SECTION 32
NATURAL HAZARDS CHAPTER

1. STRATEGIC CONTEXT

1.1 PURPOSE AND SCOPE OF THE NATURAL HAZARDS CHAPTER

The purpose of the Natural Hazards chapter is to:

1. provide a comprehensive focused and updated framework and process for the management and direction of natural hazards;
2. provide landowners, the insurance sector and the property market with certainty and clarity around the rules and standards that apply to natural hazards and associated risk;
3. address omissions in current provisions in respect of the potential for liquefaction if there are further significant earthquakes;
4. address omissions in current provisions in respect of the potential for slope instability hazards on the Port Hills and remaining hilly areas of Banks Peninsula;
5. use new LiDAR information including that provided by improved technology which identifies changes in ground surface as a result of recent earthquakes and liquefaction, resulting in changes to the extent and depth of potential flooding;
6. use new information to identify additional areas subject to flooding from rivers, streams, overland flow and lakes including the effects of climate change;
7. integrate existing provisions for the repair of land used for residential purposes damaged by earthquakes including liquefaction;
8. include some interim provisions in relation to the effects of climate change and sea level rise and
9. recognise the presence of multiple natural hazards and their implications.

Both the Christchurch City Plan (CCP) and the Banks Peninsula District Plan (BPDP) currently provide a broad suite of objectives and policies in relation to natural hazards. In reviewing those provisions, a number of changes were identified that would assist with Canterbury's recovery. In particular there is a need to:

- re-focus the objectives and policies so they specifically recognise and respond to recovery issues and identify opportunities to remove unnecessary regulatory controls on activities (i.e. reduce consent and notification requirements);
- update the provisions (some being nearly twenty years old) to reflect the direction of relevant statutory documents, in particular the Recovery Strategy for Greater Christchurch, the Land Use Recovery Plan (LURP) and Canterbury Regional Policy Statement (CRPS);
- give priority to reviewing the natural hazards provisions which are currently included in the Natural Environment section of the Christchurch City Plan; and
- use new technical information to update and improve relevant provisions in both existing district plans.

The first phase of the review covers natural hazards associated with flooding, liquefaction and slope instability.

Parts of the existing district plans that have not been reviewed and are instead to be considered in Phase 2 include the following matters: coastal hazards, high hazard flood areas and ponding areas for rural zones.

1.2 PROPOSED DISTRICT PLAN: OVERVIEW AND SYNOPSIS

The District Plan Review (DPR) Natural Hazards chapter has focused on providing a comprehensive policy framework for managing natural hazards in the District. The review includes general policies and also more specific policies on flooding, slope instability and geotechnical hazards such as liquefaction susceptibility. Rules to implement these policies rely on the mapping of natural hazard overlay throughout the district, including new slope instability hazard areas and extension of the Flood Management Areas. It is also proposed to change the name of Flood Management Areas to Floor Level and Fill Management Areas. This name change will be explained later. The natural hazards provisions have been rewritten and updated to better align with higher order statutory provisions including those contained in the Strategic Directions chapter. To better understand this evaluation it is considered important to understand the statutory documents, discussed under Section 2.1 of this report, that have significantly influenced and directed the character and content of this chapter.

The Strategic Directions chapter provides an overarching policy direction for consideration of land use in the District including the land use planning approach to natural hazards. A key strategic direction identified in this chapter, and of relevance to the whole District, is providing for recovery and growth. However, the importance of the Canterbury earthquakes and the consequences of natural hazard events for communities are also highlighted in the chapter. The need for more thorough risk assessment, active management, and avoidance or mitigation, to help ensure that losses from future events are limited is at the forefront of this District Plan Review.

The Strategic Directions chapter clearly sets out that:

a. like much of Aotearoa/New Zealand, the district is vulnerable to natural hazards including flooding, tsunami, earthquakes, slope instability and erosion and recognises that some parts of the district are more vulnerable than others giving rise to the potential for significant harm to people and property;
b. sea level rise and changed ground levels following the earthquakes create increased flooding risks for the district. Climate change is also expected to increase the frequency and severity of storms, resulting in more intense rainfall and flooding, which will be exacerbated by sea level rise; and
c. there is a need to address the nature and consequences of natural hazards (issue 3.4.5) and ensure these risks are managed to acceptable levels.

A key strategic direction is that to enhance the health and well-being of its communities the District must become safe and resilient. To do this people must be:

- protected from unacceptable risks of natural hazards;
- prepared for the future challenges and opportunities of climate change; and
- familiar with the range of tools available to mitigate the adverse effects associated with natural hazards.

The two specific objectives in the Strategic Directions Chapter of particular relevance to the Natural Hazards chapter are:

> 3.6.2 Objective - Development form and function requires an integrated pattern of development and well-functioning urban form, that amongst other things:

i. avoids natural hazards or adequately remedies or mitigates the risks.

3.6.5 Objective - Natural Hazards

i. The risk to people, property and infrastructure from natural hazards is avoided or reduced to acceptable levels.

The Natural Hazards chapter builds on the Strategic Directions chapter with three objectives, which are achieved through a number of policies as follows:

Natural Hazards Objectives and Policies Overview

5.1.1 Objective - Reduced risk Reduced risk to people, property, infrastructure and the environment from the effects of natural hazards, including: a. intense rainfall events causing flooding from rivers, streams, overland flow and lakes; b. liquefaction during earthquake shaking; c. cliff collapse , rockfall or boulder roll, and mass movement; d. tsunami; e. inundation from the sea and storm surge; f. coastal erosion; g. exacerbation of hazards (a) to (f) through climate change and sea level rise; and h. multiple hazards consisting of combinations of the above.	Achieved through: General natural hazard policies 5.2.1 Policy – Avoid development where there is unacceptable or intolerable risk 5.2.2 Policy – Critical infrastructure 5.2.3 Policy – Restrict land use to avoid or mitigate hazards 5.2.4 Policy – Precautionary approach 5.2.5 Policy –Worsening, adding or transferring hazard 5.2.6 Policy – Natural features providing hazard resilience Flooding policies 5.3.1 Policy – High flood hazard 5.3.2 Policy – Flood protection works 5.3.3 Policy - Protection of flood storage and overflow areas 5.3.4 Policy – Flood damage mitigation by raising floor levels Geotechnical risks including liquefaction (flat areas) 5.4.1 Policy – Geotechnical risk including liquefaction susceptibility 5.4.2 Policy – Management of geotechnical risks on flat land Slope instability policies 5.5.1 Policy – Areas subject to an intolerable risk to life-safety from potential cliff collapse 5.5.2 Policy – Areas potentially affected by rockfall or boulder roll 5.5.3 Policy – Areas potentially affected by mass movement 5.5.4 Policy – Slope instability in areas

	not already identified as cliff collapse, rock fall or mass movement (remainder of the Port Hills and Banks Peninsula) 5.5.5 Policy – Hazard mitigation works for slope instability in the Port Hills and across Banks Peninsula Interim Coastal Hazards Policies (to be further considered in Stage 2 of the DPR) 5.6.1 Policy – Climate change and sea level rise Multiple Hazards 5.7 Policy - Multiple natural hazard areas
5.1.2 Objective- Awareness of natural hazards. Increased public awareness of the range and scale of natural hazard events that can affect the District.	Achieved through: 5.2.7 Policy - Awareness of natural hazards
5.1.3 Objective – Repair of earthquake damaged land Repair of earthquake-damaged land used for residential purposes is facilitated as part of the recovery	Achieved through: 5.3.5 Policy – Repair of earthquake-damaged land

Broadly the objectives and policies seek to address the following key resource management issues:

1. A large part of the population and economic activity within the District is established on river flood plains, in areas of liquefaction susceptibility during earthquake shaking, areas of slope instability and areas of coastal erosion and/or inundation. These natural hazard events have damaged property, adversely affected the health and well-being of people, and in some cases resulted in loss of life. It is not expected that these natural hazards will diminish in the future. Consequently, there is a need to find ways to reduce the risk to people, property, infrastructure and the environment from the adverse effects of a range of natural hazards occurring in the district.

2. Hazard mitigation works, if not adequately considered, can cause adverse effects on the environment, sometimes transfer risk of natural hazards to another location, and/or create a false sense of security.

3. Climate change and associated sea level rise is expected to increase the severity of natural hazards in the district and have potentially wide ranging environmental impacts, but there is still uncertainty over the nature and extent of those impacts.

4. The recent Canterbury earthquakes and Christchurch flooding events have revealed a gap in people's perception and awareness of the range and scale of natural hazards affecting the District.

5. A significant proportion of residential land in the City was damaged by the Canterbury earthquakes of 2010 and 2011 and requires minor repairs. Existing regulations did not provide for these earthworks without resource consent. There is an opportunity to provide specifically for repair of residential land damaged by the earthquakes to facilitate recovery.

A table of the linkages between the Strategic Directions Chapter and the Natural Hazards chapter can be found in **Appendix 1**.

1.3 RESEARCH

The Council has commissioned technical advice and assistance from various internal and external experts and utilised this, along with internal workshops and community feedback, to assist with setting of the Plan framework for the proposed Natural Hazards chapter provisions. In the case of the Natural Hazards chapter these documents provide important background in understanding the approaches and options taken and familiarity with these documents is recommended (see **Appendix 2**). The technical advice relied upon includes the following reports:

	Title	Author	Description of Report
a.	Effects of Sea Level Rise for Christchurch City Report for the Christchurch City Council	Tonkin and Taylor Limited November 2013	Updates information contained in the 1999 T & T report titled: Study of the Effects of Sea Level Rise for Christchurch. Recommends a review of the extent of the existing Flood Management Areas and the associated minimum floor levels. Based on sea level rise projections in the report, the minimum floor level is recommended to be set at 12.3m (Christchurch City Council (CCC) datum) allowing for sea level rise of 1m to the year 2115. Recommends the Council develops a city-wide sea level rise adaptation study.
b.	Avon River Sea Level Rise Investigation March 2014	DHI Consultants	Comments on the impact of a change from 0.5m sea level rise to 1m in setting house floor levels in the Avon catchment. Explains modelling methodology for 1 in 200 year rainfall/tidal event plus sea level rise at 0.5m and 1m, and determines number of households affected by the increase (see **Appendix 3**).
c.	Climate Change Case Study: Assessment of the Impacts of Sea Level Rise on Floodplain Management Planning for the Avon River	Harris Consulting in conjunction with Christchurch City Council (2008)	Provides an assessment of the costs of flood damage and cost of mitigation works involving a range of minimum floor levels for flooding in the Avon River catchment under various scenarios (see **Appendix 4**). Provides support that land use planning regulations requiring floor levels to be above 1 in 200 year floor level could be justified in terms of damages avoided exceeding costs in the most flood prone areas studied.
d.	Stormwater modelling consolidation final reports - Styx, Avon and Heathcote River models status reports, 2012 -2014	GHD Consultants	Several reports. Explains modelling process (software etc.) and model development.
e.	Revised guidance on repairing and rebuilding houses affected by the Canterbury Earthquake Sequence:	DBH 2011 - MBIE 2012	Explains technical categories and mapping. Parts A-C are guidance for assessing,

	Parts A – D		repairing and rebuilding foundations. Technical categories and their mapping are explained in Part B (observed land and building performance and future liquefaction expectations). Part D gives guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury region.
f.	Review of liquefaction assessment hazard information in eastern Canterbury, including Christchurch City and parts of Selwyn, Waimakariri and Hurunui Districts	ECan Technical report R12/83, Dec 2012	Identifies a line between "damaging liquefaction unlikely" and "liquefaction assessment needed", which is advanced by ECan as a basis for planning controls.
g.	Canterbury Earthquakes Royal Commission reports Volume 5 Summary and Recommendations	Royal Commission	Ch 5: ECan (or Canterbury Regional Council (CRC)) and CCC - Management of Earthquake Risk and recommendations, including a recommendation that the potential effect of earthquakes, liquefaction and lateral spread should be taken into account in zoning, and in land use and subdivision consents.
h.	Planning for Development of land on or close to Major Faults : A study of the adoption and use of Active Fault Guidelines	GNS 2005	Planning for fault rupture hazards

i.	Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Principles and Criteria for the Assessment of Risk from Slope Instability in the Port Hills, Christchurch	GNS (Taig et al), March 2012	Overview of issues to be considered in establishing a risk-based approach to the management of slope instability hazards affecting people and their property in the Port Hills area of Christchurch following the 2010/11 Canterbury earthquakes.
j.	Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Pilot study for assessing life-safety risk from cliff collapse; GNS Science Consultancy Report 2012/57	GNS (Massey et al) March 2012	A pilot study to assess the risk to life (death) faced by an individual living above or below some of the major cliffs between the suburbs of Redcliffs and Scarborough.
k.	Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Life-safety risk from cliff collapse in the Port Hills; GNS Science Consultancy Report 2012/124	GNS (Massey et al) March 2012	A pilot study to assess the risk to life (death) faced by an individual living below rocky bluffs where life safety is threatened by the hazard of isolated boulders rolling and bouncing at high speed from long distances down slope.
l.	Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Life-safety risk from rockfalls (boulder rolls) in the Port Hills; GNS Science Consultancy Report 2011/123	GNS (Massey et al) September 2012	Report covers additional assessment of the rockfall reports 2011/311 and 2011/123 by further assessing the underpinning assumptions.
m.	Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Stage 1 report on the findings from investigations into areas of significant ground damage (mass movements); GNS Science Consultancy Report 2012/317	GNS (Massey et al), August 2013	Report on mass movement to assist the Council's infrastructure and land use planning in these areas. Further reports on subsequent stages of detailed investigations and assessments of selected mass movement areas are proposed.
n.	Evaluating The Effectiveness and Efficiency of the Christchurch city Plan Project Report	Response Planning Consultants Ltd, Jan 2011	Comments on practice with filling and excavation provisions and waterway setbacks.
o.	Draft Canterbury Civil Defence Emergency Management Plan	May 2013	Contains hazard/risk matrix with likelihood/consequences of particular hazards as assessed for Canterbury

In addition to the above key reports and advice, the Council has compiled, reviewed and utilised a collection of material on Natural Hazards (refer to Bibliography in **Appendix 2**). This information has been fundamental to inform the DPR and this Section 32 report.

