It is not clear from the policy’s explanation that it is intended to apply in such a way. There would certainly appear to be more direct ways of establishing that policy principle.

In summary, as noted earlier, the RPS policies are high level and it is not always apparent how they might be implemented. They are generic in scope in the sense they do not relate to specific types natural hazards or particular know hazard locations. Similarly they provide no real indication of what the regional council's role in hazard management will be.

The RPS also sets out (as required by the RMA) the methods by which the policies are to be given effect. These are:

1. Confirmation and review of the respective responsibilities of territorial authorities and the regional council for hazard management (as discussed earlier)
2. Regional plans. The regional council committed to co-ordinate the development of a joint strategy for natural hazard management to be implemented through the Regional Coastal Environment Plan, the Natural Resources Regional Plan, and other regional plans and district plans of the region. It appears that this was never completed in any formalised way.
3. Encouraging the preparation of iwi management plans
4. Information provision
5. Service provision (e.g. maintain river protection schemes)

Regional Plans

Notwithstanding method 2 above (i.e. joint strategy for hazards management implemented through regional plans), regional plans do not appear to address natural hazards comprehensively. Some plans may be said to address specific natural hazards issues (such as the Land and Vegetation Management Plan which addresses, amongst other things, increases in flood and erosion/slippage risk, or the Regional Coastal Plan¹⁷ which addresses coastal erosion risk) but earthquake risk at least does not appear to be addressed (although it may be that this is deliberately left to be addressed by district plans).

This is not unusual and reflects practice prevalent across New Zealand.

¹⁷ The regional coastal plan does control and use (i.e. it includes rules controlling building development) in hazard zone 1 and hazard zone 2 which generally run parallel to the coast and are designed to address risk of coastal erosion.

Appendix 3a – The 2011 Proposed RPS

The proposed RPS, released earlier in 2011 includes a broader suite of policies that provide guidance and direction to those exercising control over land use. These include policies relating to:

- subdivision and use of land
- location of critical infrastructure
- the general risk management approach

Consistent with past practice, however, Environment Canterbury keeps out of land use control limiting Environment Canterbury land use responsibility to

(a) land within the 100-year coastal erosion hazard zones, as defined by maps in the Canterbury Regional Coastal Environment Plan; and

(b) within the beds of rivers and lakes; and

(c) within the coastal marine area for the purpose of avoiding or mitigating natural hazards.

Appendix 4 - Planning Response of Christchurch City Council

The Christchurch City District Plan was made operative in 2005. The following provisions relate to the matter of earthquake risk management.

Chapter 3.4 of the Christchurch City District Plan notes the following.

3.4 Natural hazards

Within Christchurch there is risk from a number of natural hazards including:

- *possible sea level rises;*
- *erosion of the coastline and rivers;*
- *erosion of the Port Hills;*
- *flooding from the rivers and the coast;*
- *damage caused by high winds;*
- *earthquakes [emphasis added]; and*
- *fires in rural areas.*

More specifically it identifies earthquake risk as a specific issue as follows.

3.4.5 Earthquake risk

Christchurch lies on the edge of a seismically active region. Consequently, earthquakes are likely to occur at a magnitude which will have major impacts on the City. In addition, there are other areas of active faults close to Christchurch, including Pegasus Bay, Porters Pass, Ashley and Mt Grey, Hope and Lake Heron.

The two main hazards which result from earthquakes are earth deformation (ground surface rupture) and earth shaking (liquefaction, land sliding, ground-cracking, tsunamis).

Strong shaking associated with either a close small magnitude earthquake, or a large magnitude distant event could cause considerable damage to the City, in particular in urban areas.

While single or two storey timber-framed residential dwellings are unlikely to suffer much structural damage in these events, in some areas liquefaction (where the solid ground takes on liquid qualities due to increased pressures) could cause distortion of buildings. Damage to buried cables, water and sewage pipes could also occur.

The most susceptible areas to liquefaction are those with water saturated, loose, well soiled silt and sand. It is also common in peaty soils. Large parts of the eastern suburbs and area around the Heathcote River are underlain by these materials.

The Plan's objective for natural hazards generally is as follows.

2.5 Objective : Natural hazards

To avoid or mitigate the actual or potential adverse effects of loss or damage to life, property, or other parts of the environment from natural hazards.