1.4 CONSULTATION

During the pre-notification stage of drafting the Natural Hazards chapter, a number of consultation meetings were held.

Appendices 2 and 3 to the Section 32 Overall Introduction describe the consultation undertaken in August - September 2013 and February - March 2014 on the first phase of the DPR.

Consultation with the public on the Natural Hazards chapter focused on the second period, and was led by a forum devoted to Natural Hazards held on 15 March 2014. This was intended to promote understanding of hazards and responses on the draft chapter. The forum, titled *Our Changing Environment – the risks and challenges of living with natural hazards*, was run by the Council and supported by the Canterbury Earthquake Recovery Authority (CERA) and Environment Canterbury, and was attended by over 150 people. At this forum, risk and geotechnical experts and the Council's technical, operational and planning staff addressed the public about hazards and risks, the science behind measuring risk and probabilities, land instability and flooding and how the DPR might help address these issues.

In the two weeks following six ward-based consultation meetings, which covered natural hazards, were held at community venues across the Christchurch district (see section 6 of this report for details), and a further meeting was held with runanga. The consultation period for written and on-line responses on the chapter, and an online survey focusing on Natural Hazards, was open from mid-March.

Key messages so far from the public and general stakeholder sessions relevant to the Natural Hazards chapter include:

i. what is the Council going to do about sea level rise – will areas be identified for retreat? Need for certainty. All natural hazard issues should be addressed together in the DPR;
ii. concern about flooding issues generally and what the shorter and longer term solutions are. Suggestions for physical flood protection works, for example, dredging and stopbanks on the Heathcote River;
iii. need for more attention to be paid to Banks Peninsula flooding;
iv. that the areas for proposed intensification will not be able to cope in terms of stormwater infrastructure;
v. may not be appropriate to develop greenfields areas such as Sparks Road which are already prone to flooding;
vi. requests to remove specific properties from Port Hills instability hazard areas; and
vii. lack of clarity as to whether utilities will have to comply with Natural Hazards rules, especially in relation to areas of land instability.

Meetings were also held with staff from CERA, Environment Canterbury and Mahaanui Kurataiao Limited, and the Ministry of Business, Innovation and Employment (MBIE) during the preparation of the draft chapter, to outline the direction of the chapter and invite their feedback. Matters raised in the context of the Natural Hazards chapter included:

i. high hazard areas (deepest and swiftest flowing parts of 1 in 500 year flood event areas) should be identified in the Plan;
ii. identify areas potentially subject to 1 in 200 year flood events (major flood events) across the whole city;
iii. concern about differing information requirements between areas subject to a greater or lesser degree of potential liquefaction; and
iv. rockfall issues at Rapaki settlement.

A Collaborative Agency Group comprising representatives of the Canterbury Regional Council, Selwyn District Council, Waimakariri District Council, CERA, New Zealand Transport Agency, Ngai Tahu and the Ministry for Environment (in an advisory role), provided feedback in late 2013 and early 2014 as follows:

i. support for the idea of using an allowance for 1 metre sea level rise within the next 100 years in all flood modelling;
ii. support for making building in Flood Management Areas permitted subject to minimum floor levels, wherever possible;
iii. allow recession plane breaches to be permitted if a result of raised floor levels;
iv. add alternative mitigation options to raising floor levels;
v. further relaxation of the land repair provisions;
vi. explain risk approaches and explain/define terms such as unacceptable, acceptable, intolerable and heightened risk, and significant natural hazard; and
vii. linkages between this chapter and other relevant chapters, for example, Subdivision.

2. RESOURCE MANAGEMENT ISSUES

The resource management issues set out in this section have been identified mainly from the following sources:

a. the current operative City Plan and Banks Peninsula Plan;
b. primary and secondary research (refer **Appendix 2** Bibliography);
c. public engagement;
d. matters raised throughout the draft preparation process by statutory partners (Collaborative Advisory Group and Christchurch Joint Officials Group); and
e. the strategic planning documents outlined below and in particular the Canterbury Regional Policy Statement, 2013 (CRPS).

The following Section 2.1 Strategic Planning Documents is fundamental to understanding the Natural Hazards chapter of this DPR, more so than perhaps the other chapters. There is considerable overlap in functions of various government and local authorities in terms of responsibilities in dealing with natural hazards and the interdependencies are reasonably complex. While the Resource Management Act 1991 (RMA) is the main statute for the preparation of a district plan and works, alongside provisions in the Local Government Act 2002 that require district councils to consult in respect to their decision making functions, the recent Canterbury earthquakes have added further to this complexity and put natural hazards at the forefront in both the public and private sectors. Since 2011 the Council has been required to also comply with s 15(1) and 23 of the Canterbury Earthquake Recovery Act 2011 (CER Act) and to ensure the District Plan is not inconsistent with the Recovery Strategy (CERS) and the LURP.

There has also been discussion at a national level of elevating the management of natural hazards to a matter of national importance under s 6 of the RMA as part of the Stage 2 reforms. However, this has recently been placed on hold by the Government.

2.1 STRATEGIC PLANNING DOCUMENTS

Many issues are of a strategic nature and therefore consideration has been given to the strategic policy direction in higher order documents.

Those strategic matters and provisions that have been specifically given effect to or have had regard to in this chapter are summarised in the table below. These documents provide the higher level policy direction in respect to the resource management issues to be addressed.

It is important to note the Strategic Directions chapter also contains higher order objectives and policies to reflect the outcomes sought in the strategic planning documents. An assessment of these objectives and policies is contained within the Section 32 Strategic Directions report. Those objectives and policies within the Strategic Directions chapter relied on in this chapter are discussed in section 5 (Evaluation of Objectives).

	Document	**Relevant provisions**	**How the Natural Hazards chapter will take into account/give effect to the relevant provisions**
a.	RMA, Part 2, Section 5	*(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.* *(2) In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while –…* *(c) Avoiding, remedying or mitigating any adverse effects of activities on the environment.*	The purpose of the Act includes managing natural and physical resources to provide for the health and safety of people and communities while avoiding, remedying or mitigating any adverse effects of these activities on the environment. The first phase of the Natural Hazards chapter addresses the actual and potential adverse effects of flooding, liquefaction and slope instability on subdivision, use and development focusing on the impact of these hazards and on the health and safety of people and communities, including its economic impact.
b.	RMA, Part 2, Section 7	*Other matters* *In achieving the purpose of this Act… shall have particular regard to –* *(i) the effects of climate change…*	Climate change is addressed in this phase of the chapter in Objective 5.1.1, Policy 5.3.4(a) and Policy 5.6.1 and through the use of 1.0m Sea Level Rise in establishing minimum floor levels for Floor Level and Fill Management Areas. However, climate change will be more fully addressed in the Coastal chapter of the DPR in Phase 2.
c.	RMA Section 2	***Natural hazard*** *means any*	The definition of natural hazard

	interpretation	*atmospheric or earth or water-related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment:*	in the RMA is very wide, with Phase 1 of the chapter dealing primarily with earthquake, landslip, subsidence and flooding.
d.	RMA, Part 4, Section 31	*Section 31(1) Every territorial authority shall have the following functions for the purpose of giving effect to this Act in its district:* *(a) the establishment, implementation, and review of objectives, policies, and methods to achieve integrated management of the effects of the use, development, or protection of land and associated natural and physical resources of the district:* *(b) 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.*	Both regional and district councils have jurisdiction over control of land use for the purpose of avoidance or mitigation of natural hazards (s31(1)(c)(iv) and s31(1)(b)(i)). This subsection of the Act is a mandate for this chapter of the DPR. The objectives, policies and rules of this chapter are focused primarily on the control of the effects of land use for the purpose of avoiding or mitigating of natural hazards.
e.	RMA, Section 31 the Act	*(1) Every local authority shall gather such information, and undertake or commission such research, as is necessary to carry out effectively its functions under this Act [or regulations under this Act].* *(2) Every local authority shall monitor –* *[(a) the state of the whole or any part of the environment of its region or district –* *(i) to the extent that is appropriate to enable the local authority to effectively carry out its functions under this Act.*	This section of the Act effectively requires the Council to gather information and hold records of areas subject to natural hazards, because of its function of controlling the effects of the use and development of land to avoid or mitigate natural hazards under s 31.
f.	Local Government and Official Information and Meetings Act (LGOIMA)	Under this Act the Council is required to provide for the avoidance or mitigation of natural hazards. This includes the preparation of the Long Term Plan (LTP) including	The objectives, policy and rule framework in the Natural Hazards chapter has been developed with a longer planning horizon in mind than the LTP, but carefully recognises

		financial strategies for asset management planning over a ten-year planning period. This involves maintenance of network infrastructure, flood protection, flood control works and setting the level of event that network infrastructure will be designed and maintained to withstand. The Local government Act 2002 (LGA) also has specific requirements for consultation and provision of information as part of the Councils decision-making functions.	the role of the Council to provide for the avoidance or mitigation of natural hazards at an operational level (albeit over a shorter planning framework). The Natural Hazards chapter provides a planning mechanism for high magnitude low frequency events such as a 1 in 200 year rainfall flood event whereas it would be too costly or impractical for operational works to provide for this level of service over the whole district.
g.	The Canterbury Regional Policy Statement (CPRS)2013	Chapter 6, (Objective 6.2.1.(8): *…enabling a land use and infrastructure framework that; (8) protects people from unacceptable risk from natural hazards and effects of sea level rise*. Policy 6.3.3 on Development in accordance with outline development plans includes a requirement to: *(11) Show how the adverse effects associated with natural hazards are to be avoided, remedied or mitigated as appropriate and in accordance with Chapter 11 and any relevant guidelines*.	The Proposed District Plan must give effect to the CRPS. Chapter 6 of the CRPS (introduced via the LURP) sets out the intended land use distribution for Greater Christchurch for the period to 2028, and includes an objective of protecting people from unacceptable risk from natural hazards. This includes considering hazards in Outline Development Plans (ODPs). There are, however, no guiding policies about managing or reducing risk in existing urban areas. The Natural Hazards chapter provides a framework of objectives, policies and rules to protect people from unacceptable risk from natural hazards, including avoidance policies where the risk is considerable, to the provision of controls over the type of development where mitigation is likely to be effective. The Natural Hazards chapter therefore addresses situations where information or research suggests that risks associated with the hazard could be intolerable or unacceptable to people (see Policy 5.2.1 and 5.2.3). These policies are supported by rules applying a non-complying or prohibited

			activity status for new building activities in some slope instability management areas and discretionary control over other activities where the risk is lower and/or mitigation is possible. A permissive rule regime is also provided for in Floor Level and Fill Management Areas where the minimum finished floor levels of new development are able to be raised above the 1 in 200 year flood event.
h.	The Canterbury Regional Policy Statement (CPRS)2013	Chapter 11 – Natural Hazards: titles of objectives and policies only Objective 11.2.1 – Avoid new subdivision, use and development of land that increases risks associated with natural hazards Objective 11.2.3 – Climate change and natural hazards Policy 11.3.1 – Avoidance of inappropriate development in high hazard areas Policy 11.3.2 – Avoid development in areas subject to inundation Policy 11.3.3- Earthquake hazards Policy 11.3.4 – Critical infrastructure Policy 11.3.5 General risk management approach Policy 11.3.6 – Role of natural features Policy 11.3.7– Physical mitigation works Policy 11.3.8 – Climate change Policy 11.3.9 – Integrated management of and preparedness for natural	All the objectives and policies in this chapter of the CRPS are relevant to the DPR Natural Hazards chapter. A large proportion of Chapter 11 is devoted to managing the adverse effects and risks associated with natural hazards particularly flooding and inundation (Objective 11.2.1 and Objective 11.2.3, and Policies 11.3.1, 11.3.2 and 11.3.4.). Policy 11.3.2 in the CRPS directs subdivision, use and development be avoided in areas subject to 1 in 200 year flood event but provides for mitigation as an alternative in circumstances where there is no increased risk to life. Where this criterion is met finished floor levels for new buildings are required to be above a 1 in 200 year design flood level. The Floor Level and Fill Management Area overlay included in the Natural Hazards chapter gives effect to these provisions. Policy 11.3.1 in the CRPS is currently being revised in regard to high flood hazard areas under LURP Action point 46. The policy generally requires avoidance of development in high hazard areas but provides limited provision in existing urban zoned areas for mitigation to occur. The Natural Hazard Chapter gives effect to this policy by

		hazards.	directing that subdivision and new development be avoided in high flood hazard areas (Policy 5.3.1). Currently in this phase of the DPR high flood hazard areas are only identified in the rural area south of the Waimakariri River. The policy will need to be amended should high flood hazard areas be identified in the urban part of the district in Phase 2, in order to remain consistent with Policy 11.3.1. The provision in the CRPS most relevant to liquefaction is Policy 11.3.3, which requires that new subdivision use and development on land close to an active fault trace or in areas susceptible to liquefaction and lateral spreading, be managed in order to avoid or mitigate the adverse effects. Policies 5.4.1 and 5.4.2, the Rules in Section 5.9 and information requirements provided in the Natural Hazards chapter give effect to this. There is little specific discussion of slope instability in the CPRS chapter; however Policies 11.3.5 and 11.3.7 are relevant. Policy 11.3.5 directs that subdivision, use and development of land shall be avoided if the risk from the natural hazard is considered to be unacceptable. When there is uncertainty in the likelihood or consequences of a natural hazard event, the local authority shall adopt a precautionary approach. Policy 11.3.7 states that *…new physical works to mitigate natural hazards will be acceptable only where the natural hazard risk cannot reasonably be avoided…* Policy 5.2.4 of the Natural Hazards chapter sets out a precautionary approach where there is uncertainty, multiple

			hazards or a potential for serious or irreversible effects. Policy 5.5.5 and the rules in 5.10 implement a control regime for hazard mitigation works, which give effect to the policies in Chapter 11 of the CRPS.
i.	The Canterbury Earthquake Recovery Act 2011 (CER Act)	The purposes of the Act in s 3 include: *(f) to facilitate, co-ordinate, and direct the planning, rebuilding, and recovery of affected communities, including the repair and rebuilding of land, infrastructure, and other property.* Section 11 provides for the development of a Recovery Strategy, s 15 provides that no RMA instrument shall be inconsistent with this and s 23 provides that Councils may not make an RMA decision that is inconsistent with a Recovery Plan.	The CER Act is the overarching legislation which provides the government with statutory powers to direct recovery from the earthquakes. The Natural Hazards chapter is consistent with the section 15 and 23 requirements in respect of the review of the District Plan, as it is consistent with the Recovery Strategy and with the LURP (see below).
j.	The Canterbury Earthquake Recovery Strategy (CERS).	Section 4 and 5 state: *(i)* Section 4*–Visions and goals-Built environment recovery - 5. Develop resilient, cost effective, accessible and integrated infrastructure, buildings, housing and transport networks by: 5.7 drawing on sound information about ongoing seismic activity and environmental constraints, including other natural hazards and climate change…;* and *(ii) Section 5 Priorities This strategy identifies the following priorities to address and promote social, economic, cultural and environmental well-being. People's safety and well-being by: enabling people, particularly the most vulnerable, to access support;* and *addressing the risk to life posed by unsafe buildings and from natural hazards…*	This Recovery Strategy is the document that guides and coordinates the programmes of work, including Recovery Plans, under the CER Act. The District Plan must not be interpreted or applied in a way that is inconsistent with the Recovery Strategy. The Recovery Strategy states that CERA, the public and private sector and communities need to co-ordinate with each other and contribute to the recovery and future growth of greater Christchurch, by considering the effects of ongoing seismic activity, and addressing natural hazard risks. The Natural Hazards chapter is consistent with this.
k.	The Land Use Recovery	*Action 42: Christchurch City*	The LURP prepared under the

	Plan (LURP)	*Council District Plan Review Christchurch City Council to enable in the next review of its district plans, to provide for protection of people from risks in 'High Hazard Areas' (as defined in the Regional Policy Statement) and other risks from natural hazards, including, but not limited to, natural hazards such as rock roll and cliff collapse on the Port Hills and natural hazards such as flooding, liquefaction and sea level rise elsewhere in the city.* *Action 43: Councils to encourage and support the provision of geotechnical data and groundwater data, assessments and building information to the Canterbury Geotechnical Database (currently administered by CERA).* *Action 2 requires the Council to provide opportunities reduce consenting, in situations where it is appropriate, to facilitate recovery.*	CER Act 2011 requires the Council to provide for the avoidance of hazards via Action 42. Action 43 requires encouragement of provision of geotechnical data to the Canterbury Geotechnical Database, but does not require it. The Natural Hazards chapter provides a statutory policy and rule framework for the protection of people from risks from natural hazards such as rock roll and cliff collapse, flooding, and liquefaction. A policy framework is initiated in this phase in respect to high flood hazard which will be further implemented in Phase 2 of the DPR. Action 43 is implemented in the Natural Hazards chapter by the information requirements in Clause 5.11. Action 2 is implemented in the Natural Hazards chapter by providing permitted activity status where appropriate standards can be met, thus avoiding the cost and potential delay associated with resource consent processing.
l.	The Mahaanui Iwi Management Plan (IMP)	This plan does not comment on natural hazards but does comment on subdivision, use and development including quarrying and vegetation clearance which have the potential to exacerbate natural hazards and compromise tangata whenua values including for freshwater.	While siltation and effects on water quality are not specifically addressed in the Natural Hazards chapter policies in respect to the protection of natural features which provide resilience against the effects of natural hazards from inappropriate subdivision, use and development indicate that appropriate regard has been given to the IMP.
m.	New Zealand Coastal Policy Statement (NZCPS) 2010	The policies most relevant to district plans in the NZCPS are: Policy 24:Identification of coastal hazards Policy 25:Subdivision, use and development in areas of coastal	The NZCPS contains higher order policies that bind both the CRPS and the District Plan. They require the identification of areas in the coastal environment that are potentially affected by

		hazard risk Policy 26: Natural defences against coastal hazards Policy 27: Strategies for protecting significant existing development form coastal hazard risk.	coastal hazards, especially those at high risk of being affected by coastal hazards over at least the next 100 years, they require avoidance of increasing the risk of harm from coastal hazards and avoidance of redevelopment or change of use that would increase the risk. Natural Hazards chapter Policy 5.6.1 (Interim policy for coastal hazards) requires that intensification of built development in areas projected to be subject to inundation as a result of sea level rise be avoided. Further work on the coastal environment and coastal hazards will be implemented in Phase 2 of the DPR.
n.	Civil Defence and Emergency Management Act 2002 (CDEM ACT)	The CDEM Act has as two of its purposes the sustainable management of hazards, and encouraging and enabling communities to achieve acceptable levels of risk. Another purpose is to require local authorities to co-ordinate emergency management across the areas of: • Reduction (of risk); • Readiness (for an event); • Response (when an event occurs); and • Recovery (post event)	The framework of objectives and policies and package of rules implementing land use controls in the Natural Hazards chapter are an important means to reduce the risk to people and communities associated with natural hazards. The chapter also includes maps showing land/properties that are exposed to natural hazards through a series of natural hazard overlays, which are an important means of improving awareness.

2.2 Reduced Risk from Natural Hazards

RESOURCE MANAGEMENT ISSUE 1 – A large part of the district is established on river flood plains, in areas of liquefaction susceptibility during earthquake shaking, areas of slope instability and areas of coastal erosion and/or inundation. These natural hazard events damage property, can adversely affect the health and well-being of people, and in some cases can result in loss of life. It is not expected that these natural hazards will diminish in the future. In fact, with climate change and sea level rise some natural hazards may increase. Consequently there is a need to find ways to reduce the risk to people, property, infrastructure and the environment from the adverse effects of a range of natural hazards occurring in the district.

All cities and districts face natural hazard issues in varying degrees and the need to build resilience for the future. In this respect, Christchurch is no different but with the earthquakes of 2010 and 2011 there is a heightened awareness of the destructive consequences of natural hazard events.

Natural hazards are the result of natural processes that form, shape and alter the environment and are any atmospheric, earth or water-related occurrence that adversely affects or may adversely affect human life, property or the environment. In Christchurch and Banks Peninsula they include earthquakes, tsunami, erosion, landslips, subsidence, sedimentation, wind, drought, fire and intense rainfall events causing flooding from rivers, streams, overland flow and the sea.

Natural hazard risk is the likelihood or probability of a natural hazard event occurring combined with its impact or consequences for people, property and the environment. The likelihood of some natural hazards events occurring within a 100 year planning timeframe for example, can range from the very rare (e.g. large earthquakes or tsunami) to likely or almost certain (e.g. floods) but with any event being able to occur at any time.

The potential consequence of any natural hazard event depends on the susceptibility or resilience of the community and land use within the affected area. For example, deep flooding in an open pasture makes the land unusable for a period but overall the impact is low. If the open field contains urban development, critical infrastructure or a hospital and housing then the impact of the same flood event would be high with critical health services unavailable, people's lives in danger and significant property damage. In this second situation the natural hazard risk is considerably higher.

With some natural hazards one effective and efficient method of protecting people from the threat of serious injury, loss of human life and significant property damage, is to avoid development in those areas (e.g. areas of potential cliff collapse). However, there are other areas where mitigation measures are both an effective and cost efficient means of reducing the risk to people property, infrastructure and the environment. A key issue for this District Plan is to carefully identify the areas where a mitigation policy approach will be sufficient to reduce the natural hazard risk from areas where development should be avoided.

Flooding

While much of the flooding occurring in Christchurch is generally shallow and more of an inconvenience than a risk to life, more major events, such as the flooding in March 2014, resulted in greater depths of flooding and damage to property. Damage increases significantly when floodwaters enter houses. Climate change resulting in an increased probability of more intense storm events when combined with changes to ground surface as a result of the earthquakes, increases the future level of flood risk in large areas of Christchurch, both in terms of likelihood and consequences.

Smaller scale flood events are dealt with by the primary drainage system of pipes, waterways and detention areas, which are designed to cope with up to between a 5 and 10 year event. For more extreme and less frequent events, and when there are blockages in pipes and drains, secondary flow paths operate through a system of open channels, controlled flood plains and natural ponding areas. The secondary drainage system is designed to convey floodwaters without inundation hazard to house floors and building platforms at least to the 1 in 50 year storm; the Building Act 2004 requires floor levels to be above these levels.

For the larger events, such as a 1 in 200 year flood event, a higher level of protection is required to be provided for in the Natural Hazards chapter through statutory provisions under RMA and the CRPS.

Slope Instability

The Canterbury earthquakes of 2010 and 2011 damaged many properties on the Port Hills area of Christchurch and resulted in the deaths of five people. Hundreds of property owners and occupiers have not been permitted to occupy their homes on the Port Hills following the February 2011 earthquake event either because the damage to their homes makes them uninhabitable or because the risk posed by slope instability hazards or other unstable buildings renders them unsafe to occupy.

The slope instability hazards that contributed to this damage and loss of life were present across the Port Hills and wider Banks Peninsula prior to the 2010–2011 earthquakes.

Since the 2010–2011 earthquakes the Council has been working with engineers and geologists with geotechnical expertise to better understand slope instability hazards in the Port Hills and the risk these hazards present to human life. Investigations commissioned by the Council and undertaken by the Institute of Geological and Nuclear Sciences Limited (GNS) have been described in a number of reports and used to inform the management regime proposed for slope instability hazards in the Natural Hazards chapter. These reports have been extensively peer reviewed by national and international experts (see Section 1.3 of this report and **Appendix 2** for those key reports used to inform this chapter).

The GNS reports include estimates of the life-safety risk (or risk of death) to people living on discreet areas of the Port Hills. The reports map areas subject to life-safety risk from cliff collapse, rockfall or boulder roll and mass movement. The research into mass movement also considers the risk to infrastructure.

This level of investigation has not been undertaken for the remainder of hilly areas of

the Port Hills and the wider Banks Peninsula District which are relatively sparsely populated in comparison. Where there is an absence of research, the GNS research for the Port Hills has been used to inform assumptions about the potential for slope instability hazards across remaining hilly areas of the District.

Liquefaction

Liquefaction is one effect resulting from ground shaking during earthquakes. Liquefaction of soils causes:

1. the ground to compact and for the ground surface to lower;
2. the ground to crack and for fine grained soil material and water to be ejected causing deposition and flooding; and
3. lateral spreading, where 'blocks' of land move sideways causing cracking and ground surface deformation.