Reasons

There are a number of potential natural hazards which can affect land within the City. These hazards include the following:

- *Flooding from the Waimakariri River, or the river systems within the City, particularly the Heathcote*
- *Inundations from ponding of flood water, particularly within catchments of the upper Heathcote and lower Styx Rivers;*
- *Inundation from extreme tidal flooding especially surrounding the lower Avon and lower Heathcote Rivers and Brooklands Lagoon;*
- *Increased risk of inundation of coastal areas as a result of rising sea levels*
- *Avulsion and alluvion (hazards created by the scouring of river banks and the deposition of the material from floods);*
- *Seismic activity and liquefaction;*
- *Erosions by water or wind*
- *Subsidence; and*
- *Rockfall and land slips*

It is clear from this that earthquake risk is recognised by the Christchurch City district plan as one of a number of natural hazards faced by the City (albeit arguably greater and more specific focus is placed on flood risk). Policies associated with the objective relevant to seismic risk are as follows.

2.5.1 Policy: Presence of natural hazards

To control development within the City to protect life and investment, taking account of the presence of natural hazards and the degree of risk that those hazards impose on the environment.

Explanation and reasons

Natural hazards occur in varying degrees, and may cover greatly different areas, For example, the potential areas subject to flooding are far greater than areas subject to rock fall. The degree of risk in terms of the severity of the likely impacts are also another factor which needs to be taken into account when considered the extent of control that may be required on development.

It is not practicable, either through regulation or other means, to provide total security and protection from natural hazards. The protection of life and investment from natural hazards needs to take into account the likely risks as a result of natural hazards that may affect them. In undertaking measures which may involve intervention in the development or subdivision of land, the Council needs to provide a balance between economic and community needs and any proposals for land use controls, particularly where lower risk and the severity of likely impacts to property is apparent, and mitigation measures are effective and environmentally sound. In some areas, such as adjacent to waterways or the

coastline, the incidence of risk is extremely high which justifies strong regulation of development. The frequency, or expected “return period” of natural hazards is a primary means of assessing risk, along with anticipated costs of damage.

This seems to indicate risk-based approach to be taken to hazards management such a that the level of intervention is to vary according to the level of risk (with strong regulation reserved for high risk).

2.5.2 Policy: Limitations on development

To avoid any increased risk of adverse effects on property, wellbeing and safety from natural hazards by limiting the scale and density of development which:

- *Is within an area subject to moderate to high risk of damage from natural hazards; or*
- *Would result in an increased risk of damage from natural hazards elsewhere*

This indicates that in areas subject to “moderate to high risk” (note defined) additional development is to be limited. The explanation to the policy does not mention seismic/liquefaction risk and focused instead flood risk. Tough not stated expressly the frequent return period of floods relative to earthquakes seems the key factor here.

2.5.3 Policy: Earthquake

To ensure that buildings are constructed in a manner (or where appropriate, reconstructed) to ensure that their stability in times of earthquake is sufficient to avoid, or at least minimise, loss of life or damage to property.

Explanation and reasons

Christchurch is subject to a reasonably high level of risk from seismic activity and there are limitations to the degree of protection that can be provided from this hazard. However, there are provisions under the Building Act which ensure that new buildings are constructed to a standard which ensures that they have adequate resistance to seismic events. Where appropriate, existing buildings can be upgraded to provide a higher degree of protection. This latter matter has to be balanced however, after taking account of the Council’s life safety obligations detailed in the Building Act, with recognition that some buildings would have to be demolished if protection to full earthquake standards were required, as the cost of upgrading would be uneconomic. The Council will in these circumstances take into account the potential land use activities and the risks to life within buildings of this nature, as well as the heritage values of buildings where this is appropriate.

This policy seems to focus on building construction and indicates that significant emphasis is placed on managing earthquake risk by controlling building construction (under the building Act).

2.9.2 Policy: Natural Hazards

To provide information in respect to the presence of natural hazards and to increase public awareness of them.

Explanation and reasons

In some circumstances the provision of information is an appropriate means of signalling to landowners that constraints exist on the development of land, and that the decision as to whether or not to proceed in recognition of the risks associated with development, is left to that person to make.

The Council has a responsibility to ensure that as far as possible, a record of known hazards is available and the developers are aware of it before undertaking decisions in respect of development of land. This will be achieved through the Council's Hazards Register, a document which is not however, part of the Plan. Some hazards within it are suspected, and may be further clarified by field tests or mitigation proposals.