A significant part of Christchurch (the plains area) has the potential to be affected by liquefaction.

The impacts of liquefaction on Christchurch include subsidence and tilting of structures, foundation and structural deformation and damage to structures, and flooding of and deposition of silt in structures. Buried services and structures are also damaged through ground deformation from lateral spreading and subsidence. Liquefaction also causes direct damage to the natural environment through the deposition of sediment and flooding, and potentially indirectly through exposing buried hazardous materials.

Life safety is generally not a significant liquefaction issue unless there is catastrophic failure of a building or structure caused by liquefaction, or liquefaction along transport routes causes a fatal vehicle accident.

An environment free from the risk of liquefaction hazards in this district cannot be reasonably expected. The proposed District Plan provisions will need to address liquefaction as a hazard in a manner that will ensure that the level of risk is understood and is acceptable. The overall and long-term outcome is that the risk from liquefaction will be minimised.

2.3 Managing the effects of hazard mitigation works

RESOURCE MANAGEMENT ISSUE 2 – Hazard mitigation works, if not adequately considered and managed, can cause adverse effects on the environment, sometimes transfer risk of natural hazards to another location, and/or create a false sense of security.

Hazard mitigation works are one potential means of reducing risk associated with a wide range of natural hazards. However, their construction, operation and ongoing requirements for maintenance can lead to a host of other problems and issues if not properly considered.

A key issue for this District Plan is to carefully formulate a hazard mitigation works policy approach that is effective in reducing the risk of natural hazards but does not transfer risk elsewhere or create additional adverse effects or unintended consequences, including unacceptable costs to the community.

2.4 Public awareness of the range and scale of natural hazards

RESOURCE MANAGEMENT ISSUE 3 – The recent Canterbury earthquakes and Christchurch flooding events have revealed a gap in people's perception and awareness of the range and scale of natural hazards affecting their properties and the district as a whole.
A community which is aware and informed about the range and scale of natural hazards present where they live, work and play is likely to be better prepared to cope with natural hazard events when they occur, more likely to invest in measures to mitigate the potential damages from events and to be more responsive to warnings of natural hazard events. Overall increased awareness is likely to lead to a more resilient community when dealing with natural hazards. Most people have a range of other things in their lives than considering natural hazards and so the manner and techniques used to raise awareness within a community must be adjusted accordingly. Much of this awareness is achieved by the Council through its responsibilities under the LGA and for Civil Defence and Emergency Management. The District Plan is also an important mechanism for improving public awareness of natural hazards. How exposure to potential natural hazards in parts of the district are incorporated into land use planning and shown on the planning maps is a fundamental issue for this DPR. There is also a need to increase engagement across organisations to ensure integration between CDEM and natural hazards planning functions in communicating risk.

2.5 Repair of earthquake damaged residential land

RESOURCE MANAGEMENT ISSUE 4 – A significant proportion of residential land in the City was damaged by the Canterbury earthquakes of 2010 and 2011 and requires minor repairs. Existing regulations did not provide for this work without resource consent. There is an opportunity to provide specifically for repair of residential land damaged by the earthquakes to facilitate recovery.
Under the CER Act, in 2013 the Minister for Earthquake Recovery made changes to the Operative City Plan to provide for filling for the repair of land used for residential purposes. Previously within Flood Management Areas filling and excavation required resource consent. Filling and excavation within defined volume limits has occurred as part of the repair of earthquake damaged residential land since 2013. The experience of the Earthquake Commission with land repair is that there are no significant adverse effects and that these provisions should be continued as a permitted activity within the proposed Floor Level and Fill Management Areas to facilitate earthquake recovery.

2.6 Accommodating the effects of climate change and associated sea level rise

RESOURCE MANAGEMENT ISSUE 5 – Climate change and associated sea level rise is expected to increase the severity of natural hazards in the district and have potentially wide ranging environmental impacts. While there is still uncertainty over the nature and extent of those effects they need to be accommodated in long term land use planning.
Climate change, and in particular any associated sea level rise, is predicted to exacerbate the effects of some natural hazards across the district including flooding, storm surge and coastal inundation. The effects of sea level rise are likely to impact coastal communities to a greater extent than elsewhere in the district. While these issues will be dealt with in more detail in Phase 2 of the DPR they are a key issue for the priority chapters of the DPR to enable the development of an integrated natural hazard policy framework. Determining an appropriate allowance for sea level rise is also critical for the detailed flood modelling required to understand the likely extent of the City's exposure to this hazard.

3. SCALE AND SIGNIFICANCE EVALUATION

The level of detail undertaken for the evaluation of the proposed District Plan provisions has been determined by an assessment of the scale and significance of the implementation of the proposed provisions. The scale and significance assessment considers the environmental, economic, social and cultural effects of the provisions and in making this assessment regard has been had to the following, namely whether the provision:

a. is of a regional or city-wide significance and whether the provision is predetermined by a higher order document;
b. is important to resolve an issue or problem particularly to protect life and property; and/or
c. has a wide range of policy options or only variations of a theme; or
d. the policy direction will radically change from current provisions; and/or
e. will affect reasonable use of land; and/or
f. adversely impact those most directly affected or those with particular interests including Maori (consideration needs to be given to whether there is certainty of effects based on the availability of information to assess benefits and costs); and
g. will directly assist in the City's recovery.

3.1 Objectives, policies and rules

The key objective contained within this chapter focuses on the outcome of achieving reduced risk from the effects of natural hazards (Objective 5.1.1). This objective is largely reflective of objectives contained within the CRPS and the proposed Strategic Directions chapter, but has also been influenced by the provisions in the Civil Defence and Emergency Management Act 2002.

The objectives and associated policy provisions and rules of the Natural Hazards chapter are significant for the Christchurch district. They are designed to manage natural hazards so as to avoid situations where people put themselves, their property and critical infrastructure at unacceptable levels of risk from flooding hazards or intolerable levels of life-safety risk from cliff collapse, rockfall or mass movement. For individual property owners and occupiers, and other organisations such as the insurance industry and various service providers the provisions are significant while Christchurch makes the ongoing shift to becoming more resilient over time. In some circumstances, such as identified cliff collapse areas, future development rights will be significantly affected.

For areas subject to major flood events (i.e. 1 in 200 year flood events) policy provisions supported by rules propose reducing or mitigating the consequences of flood hazards by raising the floor levels of new buildings and additions to existing buildings.

The need for such provisions and the scope and detail of some are predetermined by higher order documents, principally Chapter 11 – Natural Hazards, Objective 11.2.1, 11.2.2, 11.2.3 and 11.2.4 of the CRPS, but also the NZCPS, CERS and LURP. It is noted that while there were already Flood Management Areas in the operative City Plan, the extent of these areas is proposed to increase substantially.

Overall, it is considered that the Natural Hazards chapter contains provisions of considerable

significance to the City and will directly assist its recovery from the earthquakes of 2010-2011. It will, however, also result in a more resilient city and assist recovery in future natural hazard events. The proposed provisions are important to resolve problems relating to the protection of life and property as per point b. above. The policy framework and rules in respect to slope instability on the Port Hills and Banks Peninsula are a significant change from the provisions in the existing operative City Plan and the BPDP.

Approach to Flood Risk in the District Plan and District Plan Review

Flood events in Christchurch are generally of shallow depth and while inconvenient pose no risk to life. More major events can result in greater depths of flooding and damage to property, which increases significantly when floodwaters enter houses. Changes to ground surface as a result of the earthquakes, coupled with climate change (causing, for example, more intense storm events) may increase the future level of flood risk in large areas of urban Christchurch, both in terms of likelihood and consequences. The draft Canterbury Civil Defence Emergency Management Plan 2014 classifies flooding as a high priority hazard because flooding is 'likely' (will probably occur in most circumstances) and will have at least moderate consequences.

Planning measures for flooding are primarily focused on larger scale flood events and in controlling future development to reduce risk. As such land use planning fits neatly within the Risk Reduction element of the Civil Defence Four Rs – Risk Reduction, Readiness, Response and Recovery.

Smaller scale flood events are dealt with by primary drainage infrastructure (pipes and detention areas), which are designed to cope with up to a 5 and 10 year event. For more extreme and less frequent events, secondary flow paths operate through a system of open channels, controlled flood plains and natural ponding areas. The secondary drainage system is designed to convey floodwaters to prevent inundation above house floors and building platforms at least to the 1 in 50 year storm. The Building Act 2004 requires floor levels to be above these levels.

It is not always practical or desirable to engineer a system to deal completely with the risk of flooding from events exceeding the 1 in 50 year storm event. This is because there is often not enough open space within the urban area to accommodate the flood waters and the costs of hard engineering solutions is often prohibitive. However some engineered flood protection has been designed to higher levels in Christchurch, for example, the stopbanks along the Avon were designed to protect developed areas from significant tidal flooding in up to a 1 in 100 year event.

In Christchurch the statutory direction under the CRPS is to achieve a higher level of protection than provided through the Building Act 2004. Policy 11.3.2 in the CRPS directs that subdivision, use and development be avoided in areas subject to 1 in 200 year flood event but provides for mitigation as an alternative in circumstances where there is no increased risk to life. Where this criterion is met finished floor levels for new buildings are required to be above a 1 in 200 year design flood level. The Floor Level and Fill Management Area overlay proposed in the Natural Hazards chapter gives effect to these provisions.

More specific consideration will be given in Phase 2 of the DPR to the risk represented by the depth and velocity of flood waters in more extreme events (i.e. 1 in 500 year flood events) as required by Policy 11.3.1 of the CRPS.

History of planning provisions on flooding

The Christchurch City Council has a history of planning provisions relating to flood hazard dating back to the proposed City Plan in 1995, which included measures to restrict development in identified ponding areas such as Henderson's Basin and Lower Styx, in order to mitigate downstream flooding.

Variation 48 was notified by the Christchurch City Council in December 2003. It contained a package of measures relating to managing the potential effects of flooding and inundation in Christchurch. It had originated as two separate draft variations, one updating earlier ponding area provisions and protecting the hydraulic functioning of these areas and life and property within and beyond them, and the other identifying Flood Management Areas within which minimum floor levels at or above 1 in 200 year levels were identified as a mitigation measure. These two variations were brought together as one variation before public notification.

Variation 48 was a response to an appeal lodged in 1999 by the Canterbury Regional Council on the City Plan flood protection provisions, seeking amongst other things greater recognition of the implications of sea level rise. The parties had agreed that the 1 in 50 year flood floor levels required under the Building Act for residential buildings were inadequate for 'future proofing' many of Christchurch's low lying areas from flooding. In addition, an economic assessment had shown that the costs of requiring a 1 in 200 year flood floor level for new building could be justified in terms of damages avoided in the most flood prone areas (see **Appendix 4**).

At the time the accepted understanding was that the Building Act did not allow for consideration of sea level rise in setting floor levels. An RMA solution was proposed via Variation 48, where defined areas of the City in the most flood prone areas (mapped on the Planning Maps as Flood Management Areas or FMAs) would have 1 in 200 year flood event minimum floor levels applied to new development. To deal with sea level rise issues an extra allowance for up to 0.5m for Sea Level Rise out to 2100 was added to the calculations.

Under Variation 48, industrial and commercial buildings in the most flood prone areas were made subject to the same minimum floor levels as residential buildings. At the time that Variation 48 was proposed, it was anticipated that minimum floor levels would be raised only gradually as redevelopment or infill occurred. It should be noted that flood modelling under Variation 48 was based on a banks down scenario and therefore did not take into account the presence of stopbanks, for example alongside the Lower Avon River. This was because it was considered that liquefaction could result in the failure of stopbanks in a large earthquake event; in any case the stopbanks had originally been built only to a 1 in 100 year design standard and would be overtopped in larger events.

Variation 48 took a number of years to make its way through the RMA process at the Council and appeal levels, and to become operative. A final decision was issued by the Environment Court in 2009, essentially confirming the Council's approach with some minor rule amendments.

Approach to Slope Instability in the District Plan Review

Since the 2010-2011 earthquakes the Council has been working with engineers and geologists with geotechnical expertise to better understand slope instability hazards in the Port Hills and the risk these hazards present to human life. Investigations commissioned by the Council and undertaken by the Institute of Geological and Nuclear Sciences Limited (GNS) have been described in a number of reports and used to inform the management regime proposed for slope instability hazards in the Natural Hazards chapter. These reports have been extensively peer reviewed by national and international experts (see Section 1.3 of this report and Appendix 2 for those key reports used to inform this chapter).

The GNS research has also been informed from both central government and local government statutory responsibilities. The Canterbury Earthquake Recovery Authority under the CER Act has used this research to inform the creation of the Red Zone on the Port Hills, for properties at risk from cliff collapse and/or rockfall or boulder roll. The Council has used the research findings to inform its responsibilities under the Building Act 2004 (relating to s 124 notices and building consent applications) and the RMA.

The GNS reports include estimates of the life-safety risk (or risk of death) to people living on discreet areas of the Port Hills. The reports map areas subject to life-safety risk from cliff collapse, rock fall or boulder roll and mass movement. The research into mass movement also considers the risk to infrastructure.

This level of investigation has not been undertaken for the remainder of hilly areas of the Port Hills and the wider Banks Peninsula District which are relatively sparsely populated in comparison. Where there is an absence of research, the GNS research for the Port Hills has been used to inform assumptions about the potential for slope instability hazards across remaining hilly areas of the district.

The approach in the Natural Hazards chapter has been to translate the GNS reports into mapped slope instability management areas on the Port Hills for cliff collapse, rockfall, mass movement and the remainder of the Port Hills (less work has been carried out on the latter) and establish a policy framework based largely on avoidance of future development where an intolerable life safety risk (risk of death) has been determined (defined in the reports as being an annual individual fatality risk of 1 in 10,000 **or greater**). Stringent policies and controls that provide for some future development are applied where the life safety risk is not intolerable, but is heightened or tolerable (defined generally as an annual individual fatality risk of less than 1 in 10,000 (or $1x10^{-4}$).

4. EVALUATION OF OBJECTIVES

Section 32(1) (a) of the RMA requires the Council to evaluate the extent to which the objectives are the most appropriate way to achieve the purpose (Section 5) of the Act.

4.1 Evaluation of Proposed Objectives

The objective and policy approach for the Natural Hazards chapter comes from numerous higher order statutory directions. The most important statutory directions and documents are identified in the table in Section 2.1. This includes the CRPS (particularly Chapter 11) and the LURP. It is also necessary that the Natural Hazard chapter is consistent with the Strategic Directions chapter of the DPR. Any proposed objective and policy framework needs to give effect to the statutory directions and the Strategic Directions chapter and have regard to lesser documents and is an important consideration in any evaluation of the objectives proposed.

Options are therefore constrained and focus around whether to retain the existing objective and policy framework in the District Plan (Option 1) or whether a new or amended objective and policy framework is more appropriate (Option 2). A third option is to step back from a regulatory approach, but this is a limited option given the statutory directions already in place.

With the second option there is considerable opportunity to amend existing objectives, policies and rules and strengthen provisions to reflect new information and statutory directions and create new provisions altogether. Within this option there is potential for different method or rule approaches to give effect to the objective and policy framework. In some cases there are also multiple policy approaches. For example, one policy approach is to reduce potential flood damage by ensuring floor levels for new buildings and additions to buildings are above flooding predicted to occur in a 1 in 200 year storm event. This is implemented through Floor Level and Fill Management Areas and rules requiring new buildings and additions to meet minimum floor levels determined by flood models for this event, with an allowance for freeboard and sea level rise. This proposal strengthens the Flood Management Area approach in the existing operative City Plan. However, there are several other policy approaches which may not lead to raising floor levels but may still achieve the overall objective to reduce risk required by proposed Objective 5.1.1. Potential sub-options will be explored briefly in Section 5.

The third approach is to apply a less directive approach to objectives, policies and rules. This is likely to involve a strategy where district planning takes a 'back seat' approach to future planning for natural hazards providing a minimalist policy and rule regime but perhaps a number of guidelines for development in hazard-prone areas. It is noted that all three options listed above are able to be supplemented by methods outside the District Plan process including the Council and other agencies providing protection work, advice, guidelines and civil defence measures under other legislation.

Option 1: The Status Quo – Retain Existing Objectives, Polices and Rules

The Objective for Natural Hazards in the operative City Plan in respect to use, subdivision and development in areas at risk of natural hazards states the following:

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.*

It is noted that the supporting 'reasons' for this objective discuss a wide range of natural hazards in the district but concentrate on flooding and inundation with minimum consideration given to the risk posed by slope instability hazards. The relevant natural hazard policies include:

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.

2.5.2 Policy: Limitations on development

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

(a) is within an area subject to moderate to high risk of damage from natural hazards; or
(b) would result in an increased risk of damage from natural hazards elsewhere; or
(c) *would adversely affect the functioning of existing flood protection works.*

2.5.5 Policy: Flooding

To impose standards in areas subject to flood hazard in order to ensure that the risk of adverse effects on property and people's well-being and safety from flooding and inundation is not increased.

2.5.6 Policy: Waimakariri River stopbank floodplain

(a) To manage development between the primary and secondary Waimakariri river stopbanks where the potential for adverse flooding effects can be avoided or mitigated; and
(b) To avoid development in the areas where:
    i. The natural hazard presented by floodwaters is high; or
    ii. Land use activity can undermine the integrity of the stopbank system and/or exacerbate flood risk elsewhere;

    so as to not increase the risk to people's safety, well-being and property.

2.5.7 Policy: Floodwaters, storage and flood flow control

To maintain the storage and flood flow capacity of floodplains, wetlands and ponding areas, particularly those located within the upper Heathcote river catchment and the lower Styx river catchment so as to protect the hydraulic function of such areas.

2.5.8 Policy: flooding mitigation

To ensure that any measures proposed to avoid or mitigate the adverse effects of flooding and inundation are environmentally acceptable.

2.5.9 Policy: Works
To undertake works to avoid or mitigate the adverse effects of natural hazards as a supplementary measure to regulation of activities, and the provision of information.

2.5.11 Policy: Intervention
To avoid or mitigate natural hazards through either or both of the land use and subdivision consent processes.

2.5.12 Policy: Effects of mitigation works
To avoid, remedy or mitigate significant adverse effects on the landscape or environment as a result of methods used to manage natural hazards.

The current Banks Peninsula District Plan (BPDP) contains objectives that remain pertinent where they direct use, development and subdivision as follows:

Objective 1

To avoid or mitigate the costs resulting from natural hazards in terms of loss of life and loss or damage to property and the environment.

Objective 2

To avoid or mitigate significant adverse effects on the environment as a result of methods used to manage natural hazards.

Relevant policies associated with these objectives include:

Policy 1A
New subdivision and development shall take into account any potential risks from natural hazards. The minimum protection aimed for is that there should be no damage:

- *To new dwellings or their contents from flood events with a 1:500 probability of occurrence, or from events arising from slope instability.*
- *To existing dwellings or their contents from flood events with a 1:200 probability of occurrence, or from events arising from slope instability.*

Policy 1C

Risk reduction measures shall be promoted where existing activities are located in areas of high existing or potential risk.

Policy 1I

Where existing development is at risk from slope instability, and a benefit can be provided to the wider community, the Council will give consideration to providing additional retaining structures or other means. Where the main benefit would be to individual property owners, the council will encourage the owners to do the same.

Policy 2A

No measure intended to remedy or mitigate a natural hazard should not have a significant adverse effect on the environment.

Option 2: Amend and Strengthen to Reflect New Information and Statutory Directions

The objectives and policies for this option have been provided in Section 1.2, Table 1.

Option 3: Apply a Less Directive Approach (Minimal Regulation)

Under Option 3 the Council could seek to achieve the requirements of the RMA and control the effects of the use, development and protection of land for the purpose of avoiding or mitigating natural hazards by relying on policy guidance in the new District Plan supported by non-regulatory methods. This approach could rely on the provision of information to create public awareness of the presence of flooding and slope instability hazards and the associated risks and would depend on individual property owners making informed choices about land use, development and subdivision based on the most up-to-date research available. Where control is required reliance could be placed on the Building Act and by relevant sections of the RMA.

GENERAL POLICY DIRECTION OPTIONS & RECOMMENDATIONS

Options

1. Status Quo – retain existing objectives, policies and rules;
2. Amend existing objectives, policies and rules and strengthen provisions to reflect new information and statutory direction; and
3. A less directive approach to policies and rules (minimal regulation).

The recommendation is to adopt Option 2 for the DPR and amend the existing objectives, policies and rules in order to:

a. reduce the risk from natural hazards to people, property, infrastructure and the environment;
b. give effect to and take account of strategic planning documents particularly Chapter 11 of the CRPS;
c. provide a streamlined, focused and updated framework and process for the management and direction of natural hazards;
d. provide landowners, the insurance sector and the property market with certainty and clarity around the rules and standards applying to natural hazards;
e. address omissions in current provisions in respect of the potential for liquefaction if there are further significant earthquakes;
f. address omissions in current provisions in respect of the potential for slope instability hazards on the Port Hills and remaining hilly areas;
g. use new information including that provided by improved technology that identifies changes in ground surface as a result of recent earthquakes and liquefaction to update information on the extent and depth of potential flooding;
h. rollover and amend existing provisions for the repair of land used for residential purposes damaged by ground shaking during recent earthquakes (liquefaction);
i. update existing information and make allowance in provisions for the effects of sea level rise; and
j. recognise the presence of multiple natural hazards and their implications.

ADOPTED GENERAL POLICY DIRECTION OPTION

Option 2 as a general direction was adopted for the reasons given above. Ongoing feedback from the public, statutory partners and community and industry representatives over a reasonable period of time indicated the natural hazard policy framework in the current District Plan is inadequate to

deal with natural hazard issues in the post-earthquake environment. Put simply, new information on natural hazards means that in the existing District Plan there is an absence of some key land use planning opportunities in terms of natural hazards; it is out of date and revisions are required. In terms of the third option, generally there was little-to-no support in consultation meetings for a less regulatory approach. This approach may also fail to give effect to the strong statutory directions on natural hazards given in the CRPS and other higher order documents.

OBJECTIVES MOST APPROPRIATE WAY TO ACHIEVE THE PURPOSE OF THE RMA	
Objective 1	**Summary of Evaluation**
5.1.1 Objective - Reduced risk Reduced risk to people, property, infrastructure and the environment from the effects of natural hazards, including: (a) intense rainfall events causing flooding from rivers, streams, overland flow and lakes; (b) liquefaction during earthquake shaking; (c) cliff collapse, rockfall or boulder roll and mass movement; (d) tsunami; (e) inundation from the sea and storm surge; (f) coastal erosion; (g) exacerbation of hazards (a) to (f) through climate change and sea level rise; and (h) multiple hazards consisting of combinations of the above.	Proposed Objective 5.1.1 gives effect to the following higher statutory documents: i. The CRPS Chapter 11, Objective 11.2.1, which requires that increased risk associated with natural hazards development be avoided and if this is not possible, mitigated. Reduced risk to people, property, infrastructure and the environment can only occur if the natural hazard in question is avoided or mitigated in some way. ii. The LURP, Action 42 requires the Council in its DPR: *to provide for protection of people from risks in 'High Hazard Areas' (as defined in the Regional Policy Statement) and other risks from natural hazards, including, but not limited to, natural hazards such as rock roll and cliff collapse on the Port Hills and natural hazards such as flooding, liquefaction and sea level rise elsewhere in the city*. While proposed Objective 5.1.1 does not use the word 'protection' the objective seeks as an outcome reduced risk from the effects of natural hazards. This objective will protect people from risks associated with natural hazards in a manner that also acknowledges Resource Management Issue 1 - natural hazards are natural phenomena that occur and will continue to occur in the district, they cannot be eliminated entirely but the planning response can be to reduce the risk they pose to people and communities. iii. The CDEM Act mandates the enabling of communities to achieve acceptable levels of risk. As part of that purpose the CDEM Act requires local authorities to coordinate emergency management across a number of areas including strategies to achieve reduction of risk. The proposed objective is therefore consistent with the purposes of the

	CDEM Act. iv. Proposed Objective 5.1.1 aligns closely with the provisions of the Strategic Directions chapter of the proposed plan, in particular **3.6.5 Objective - Natural hazards.** Proposed Objective 5.1.1 drives an approach enabling policies and rules to be developed that recognise natural hazards, and who and what is affected by natural hazard events, varies in time and spatially, and different responses are required in different circumstances. Hence it is important to distinguish between where it is necessary to avoid and where a lower natural hazard risk provides potential for assessment and implementation of mitigation measures. An objective that seeks reduced risk from the effects of natural hazards allows for avoidance (where there is no other way to achieve reduced risk) or mitigation or other methods as circumstances dictate and while it is a flexible objective it is also clear. Resource Management Issue 2 is also addressed by this objective, being focused on the reduction of risk. If the hazard mitigation works cannot meet this objective (and its associated supporting polices) and reduce the risk, then there is no support for the implementation of those works. Further clarity is provided within the objective on the range of natural hazards the objective relates to, that affect the district, giving it specificity and context often missing from high level objectives. Proposed Objective 5.1.1 is more comprehensive and outcome-focused than what is provided for in the current District Plan (the status quo position). Objective 2.5 in the District Plan is not framed as a desired outcome and more closely resembles a policy. Similar policies are included in the policy framework in the Natural Hazards chapter and will be discussed later. The current BPDP has objectives that remain pertinent where they direct use, development and subdivision to: *avoid or mitigate the costs resulting from natural hazards in terms of loss of life and loss or damage to property and the environment…* (Objective 1*)* and to: *avoid or mitigate significant adverse effects on the environment as a result of methods used to manage natural hazards…* (Objective 2*).*