It is not practical to identify all sites in the Plan that may be subject to natural hazards as the presence of hazards can sometimes only be discovered upon detailed site investigation. The provision of information does enable a decision to be made on the degree of risk involved and gives more flexibility to landowners to make decisions on their own behalf as to the degree of potential loss they may suffer. However, in many cases it is necessary to proceed beyond the provision of information into more definitive regulation, because some decisions are made on a short term basis, whereas the return events of hazards may be over a longer term and affect subsequent owners. The Council maintains the Hazards Register containing information relevant to the development of land, particularly at the time that consents are applied for under the Building Act.

Many of the areas subject to natural hazards by their physical and geographical nature have high natural or landscape values and upon which development may be restricted for other reasons. However, in many areas development can take place and still be subject to some degree of natural hazards, however slight. It is important to ensure that the quality of the environment, and people's amenity values, are not unduly affected by them being placed in a situation of undue risk from natural hazards, particularly in terms of damage to property or personal danger.

This policy highlights two key matters. First, the role in providing information in allowing informed private choices to be made. Second that information is incomplete and broad brush and site-specific investigation will often be required to fully assess risk. Again the building Act mechanism is identified (together with the Hazards Register) as a key means of risk management.

6.3.6 Policy: Hazards

To ensure that development is avoided, or limited in scale or density in areas subject to natural and other hazards, particularly flooding, erosion, or potential sea level rise, unless these hazards can be adequately remedied or mitigated.

It is notable, perhaps, the seismic risk and liquefaction are not mentioned in this policy or in the policy's explanation.

10.1 Objective: Subdivisions and natural hazards

That subdivision not be permitted to occur in localities where there are significant natural hazards, unless these can be adequately mitigated, and that any such mitigation measures not have significant adverse effects on the environment.

Reasons

There are areas within the City boundary, which because of risk of natural hazards including flooding, inundation, erosion, alluvium, avulsion, subsidence or slippage, would be unsuitable for development, or require specific measures to be undertaken to overcome, or reduce the risk of these hazards.

The Council has an obligation under Section 106 of the Act to decline consent to any subdivision in areas where these hazards cannot be adequately mitigated, in addition to ensuring that the mitigation measures are in fact adequate to overcome the hazard. It is also necessary to consider the effects of the mitigation measures themselves which may also create adverse environmental affects. An example of this is the filling of land which may interfere with the functioning of natural flood plains or ponding areas.

Again, it is perhaps notable that seismic risk and liquefaction are not mentioned in this policy or in the reasons.

Appendix 5 – GNS advice on liquefaction risk

The following extracts are taken from a letter from GNS to the Christchurch City Council Building Control Manager. The letter responds to a report by Kirsti Maria Carr (then a student at the University of Canterbury) on the effects of liquefaction induced differential settlement on concrete slab foundations of domestic buildings.

The GNS review found that the Carr report was mostly complementary to a report by GNS that modelled earthquake risks to property of the Christchurch City Council. It did point out though that the effects of liquefaction at high intensities of shaking (MM9 and above) were unlikely given an event of that intensity had a very low probability of occurrence (>70,000 years).

The following extracts from the GNS review are of particular note.

For Christchurch the major known active faults are 25 to 45km away, and the likely strength of shaking as predicted by the New Zealand attenuation model for MM Intensity is MM7 Zone. Within Christchurch however, the resulting damage is likely to be somewhat more severe than indicated by the MM7 Zone descriptors as a result of amplification of the shaking by the soils underlying Christchurch, and sporadic liquefaction.

Thus instead of

“a few instances of non-damaging liquefaction (small water and sand ejections) in alluvium”

which is appropriate for an MM7 Zone, we would expect to see

“evidence of soil liquefaction common, with small sand boils and water ejections on alluvium, and localised lateral spreading (fissuring, sand and water ejections) and settlements along banks of rivers, lakes and canals etc”

Nevertheless, we would not expect to see major damage to buildings as a result of the liquefaction, even though the total cost of damage to building in Christchurch could in some cases be in the vicinity of \$1 billion.

....

In the above discussion we are not saying that intensities of MM9 and MM10 will never occur in Christchurch. There is a possibility, but the probability is very low (return period >70,000 years). The probability is sufficiently low that, in our opinion, it would not be reasonable to require ordinary structures, like houses, be constructed to withstand all of the adverse effects of such strong shaking.