	Option 3 provides for a less directive approach to be developed. It is considered this proposed objective is already flexible and an alternative less directive objective would not give effect to, or be consistent with (whichever is the case), the higher order statutory documents, particularly the CRPS. This is because a less directive objective to what is proposed would have to remove the word 'reduced' and replace it with something weaker or alternatively provide no objective at all.
Objective 2	**Summary of Evaluation**
5.1.2 Objective- Awareness of natural hazards Increased public awareness of the range and scale of natural hazard events that can affect the District.	Both the CDEM Act and the LURP have mandates associated with increasing public awareness (or readiness) in respect to natural hazards. The LURP in Action 43 requires Councils to encourage information on site assessments to be placed on the Canterbury Geotechnical Database (currently administered by CERA). Availability of such information has the purpose of increasing awareness amongst the public and agencies of the presence of hazards. Increased awareness is likely to lead to a more resilient community when dealing with natural hazards. This objective addresses Resource Management Issue 2. The Council is also required under s 35 of the RMA to gather information and hold records of areas subject to natural hazards, because of its function of controlling the effects of the use and development of land to avoid or mitigate natural hazards under s 31 of the RMA. This objective will drive the Council to gather more information, make that information available (as appropriate) on the district planning maps and other council documents, and increase public information and awareness of natural hazards. There are considerable obligations under the LGA and LGOIMA to enable people to find out information and be aware of the natural hazards that affect their properties. Under the status quo option there is no similar objective in the current District Plan reflective of these statutory requirements and obligations. It is considered that the status quo of no objective is likely to be less effective in addressing Resource Management Issue 2. Option 3 requires a less directive approach. A less directive objective will have the same effect as the status quo option of having no objective. Neither of

	these alternative options will achieve the higher statutory intentions contained in the RMA, the LURP and the CDEM Act, and will not provide the necessary direction to specifically achieve more awareness of the natural hazards in the district and hence contribute towards greater resilience.
Objective 3	**Summary of Evaluation**
5.1.3 Objective – Repair of earthquake-damaged land Repair of earthquake-damaged land used for residential purposes is facilitated as part of the recovery.	Objective 5.1.3 addresses Resource Management Issue 4 and provides an objective and hence a supporting policy framework for the inclusion of provisions to facilitate the repair of earthquake-damaged residential land within Floor Level and Fill Management Areas (previously Flood Management Areas). Inclusion of this objective is considered the most appropriate way to achieve the purpose of the Act than the status quo (Option 1). While the current operative City Plan contains earthwork rules (inserted under s 27 of the CER Act) for repair of earthquake damaged residential land it has no objective and policy framework to support inclusion of those rules. Option 3 would either have a more permissive objective or no objective (and no regulation). However, this objective is already intended to be permissive and has been inserted into the DPR to carry over provisions under the CER Act to avoid unnecessary regulation while the district is recovering from the earthquakes. The effect of the objective as proposed is to override what would otherwise be restrictive earthwork provisions.

5. EVALUATION OF PROPOSED POLICIES, RULES AND METHODS

Section 32 (1)(b) requires an evaluation of whether the provisions are the most appropriate way to achieve the objectives by identifying other reasonable practicable options, assessing the efficiency and effectiveness of the provisions in achieving the objectives, and summarising the reasons for deciding on the provisions.

The assessment must identify and assess the benefits and costs of environmental, economic, social and cultural effects that are anticipated from the implementation of the provisions, including opportunities for economic growth and employment. The assessment must if practicable quantify the benefits and costs and assess the risk of acting or not acting if there is uncertain or insufficient information available about the subject matter.

5.1 Identification of options

The proposed policies and methods begin with a general policy framework intended to capture the wide range of hazards that may affect the district as per Objective 5.1.1. This general policy framework is strengthened by polices and rules or methods specific to the three main natural hazards covered in this phase of the DPR:

1. General policies;
2. Flood hazard;
3. Slope instability hazard; and
4. Liquefaction hazard and other geotechnical risks on flat land.

Together this package forms a comprehensive approach to achieve the three objectives proposed earlier.

The main alternative approach is to retain the policies and rules in the current District Plan to the extent that they are still appropriate polices and rules to meet Objectives 5.1.1, 5.1.2 and 5.1.3. An example of this is the Flood Management Areas, which are in the existing District Plan and are proposed to be included in the Natural Hazards chapter, albeit they are proposed to be renamed, extended and the rules revised. This will be discussed in the table below. In addition, alternatives that involve a less regulatory approach will also be examined.

PROVISIONS (POLICY, RULE, METHOD) <u>MOST APPROPRIATE WAY</u> TO ACHIEVE THE OBJECTIVES
5.1.1 Objective - Reduced risk Reduced risk to people, property, infrastructure and the environment from the effects of natural hazards, including: a. intense rainfall events causing flooding from rivers, streams, overland flow and lakes; b. liquefaction during earthquake shaking; c. cliff collapse, rock fall or boulder roll and mass movement; d. tsunami; e. inundation from the sea and storm surge; f. coastal erosion; g. exacerbation of hazards (a) to (f) through climate change and sea level rise; and h. multiple hazards consisting of combinations of the above.

Provision(s) most appropriate **(NB: most relevant parts of policies are <u>underlined</u>)**	Effectiveness and Efficiency
Option 2 (Strengthened policies and rules) ***5.2.1 Policy – Avoid development where there is unacceptable or intolerable risk*** Avoid new subdivision, use and development, particularly new urban zonings, where: (a) there is intolerable risk of loss of life or serious injury in the event of a natural hazard occurrence; or (b) other potential adverse effects arising from a natural hazard event are serious and the natural hazard cannot be mitigated to an acceptable level. ***5.2.2 Policy – Critical infrastructure*** Avoid new critical infrastructure locating where it is at risk of being affected by a significant natural hazard unless there is no reasonable alternative location, and infrastructure is designed, maintained and managed to function to the fullest extent possible during and after natural hazard events. ***5.2.3 Policy – Restrict land use to avoid or mitigate hazards*** Apply different levels of control on subdivision, use and development in areas at risk of natural hazards, depending on the level of risk, to ensure that the adverse effects of natural hazards are avoided or adequately mitigated. ***5.2.4 Policy – Precautionary approach*** Adopt a precautionary approach to subdivision, use and development where: a. there is uncertainty as to likelihood and scale of a natural hazard; or b. there are multiple natural hazards, with potential cumulative effects, or c. there is potential for serious or irreversible effects from a natural hazard.	**Effectiveness** **Policy Framework Overall** i. All the policies work towards a reduction in natural hazard risk to people, property, infrastructure and the environment. ii. By providing supporting rules and planning maps that clearly define areas of significant natural hazards where subdivision, use and development of land is avoided or those areas where mitigation is acceptable, the policies are an effective means of reducing the risk of natural hazards. iii. Land use provisions that avoid subdivision, use and development occurring in localities where the risk from natural hazards is unacceptable or intolerable or require mitigation to reduce the risks to acceptable or tolerable levels, have been found nationally and internationally to be an effective means of natural hazards risk reduction. iv. The policies are effective as they identify areas potentially affected by natural hazards. This can reduce risk by communicating where at-risk areas are as well as spatially limiting where rules apply. In other words, the polices and rules are effective in achieving the objective of reducing risk, as they are designed to target specific areas rather than applying across the board. This also contributes to policies and rules that are more efficient than more general ones that are not mapped. v. The policies apply the most up-to-date information from a wide range of sources and in co-operation with other organisations such as ECAN, EQC, CERA, GNS, MBIE and NIWA. vi. The information on natural hazards is applied using risk-based approaches where both the probability of a natural hazard event and its consequences are taken into account in setting both the policies and the rules, including the planning maps. vii. Some rules and supporting policies such as those requiring raising floor levels of

5.2.5 Policy – Worsening, adding or transferring hazard Ensure that subdivision, use and development, or hazard mitigation proposals do not: a. worsen the adverse effects of any known natural hazard; b. create a new hazard; or c. transfer or increase risk of loss or damage to other people, property, infrastructure or the environment. ***5.2.6 Policy – Natural features providing hazard resilience*** Ensure that natural features which assist in avoiding or reducing the effects of natural hazards, such as natural ponding areas, coastal dunes, wetlands, waterway margins and riparian vegetation, are protected from inappropriate subdivision, use and development. ***Policy for Multiple Natural Hazard Areas*** ***5.7 Policy – Multiple Natural Hazard Areas*** Where multiple natural hazards have been identified on a site and result in an elevated overall risk profile, adopt a precautionary approach to subdivision, use and development.	new buildings and additions in flood hazard areas (Policy 5.2.3, 5.3.4, and Rule 5.8), which build on those already in the operative District Plan, have already proven their effectiveness at mitigating the flood hazard over a number of years and hence will be very effective in achieving Objective 5.1.1 (reducing risk). viii. The natural hazard policies and rules by requiring more geotechnical assessments and mitigation are likely to play a part (alongside other agencies) in the increased employment opportunities in the engineering and science fields, which deal with natural hazards assessment, monitoring and hazard mitigation design. There is potential for this to contribute to economic growth of the district through recruitment of specialists from other parts of New Zealand and overseas. **Efficiency** i. By protecting natural defence systems (Policy 5.2.6), Christchurch is building its resilience to natural hazards in a cost-effective manner. This can reduce the need for and associated costs of designed hazard mitigation works. ii. The policies are efficient as they identify areas potentially affected by natural hazards (both in the policies and by rules and associated maps). This can reduce risk by communicating where at-risk areas are as well as spatially limiting where rules apply. The policies and rules are efficient as they are designed to target specific areas rather than applying across the board. **Benefits** i. The policies provide clear guidance for managing activities to ensure risks are reduced to acceptable levels through avoidance or mitigation. ii. Future natural hazard damages are avoided by new subdivision, use and development not occurring in areas of significant natural hazard risk and from the effectiveness of mitigation measures where development is able to proceed. Christchurch is fortunate to have an urban land supply (see LURP and

	Chapter 6 of CRPS) such that it is not reliant on those areas where the natural hazards risk requires they be avoided. iii. The development 'certainty' for: • areas not defined for particular natural hazards; and • areas where mitigation measures enable development to proceed due to the risks being reduced to acceptable levels. iv. Increased avoidance of areas of significant natural hazards risk and mitigation of risk where those measures are effective and economic will help build resilience, reduce risk and potentially help prevent costly remediation or retreat being required in the future. v. The actual costs of loss of life and damage to property, infrastructure and the environment will be reduced by polices and rules that are effective in mitigating or avoiding adverse effects of natural hazards. **Costs** i. Possible loss of development capacity in greenfield areas where development is avoided in areas subject to significant natural hazards. Generates a need to find other more suitable land areas. ii. Property owners individual loss of development potential of land where polices require avoidance. iii. Increased immediate term costs for subdivision and building to mitigate against the effects of natural hazards; that is: actual costs associated with mitigation proposals. This cost is primarily borne by the land developer and then potentially passed on to the price of subdivided lots and buildings. iv. Negative perception on land values for those identified in Floor and Fill Management Areas and slope instability hazard management areas on the Port Hills (cliff collapse, rockfall, mass movement areas). v. Potential impacts on insurance premiums or insurance excesses. vi. Costs to the Council and the community of natural hazard research, advice, modelling, mapping, consultation with various agencies (as required by the CRPS), plan drafting to effect a more up to date and technically robust natural

	hazards framework to achieve the outcome of reduced risk. This cost increases the more specific the policies and rules are, and the more detailed the planning maps need to be. It is considered the proposed polices and rules (and accompanying natural hazard planning maps) strike a balance at the present time with the amount of further research required to provide even greater detail. This is particularly the case for the work done on land instability in the Port Hills and the modelling required for the 1 in 200 year flood event. There has also been a time cost in producing the material to date. vii. There will be implementation costs to give effect to the proposed objective and associated policies and rules. This could be administration, monitoring and enforcement costs for the Council; costs often passed on to developers and property owners to the extent that the Council is able. Where they cannot be passed on then they are ultimately ratepayers' costs. viii. In terms of mitigation required by the policies and rules, property owners will, by and large be responsible for implementing these. For example, the cost of actually raising floor levels for new dwellings in the Floor and Fill Management Areas, including costs of preparing resource consent applications and processing of those applications (cost passed on by the Council). Ongoing monitoring costs often passed on to developers/property owners through conditions of resource consent. ix. Possible increase in costs associated with plan changes (both Council initiated and privately initiated) and resource consent applications as additional geotechnical and other site-specific hazard information is required (for example, the proposed liquefaction and land instability geotechnical assessment investigation and reporting requirements). Generally, resource consent fees and plan change fees could increase for areas with identified natural hazards. An analysis of costs and benefits of the natural hazard key policies and rules has been

	undertaken in accordance with the Ministry for the Environment (MfE) guidance on s 32 analysis. Given the time constraints the analysis is undertaken at a qualitative level using expert judgements about the impacts and the magnitude of the impacts. Where possible, quantitative evidence from past studies (**Appendix 4**) has been used to establish financial costs and benefits. The report can be found in **Appendix 5**. In terms of the Floor and Fill Management Areas the report considers only the marginal costs and benefits of the new areas not previously covered by a Flood Management Area. It does not assess the costs and benefits to areas already subject to FMA's and the minimum floor level rules under the operative City Plan. **Conclusion** Generally, the costs of hazard events can be substantial in terms of both lives lost and in damage to property. The financial cost of hazards can in part be measured by the insurance pay out (projected pay out of the Canterbury earthquakes is $26.6 billion)[1]. Other costs include uninsured items (for example cost of temporary accommodation exceeding policy allowances); cost of economic and social disruption including the number of days businesses unable to operate at full production, civil defence responses, intangibles such as unhappiness with location living in due to hazards, psychological impacts including on going health effects. Avoidance of development in natural hazard-prone areas and provision of mitigation (in its various forms) where this is appropriate, can substantially reduce the costs associated with the adverse effects of natural hazard events. The proposed polices and rules as a land use planning package will be effective and efficient in mitigating or avoiding adverse effects of natural hazards and result in reduced risks to people, property, infrastructure and the environment. The actual costs of loss of life and damage to property, infrastructure and the environment will be reduced and the community will be more resilient, in terms of the contribution that land use planning can make to this complex issue. It is considered the overall community benefits of the proposed approach out weigh the costs likely to result from implementing it.

[1] Managing Natural Hazards in New Zealand :Think piece April 2014

Policies and Rules for Flooding

5.3.2 Policy – Flood protection works

a. Avoid activities locating where they could undermine the integrity of the Waimakariri River primary stopbank system.
b. Restrict activities locating where they could undermine the integrity of the Waimakariri River secondary stopbank system.
c. Ensure that activities located near stopbank systems do not exacerbate or transfer flood risk elsewhere.

5.3.3 Policy - Protection of flood storage and overflow areas

a. Maintain the flood storage capacity and function of natural floodplains, wetlands and ponding areas, including the Henderson's Basin, Cashmere Stream Floodplain, Hoon Hay Valley, Cashmere-Worsleys Ponding Area, Cranford Basin, and Lower Styx Ponding Area.
b. Limit filling in urban areas at risk of flooding in a major flood event, where that filling activity could transfer risk to other properties.

5.3.4 Policy - Flood damage mitigation by raising floor levels

a. Reduce potential flood damage by ensuring floor levels for new buildings or additions to buildings are above flooding predicted to occur in a major flood event, including an allowance for sea level rise.
b. Provide for variations in minimum floor levels based on a major flood event only in the Waimakariri Stopbank Floodplain, within the Open Space 3D (Clearwater) zone, and around Te Waihora (Lake Ellesmere) and Wairewa (Lake Forsyth).

Interim Policies for High Flood Hazard and Coastal Hazards (to be further considered in Phase 2 of the District Plan Review)

Additional Evaluation of Flood Hazard Specific Policies and Rules

a. Effectiveness

Floor Level and Fill Management Areas and Fixed Minimum Floor Overlay

The flood hazard policies and associated rules specifically aim to reduce the risk to people and property (Policy 5.3.4). In Christchurch floodwaters are generally not a hazard to life, as the mostly flat topography limits flood depth and speed. Consequently Phase 1 of the chapter which is limited to urban zones (excluding Banks Peninsula) concentrates on mitigation measures, and in particular requires finished floor levels in new buildings within Floor Level and Fill Management Areas to be above the 1 in 200 year design flood level. This is required as it has been found that when floodwaters enter buildings, damage costs increase considerably. The modelling includes the 1 in 200 storm event plus 400mm of freeboard and an allowance for sea level rise.

Mapping of the extent of the Floor Level and Fill Management Areas was examined under two different sea level rise scenarios: a 0.5m sea level rise and a 1m sea level rise (the operative City Plan applies an allowance of 0.5m for Sea Level Rise).

The Tonkin and Taylor report on the implications of sea level rise for Christchurch produced in August 2013 recommends that the Council should plan for the possibility of a 1.0m Sea Level Rise by 2115. The Fifth Intergovernmental Panel for Climate Change (IPCC) reports released in September 2013 and March 2014 can also be considered as reinforcing this option, as under a high global greenhouse gas emission scenario (which at this stage looks likely), global mean sea level would likely rise by 0.53 to 0.97m by 2100.

The proposed planning maps now include 1m sea level rise as this was the most preferred position following advice and consultation on this issue. Modelling of flood extents for a 1 in 200 year flood using 1.0m as the allowance for sea level rise increases the land area in Christchurch City which would be brought under the Floor Level and Fill Management Area rules and hence subject to the rule on minimum floor levels. As depths of flooding in this scenario would also increase, the required minimum floor level

5.3.1 Policy – High flood hazard

Avoid subdividing or developing new residential units, other habitable buildings, buildings for concentrations of people and additions to those buildings, in areas where there is a high flood hazard.

5.6.1 Policy – Climate Change and Sea Level Rise

a. Avoid intensification of built development in areas that are projected to be subject to flooding and/ or inundation as a result of the effects of climate change, including sea level rise.
b. Limit intensification of development in locations where the effects of climate change including sea level rise, are likely to result in decreasing levels of service from drainage or other infrastructure.

Rules
Flood hazard rules (Rule 5.8) summary (see chapter for actual rules)

5.8.1.1 Permitted activities in Residential Zones within the Fixed Minimum Floor Overlay within Floor Level and Fill Management Areas shown on the Planning Maps where finished floor levels comply with the prescribed minimum floor level in relation to the 1 in 200 year flood event including:

a. new buildings and additions to buildings (with certain minor exceptions).

Breach of recession plane is exempt where (and only where and only to the extent) it occurs as a result of raising floor levels to comply with flood hazard rules.

Permitted activity provision is also made for minor additions, garages and accessory buildings within certain limits, and support structures for overhead transmission lines, to not need to comply with minimum finished floor levels.

Permitted activity provision for filling and excavation for residential building platforms, permitted utilities, flood protection and drainage works and minor amounts of filling and

height also increases especially for areas with tidal influence.

A report by DHI looking at effects on the Avon catchment of a 1.0m Sea Level Rise scenario, estimates that approximately 2000 more households would require floor level raising, with those properties requiring most increase in floor level being in the New Brighton, Burwood, Porritt Park and Avondale areas (areas closest to the coast). Under the increased sea level rise scenario, there is tidal influence as far upstream as Manchester St (**Appendix 3**). No similar work has been completed for the other catchments that make up the areas covered by the Flood Management Areas. It is also important to note that this report predates new modelling work undertaken in the Avon Catchment (and the other catchments) for the DPR.

The Flood Management Areas (Floor Level and Fill Management Areas) increase in extent significantly from the extent in the operative City Plan. This is largely the result of the modelling of flood extents for the 1 in 200 year flood:

1. utilising the most up-to-date LiDAR information, which is now more precise;
2. capturing areas beyond the main stem of the rivers (the operative City Plan only incorporated modelling of the main stem of the rivers). This also includes the incorporation of the Dudley Creek model;
3. capturing changes to ground surface post-earthquakes, with this having a substantial effect in some areas and a minimal or no effect in others; and
4. inclusion of 1m allowance for sea level rise compared with 0.5m allowance in the operative City Plan.

See the Natural Hazards Planning Maps for actual location of Floor Level and Fill Management Areas. Note that an information only overview map is provided in Appendix 6.

The operative City Plan corrects to the nearest cadastral boundary while this modelling shows the flood extent where it falls (that is, it does not correct to the nearest cadastral boundary). This counteracts some of the increase in extent in specific locations. Overall the result is that some property owners who were in a Flood Management Area in the operative City Plan may not necessarily be in the new modelled area,

excavation within certain limits.

5.8.1.2 Restricted Discretionary Activities within the Residential Zone in the Floor Level and Fill Management Areas:

a. where floor levels of new buildings and significant building additions located within the Fixed Minimum Floor Overlay do not meet the standard prescribed for minimum finished floor levels in relation to the 1 in 200 year flood event;
b. new buildings and significant building additions located outside the Fixed Minimum Floor Overlay areas; and
c. filling and excavation not within the limits to be considered as a permitted activity.

5.8.3.1 Permitted activities within Commercial and Industrial Zones within the Fixed Minimum Floor Overlay within Floor Level and Fill Management Areas shown on the Planning Maps where finished floor levels comply with the prescribed minimum floor level in relation to the 1 in 200 year flood event including:

a. new buildings and additions to buildings (with certain minor exceptions).

Permitted activity provision is also made for minor additions within certain limits, and support structures for overhead transmission lines, to not need to comply with minimum finished floor levels.

Permitted activity provision for filling and excavation for building platforms, permitted utilities, flood protection and drainage works and minor amounts of filling and excavation within certain limits.

5.8.3.2 Restricted Discretionary Activities within the Commercial and Industrial Zones in the Floor Level and Fill Management Areas:

a. where floor levels of new buildings and significant building additions located within the Fixed Minimum Floor Overlay do not meet the standard prescribed for minimum finished floor levels in relation to the 1 in 200 year flood event;
b. new buildings and significant

particularly if they were on its edges. If the property contains land higher than the surrounding area part of the site may be shown as being outside the Floor Level and Fill Management Area. The proposed rule also focuses on the activity taking pace within the Floor Level and Fill Management Area; if the actual activity is taking place entirely in a part of the site that is not within the Floor Level and Fill Management Area then the minimum floor level requirement will not apply.

Overall, in terms of rating units and land parcels (a different measure than actual households as per Appendix 3), the following table demonstrates the effect of new modelling of the 1 in 200 year flood extent from the operative City Plan. A further breakdown is given demonstrating the effect of increasing the allowance for sea level rise from 0.5m to 1m:

FMA version plus sea level rise (slr)	**Rating Units**	**Parcels**	**Area (km^2)**
Operative City Plan @ 0.5mslr	19,453	17,858	40.15
New FMA @ 0.5m slr	39,725	35,237	55.68
New FMA @ 1m slr	44,990	40,267	65.89

It is considered that this new modelling supporting the policies, rules and associated planning maps will be effective in achieving Objective 5.1.1 compared with the provisions in the operative City Plan as it better encapsulates those properties affected by the 1 in 200 year flood hazard event.

Change of Name for Flood Management Areas

It is proposed to change the name of Flood Management Areas to Floor Level and Fill Management Areas in this DPR. This is largely to use a name that more accurately describes what the overlay does. The definition has also been altered accordingly to read:

Floor Level and Fill Management Area

building additions located outside the Fixed Minimum Floor Overlay area; and c. filling and excavation not within the limits to be considered as a permitted activity.	*means an area identified on the planning maps which is at risk of flooding in a major flood event, where specific minimum floor level and earthwork rules apply.* At the time of writing the District Plan Review there were a number of other flood maps and information being used in the community associated with flooding issues. It was considered important to clearly differentiate the Flood Taskforce work, work by the Earthquake Commission on areas of increased flooding vulnerability (IFV), and Flood Ponding Areas from the minimum floor level and filling rules that apply in areas potentially affected by the less frequent but larger 1 in 200 year flood event. **Why choose the 1 in 200 year flood event for the Floor Level and Fill Management Areas?** The 1 in 200 year flood event is a Statutory Direction from the CRPS (see Section 2.1). Policy 11.3.2 in the CRPS directs subdivision, use and development be avoided in areas subject to 1 in 200 year flood event but provides for mitigation as an alternative in circumstances where there is no increased risk to life. Where this criterion is met finished floor levels for new buildings are required to be above a 1 in 200 year design flood level. The Floor Level and Fill Management Area overlay included in the Natural Hazard chapter gives effect to these provisions. **Fixed Minimum Floor Overlay – Permitted activity for new buildings** As previously noted the Floor Level and Fill Management Areas are already an existing provision in the Operative City Plan, previously named Flood Management Areas, which has been extended and strengthened in this Review (see **Appendix 6** for flood modelling details). As part of giving effect to Action 2 in the LURP effort has been made to identify areas within Floor Level and Fill Management Areas where new building and significant additions could be permitted activities provided the activities meet set minimum finished floor levels set above the 1 in 200 year flood event. This was more difficult than initially thought as the modelling outputs of the various catchments that make up the entire suite of Floor Level and Fill Management Areas are less robust in some areas. Areas where the modelling results are not sufficiently robust without specific assessment to verify the modelled result have been excluded from the