....

In our assessment of the cost of earthquake damage to the property of Christchurch City Council we made some assumptions about the effects of liquefaction. We believe that those assumptions are consistent with the work presented in the Carr report. Specifically:

In allowing for potential liquefaction in Christchurch we assume the following:

....

- *The majority of house in Christchurch will not be affected by liquefaction, even during the strongest shaking (MM8) likely to be experienced.*

This seems consistent with the findings of the Carr report. The case histories presented by Carr, which mostly are for more severe shaking than expected in Christchurch except at very low probabilities, indicate that damage to houses with well-constructed foundations, as a result of liquefaction and settlement, is a relatively rare occurrence. We would be comfortable with extending this assumption to cover all houses in Christchurch. The 30% increase in damage ratio at MM8.5, to allow for amplification, is in line with experience at Westport in 1968.

- *The proportion of low rise buildings located in places likely to be affected by lateral spreading or substantial settlement is small, about 5% of all low-rise buildings at most.*

For lateral spreading to occur there needs to be a step in the topography or free surface, such as the bank of a lake or stream. The parts of Christchurch susceptible to liquefaction are generally very flat with only a few small streams passing through. Because of the small size of the streams, any lateral spreading is unlikely to extend more than a few metres from the original banks and will, therefore affect only a small proportion of all houses. However, differential settlements caused by consolidation of peat horizons within the gravel and soil sediments underlying Christchurch may be more common.

Appendix 6 – Plan Change 28

Plan Change 28 was a private plan change (meaning it was not proposed by the Council but by a private party). It related to an area of land some 29.9 hectares. Of some interest, the Council’s Section 42a report associated with the plan change request had attached a “Liquefaction Hazard Assessment report” prepared by Ian McCahon, Geotech Consulting Ltd. Mr McCahon’s report noted that the geotechnical report for the proposed Change did not consider liquefaction, and that the Christchurch City Council subsequently requested further information. That resulted in a further report by Coffey Geotechnics (NZ) Ltd. Thus, far from ignoring the issue, the council had actively ensured it was addressed in the private plan change process.

The Coffey report contained no detail on what measures might be proposed. Mr McCahon noted that “it really only says that yes, there is a liquefaction potential, (based solely on the S+F report) and that remedial work can be carried out”.

Mr McCahon’s recommendation is worth quoting in full:

32. For all the above reasons, I recommend that the following minimum requirements be incorporated into the subdivision rules of the City Plan to apply to the plan change for the site known as Kennaway Park:
- a) All utilities shall be designed and constructed to ensure they will remain in service after a 150 year return period earthquake. This shall include taking into account the effects of earthquake induced liquefaction and lateral spread of the ground.
 - b) The layout, design and construction of any subdivision in the plan change area shall take into account the potential for earthquake induced liquefaction of the ground within these zones, and the potential effects of associated ground settlement and lateral spreading of the ground on structures and utility services.
 - c) Liquefaction mitigation measures shall be designed and constructed to achieve the standards set out in Table 1 below:

Table 1 Liquefaction Mitigation Design Standards:

Design Earthquake Return Period	Maximum Permanent Ground Movement	
	Settlement	Lateral movement
150 years	Limits to be within tolerance of all utilities to remain in service	
475 years	100mm	400mm

33. I conclude that the liquefaction hazard in itself is not sufficient to recommend declining the proposed plan change. If the zoning is changed however, the conditions as set out above in paragraph 32 should be included in the City Plan in order to prevent any subdivision consent being granted prior to compliance being achieved. Furthermore, I consider that the proposed 50 metre setback for all development from the Heathcote River bank should be retained in

order to reduce the exposure to lateral spread. As part of the overall site planning, post plan change but prior to subdivision, the liquefaction hazard must be further investigated and analysed, and compared with the proposed standards. Those areas with settlement and lateral spread predictions outside the standards, must then be dealt with appropriately by exclusion from development or mitigation. Additional mitigation may be necessary for particular buildings or development on particular sites where the risk of ground movements as set in the standards may be too great for that particular structure or land use.

Mr McMahon noted that the proposed procedure had a precedent in Waimakariri District with the Pegasus new town development. The 42a Planner's report had the following to say about Mr McMahon's evidence:

ASSESSMENT OF LIQUEFACTION HAZARD

88. I rely on the evidence of Mr McCahon in **Attachment C** for the assessment of liquefaction potential on the plan change site. Mr McCahon has 20 years of specialist experience in geotechnical and hazard identification and mitigation work, including previous work in relation to the plan change site in 1999-2000.

89. There are several references to natural hazards in the objectives and policies of the City Plan, and liquefaction is regarded as a natural hazard. After listing the relevant objectives and policies, Mr McCahon states:

"It may be argued that the liquefaction hazard in the subject area is no worse than is probably present in many other parts of the city, including the areas along the Heathcote River opposite and upstream of the plan change area. However, at the time these areas were developed, the liquefaction hazard, and particularly the lateral spread hazard, had not been identified. Whilst these long-established urban areas may suffer liquefaction damage, there is a strong argument to mitigate that hazard in any new greenfield area where the opportunity to do so allows, now that the hazard has been identified. To not do so for the proposed development would be in contravention to the intent of the above objectives and policies." (my emphasis)

90. I agree with Mr McCahon in this regard, and accordingly I agree with all of his recommendations regarding mitigation of the liquefaction hazard. His evidence adds significant weight to the arguments that there should be no Business 4 zoning of the 50-metre setback from the Heathcote riverbank, and that the submissions from the applicant (and others) regarding any commercial use of this land should be rejected.

Interestingly the planner's report recommended *declining* the application (for unrelated reasons). The matter was considered by an independent hearings commissioner who recommended approving the plan change (with modifications). That recommendation was accepted by the City Council and the Plan Change was approved in October 2009.

The hearing commissioner's report addressed the issue of liquefaction as follows:

GEOTECHNICAL ISSUES

69. Like other parts of Christchurch close to the rivers, the site presents geotechnical challenges for the construction of buildings and services. Investigations carried out on the site indicate that there is a significant risk of ground liquefaction in the event of a major earthquake. Structures will have to be designed to allow for this, at greater cost than for structures built elsewhere.
70. The evidence was that lateral spreading is the most significant issue, and that the potential for this increases exponentially with proximity to the river. The Council's geotechnical witness, Mr McCahon, suggested that this would be better dealt with at subdivision stage, rather than building by building, because the work needed to densify the ground is expensive and messy, it is more cost effective to improve larger areas at one time, and because the work is less effective if some individual sites are not treated. His primary recommendation though was that buildings and services should be set well back from the river.
71. There is no particular distance at which the liquefaction hazard suddenly diminishes. The 20 metre setback requested by many submitters would seem to me to be creating expectations, while anything greater than the various setbacks now proposed by the applicant (for other reasons) raise the question of the relationship between the additional cost of allowing for liquefaction and the value of the land as a resource for business activities. Mr Donnelly's economic evidence was that the latter is such that setbacks should be minimised. I consider that the latest proposal strikes a reasonable compromise. It prevents buildings within 30 metres of the river along the central part of the site, within 40 metres at the south end, and 50 metres at the north end.
72. The liquefaction hazard may have one useful consequence: developers may locate buildings on the side of their sites away from the river to minimise additional construction cost, which would provide more separation between buildings and the public walkway along the river margin.

Appendix 7 – Urban Growth Plan Change or Variation Proposals from 2002

Plan Change 5 Awatea - Rezone 148 Ha from Various zones to Living G

There is a note of a geotechnical report prepared by Tonkin and Taylor for the preparation of the Council's South West Area Plan. There is no evaluation of the liquefaction/lateral spread risk under the Natural Hazard heading in the section 32 assessment (May 2010). Following 4 September 2010, the section 42A report includes an assessment from Dr Ian Brown, a consultant geotechnical engineer engaged by the Council

Plan Change 8 - Musgroves - Rezone land at Wigram Road from B4 to B5

No mention of assessment of risk from liquefaction/lateral spread in Section 42A report, nor in the Commissioner's recommendation of July 2009.

Private Plan Change 9 - Prestons Road Elderly Persons Village 2009

No assessment of risk from liquefaction/lateral spread in the plan change request other than a statement that "*The property is not susceptible to any known natural hazards, including flooding and unstable land*". The risk is not discussed in the section 42A report.

Private Plan Change 10 - Hussey Road 2007

No assessment of risk from liquefaction/lateral spread in change request nor in the section 42A report.

Plan Change 12 Rezone 84 ha of Special Purpose Wigram Zone 2007

No assessment of risk from liquefaction/lateral spread in change request nor in the section 42A report.

Private Plan Change 19 Islington Park 2011

No assessment of risk from liquefaction/lateral spread in change request (2008), section 42A report (2011) or the Commissioner's recommendation.

Private Plan Change 22 Rezone 9 ha from Rural 3 to Business 2 Belfast 2008

Brief mention in Change request that liquefaction will be a consideration in foundation design and piling may be a requirement for major structures. No comment or assessment by Council witnesses nor by commissioners.

Private Plan Change 23 Maddison Park 2009 Rezone Templeton Hospital site to a Business zoning

Brief statement in section 32 assessment that *Buildings complying with the Building Act mitigate earthquake effects*. No evidence at hearing (February 2010) regarding the risk from liquefaction/lateral spread and not referred to in Commissioner's report.

Plan Change 27 (New Brighton)

Not an urban growth change –no assessment of geotechnical issues

Private Plan Change 30 Prestons Road Rezone 205 ha from Rural to Living G (2010)

A geotechnical report was included in the Plan Change request in 2008. No peer review of report nor any mention of liquefaction/lateral spread in section 42A report (July 2010). Prestons submitted updated geotechnical reports following September 2010, February 2011, and June 2011 events. These were peer reviewed by a geotechnical consultant engaged by Council.

Private Plan Change 36 Spencerville West

This request sought the rezoning of land at Spencerville to provide for residential development. No assessment of seismic hazards was provided with the request. The Council has made a request for further information, and has served notice under Clause 28 First Schedule of the RMA that the private Plan Change Request will be deemed to be withdrawn if there is no response within 30 working days from 13 October 2011.

Private Plan Change 43 East Belfast – Rezone 64 ha from Rural 3 to Living G with some Business 1 and Business 4 – Council Hearing August 2010 and Environment Court Hearing November 2011

A comprehensive geotechnical report by Tonkin and Taylor detailing results of soils and ground testing was submitted as part of the Change request. It identified a significant area of the site as having potential for significant liquefaction damage with other areas having potential for minor liquefaction damage and further areas requiring specific foundation design. Further geotechnical assessment is being adduced in evidence for the Plan Change Requester in the Environment Court.

Private Plan Change 45 Christchurch Golf Resort

This plan change request sought to rezone 132 ha of land from Rural 3 to Open Space 3D and a further 41 ha from Rural 3 to Conservation 3 for the purpose of establishing an international golf course and academy. The proposal included provision for up to 150 residential housing units, 380 apartments, and dormitory accommodation for up to 160 students at the academy.

A geotechnical report submitted with the request in February 2009 identified the subject area as being susceptible to liquefaction and lateral spread. The report identified a number of ground testing matters that should be carried out at subdivision and building consent stage. It does not disclose that any investigation or testing had been carried out. There is no reference to liquefaction or lateral spread in the section 42A report (November 2009) and a perusal of the briefs of evidence presented by the Council discloses none with any expertise in geotechnical hazards. No mention in Commissioner's report.

Private Plan Change 47 Sir James Wattie Drive – Rezone 3 ha from Ru2 to Business 5 (December 2009)

No assessment of any seismic hazards provided in the Plan Change Request, nor in the section 42A report or Commissioner's recommendation to Council.

Private Plan Change 54 Marshs Road – Rezone 39 ha from Rural 2 to Business 5

No assessment of any seismic hazards provided with request in October 2009. Not yet heard.

Private Plan Change 58 Wrights Road – Rezone 2 ha of Open Space 3B land to Business 4

No assessment of any seismic hazards provided with the request in January 2011.

Private Plan Change 60 Halswell West Rezone 129 Ha of rural land to Living G – March 2011.

A detailed geotechnical report was submitted with the Request. This information was assessed by a Council witness, reference was made to it in the section 42A report and the matter was addressed by the Commissioner at the hearing.

Private Plan Change 62 Wigram Airfield – Rezone 153 ha of Wigram Airfield for residential purposes (Living G)

A geotechnical report was prepared in March 2009 and this disclosed no significant hazards. Following the earthquake in September 2010 the Council engaged a consultant to peer review the report and a supplementary report was prepared following that event.

Variation 93 Clearwater Rezone land to allow for, among other things, a 350 bed resort hotel and 111 residential units. 2005

No seismic hazard evidence produced or assessed.