	Fixed Minimum Floor Overlay Areas. These areas will require a restricted activity resource consent application to be lodged for new buildings and significant additions, with the required minimum finished floor level set as part of that process. This is a status quo position in terms of the operative City Plan for those property owners who were already in an existing Flood Management Area. It is a new requirement to go through the resource consent process to set minimum floor levels when new buildings are proposed for those who previously were outside the Flood Management Area. Overall, the difference in status of activity (permitted or restricted discretionary) between Fixed Minimum Floor Overlay areas and the rest of the Floor Level and Fill Management Areas is based on the level of certainty as to what finished minimum floor level will be required. **Recession plane exemption:** Raising floor levels to the 1 in 200 year standard can cause recession plane breaches, especially on narrow sites where houses are close to boundaries. While the operative City Plan includes assessment criteria in Living Zones which provides for positive consideration to be given to recession plane breaches caused by floor level raising, recession plane breaches can result in loss of amenity for neighbours. This is generally carried over in the proposed provisions in the Floor Level and Fill Management Areas and the recession plane issues can be dealt with jointly when the resource consent application is lodged to set the finished floor levels. However, within the Fixed Minimum Floor Overlay an exemption from the recession plane rule in the specified residential zones is provided for given that in this overlay compliance with the minimum floor level required is a permitted activity. This avoids the need for a resource consent application specifically for a breach of the recession plane resulting from raising the floor level to comply with Rule 5.8.1. This is considered to be appropriate as it gives due priority to the need to achieve the objective of reduced risk to people, and property damage from the effects of flooding (Objective 5.1.1). This provision essentially preserves the building envelope available to the property owner prior to raising the floor levels. For example, this

	enables an existing dwelling compliant with the recession plane before raising the floor level, to be raised to the new level by the property owner to mitigate flooding effects. While this will potentially result in some amenity issues for neighbours, these are seen as of lesser significance in most cases than the outcome of increased flood protection enabled by floor level raising. Where breaches in the recession plane go beyond the limits of the exemption (that is they are additional) they will be subject to restricted discretionary activity consent. It is noted there is no similar exemption provision in respect to height. For most single storey development the maximum height in residential zones of 8m is considered sufficient to allow for a single-storey house at the required raised levels. Where the floors are to be raised to the minimum floor level for a two storey new building it is considered appropriate to consider the effect of the increase in height. The exemption to the recession plane is considered an effective way of incentivising raised floor levels in areas affected by flood hazard and potentially assists in achieving LURP Action 2. An alternative method of providing for recession plane breaches would be to change the origin point for recession planes, by amending the definition of ground level within Fixed Minimum Floor Overlay in Flood Management Areas to the level of the raised floor level, minus the 400mm freeboard. Aside from measurement difficulties, a number of complexities in the Proposed Plan will arise if the definition of ground level is amended specifically for the Fixed Minimum Floor Overlay and specifically for the recession plane breach attributable to raising floor levels, and it is considered better to include the exemption specifically as part of the Natural Hazards chapter at this stage. **Efficiency, benefits and costs** An economic impact assessment has been carried out on the proposal to require new dwellings and additions to existing dwellings to have a minimum finished floor level based on the 1 in 200 year storm event. The brief analysis can be found in **Appendix 5**. Flooding of floors bears a high cost in house and contents repair or replacement, high personal disruption and increased health risks (mould,

	rising damp and cleaning up contaminated water under homes). The cost of damage has already been covered in the natural hazards general policy framework section above. Even where floors are not flooded, recent flooding in Christchurch has revealed that flooding under homes is a significant health and property concern, as was reduced access to properties as a result of flooding. A number of detailed quantitative reports have been undertaken in respect to flood damage and flood mitigation costs. In most of these reports (for an example see **Appendix 4**) the cost of damage for affected communities far exceeds the costs of mitigation proposals, which include raising floor levels. It is difficult to extrapolate the costs of damage and the costs of raising floor levels from such reports to present day Christchurch circumstances as foundation requirements and ground conditions have changed substantially post-earthquakes. In addition, the amount that floor levels will need to be raised is higher in this proposed Natural Hazards chapter than any of the scenarios in the Harris report (**Appendix 4**). However, this earlier report gives the closest quantified information available. The overall conclusion that the costs of flood damages to the community are much greater than the costs of mitigation through requiring minimum floor levels is still likely to hold for many of the reasons given in the general section above. It is further noted that while raising floor levels has a cost associated with it, the market recognises that cost in the consequent value of the property, in comparison with a similar property in a similar area affected by similar natural hazards which has not had the work completed. Overall, it is considered that requiring new buildings and significant additions to buildings to meet minimum finished floor levels in the Floor Level and Fill Management Areas is considered to be an effective and efficient proposal to meet Objective 5.1.1. **Existing use rights** The provisions in a new district plan do not affect a person's existing use rights which are clearly specified in s 10 of the RMA. Where existing use rights are able to be relied upon, the

	effectiveness of the proposed new rules can be reduced. However, this potential for reduced effectiveness of new rules is inherent in the RMA for district plans and confers clear and expected rights to property owners. The process of raising floor levels over time as housing stockis replaced was always intended to be a gradual one in terms of the provisions inserted via Variation 48 to the operative City Plan. The rebuilding currently occurring in Christchurch does provide a greater opportunity for raising floor levels in circumstances where existing use rights are not being relied upon. It is noted that the Council has guidance on its website on existing use rights, in relation to floor levels and other matters. This includes a specific guidance sheet entitled "Existing Use Rights: Replacement of Earthquake Damaged Buildings".
Policies and Rules for Liquefaction ***Policies for geotechnical hazard and risks for flat areas of the district*** ***5.4.1 Policy – Geotechnical risk including liquefaction susceptibility*** (a) In flat areas of the district, ensure that geotechnical site suitability is assessed, including liquefaction susceptibility, before new areas are zoned for urban activities or where they are already zoned, before subdivision, use and development take place. (b) Ensure that the level of assessment undertaken for subdivision reflects the potential scale and significance of the liquefaction hazard that could occur during ground shaking, acknowledging that some areas are more susceptible to these hazards than others. ***5.4.2 Policy – Management of geotechnical risks on flat land*** (a) Ensure subdivision, use and development is able to occur where geotechnical hazards have been appropriately identified and assessed and risks can be adequately remedied or mitigated. (b) Avoid subdivision, use and	**Additional evaluation of Liquefaction - Specific Policies and Rules** **1. Effectiveness** **Liquefaction Assessment Areas 1 and 2** The division of the district into two distinct liquefaction assessment areas (LAA1 and LAA2) comes largely from a report prepared specifically to assist territorial authorities in their long-term planning in respect to risk from liquefaction hazard. This report is identified at the beginning of this evaluation in Section 1.3 as ECan Technical Report R12/83, Dec 2012. The land area within LAA1 closely corresponds to the area in this report where it is considered liquefaction assessment is needed. Consequently the Natural Hazard chapter requires more assessment of liquefaction to be undertaken for subdivision in this area, and also adds geotechnical assessment of liquefaction susceptibility a matter of discretion in determining residential intensification projects proposed on sites greater than 1500m^2. LAA2 demarks areas where it is generally accepted that damaging liquefaction is unlikely and therefore requires a less rigorous geotechnical assessment process. The LAA2 boundary crossing the western part of Christchurch City is extended further eastward from that contained in the ECan Report. This is because that part of the city is zoned as Technical Category 1(TC1) by MBIE "future land

	development, where the risk arising from geotechnical hazard cannot be mitigated and the site would not be suitable for reasonable use. **Liquefaction Rules** This part of the Natural Hazard chapter rules divides the district into two liquefaction assessment areas - Liquefaction Assessment Area 1 (LAA1) and Liquefaction Assessment Area 2 (LAA2). Rule 5.9.2 provides for subdivision that creates additional vacant lot(s) to be assessed as a Restricted Discretionary Activity in both LAA1 and LAA2. This is consistent with the status of subdivision in the DPR generally. Matters the Council will restrict its discretion to in respect to the liquefaction hazard include: the nature and extent of the liquefaction hazard; proposed mitigation of the effects of the liquefaction hazard present, including measures for ground strengthening; subdivision layout and proposed location of buildings and services that assist mitigation of the hazard where it varies across a site; and the ability to relocate services affected by liquefaction to more desirable locations. Information requirements and geotechnical assessment for subdivision consents have been proposed that in most cases are likely to be more onerous in LAA1, which is located in the eastern part of the district covering a large part of Christchurch City and in low lying flat inlets on Bank Peninsula. Rule 5.9.3 requires that specified residential intensification proposals on sites greater than 1500m2 in the residential zones located in the LAA1 part of the district be assessed as a restricted discretionary activity. These land use proposals will already be prescribed as restricted discretionary activities in the Residential Zones chapter, but this provision enables liquefaction susceptibility of the site to be an added consideration. The Council's discretion is restricted to matters such as the nature and extent of the liquefaction hazard, the techniques to be used to mitigate the hazard and the environmental effects of any mitigation measures proposed. These additional provisions do not apply to	damage from liquefaction is unlikely". While it is recognised that the TC classifications are due largely to observation of liquefaction processes during and after particular earthquake shaking events surrounding the Canterbury Earthquakes (Sept 2010-December 2011 and aftershocks) it is considered that for the purposes of district land use planning (involving the imposition of an assessment line for management purposes rather than a change in the status of activities) that this part of the city can be included in LAA2 rather than LAA1 and the less rigorous geotechnical assessment process will be generally more appropriate. Provision is, however, made in the information requirements of the Natural Hazards chapter for more detailed geotechnical assessment to occur where visual assessment and reasonable enquiry of a site to be subdivided in the LAA2 area suggests the presence of a liquefaction hazard. In general, it is considered that with this approach the liquefaction hazard risk will be reduced (proposed Objective 5.1.1.). Some ground improvement techniques (potentially the outcome of some of the geotechnical assessment requirements of the provisions proposed) will reduce the likelihood of liquefaction occurring and therefore reduce risk to people, property, infrastructure and the environment. The provisions also have regard to the Canterbury Earthquakes Royal Commission reports Volume 5 Summary and Recommendations, which include a recommendation that the potential effect of earthquakes, liquefaction and lateral spread should be taken into account in zoning, and in land use and subdivision consents, and further give effect to the LURP Action 42, and Policy 11.3.3 of the CRPS. It is noted that as a restricted discretionary activity subdivisions in the district can be turned down on the basis that there is a liquefaction hazard that cannot be reasonably mitigated. At a broad scale the effects (for example subsidence, lateral spreading and ground cracking) of liquefaction and the consequences (for example, displaced people because of damaged homes) will not be eliminated. However, through early decisions on location and engineering design (ground treatment and structure) resulting from the requirement for more detailed initial investigations, risk will be

Liquefaction Assessment Area 2.	reduced. The acceptability of the reduction in risk or the level of reduction that can be obtained through these measures has not been quantified. The level proposed in these provisions is greater than in the existing operative City Plan and the BPDP, and arguably Option 3 in this case would amount to a similar option to the status quo, with or without guidelines such as those produced by MBIE. This does not rule out, however, the possibility of more stringent regulatory controls to address liquefaction hazard. No cost-benefit analysis has been undertaken of that position Given the highly variable nature of soils in Christchurch both with depth and spatially there may be situations, and in-spite of more intensive investigations, where some damage from liquefaction will still occur. Overall it is expected the proposed polices and rules on liquefaction proposed will be effective in achieving reduced risk to people, property, infrastructure and the environment. Policies 5.4.1 and 5.4.2, Rules in Section 5.9 and information requirements provided in the Natural Hazards chapter are consistent with and designed to give effect to the CRPS, and to formalise and provide a more comprehensive approach to geotechnical assessment at each stage of the development process. Large areas of the city are susceptible to liquefaction, which includes lateral spreading. These proposed processes should reduce risk associated with liquefaction hazard in the future. The proposed provisions specifically identify liquefaction as a significant hazard in itself and one where the associated risks can be reduced. The greater recognition of liquefaction and its consequences, through the requirement for more detailed investigations, will assist in achieving Objective 5.1.1. The proposed rules and policies reflect current thinking and best-practice within various technical fields and specifically engineering geology and geotechnical engineering. Although there are provisions which are 'unique' to managing liquefaction, the provisions reflect well-established and well-accepted general approaches to defining hazard and risk, and managing it. The proposed policies and rules, stemming

	from risk-management based Objective 5.1.1 focus on reducing risk consistent with the intent of New Zealand Standard ISO 31000 Risk Management (2009). The policies and rules generally encourage and encapsulate the key steps in risk management - identifying and defining the hazard, assessing risk and vulnerability, identifying risk management options, and implementing risk reduction measures as appropriate. The explicit recognition of liquefaction in the proposed provisions compared with the status quo in the operative City Plan and BPDP is considered appropriate. **2. Efficiency, benefits and costs** In the long-term the benefits of a reduction in liquefaction risk will be realised, however the cost-benefit of mitigation measures is not easily established. The cost of carrying out more detailed investigations is likely to be significant given the specificity of investigation required. However, a staged approach utilising the LAA1 and LAA2 approach with the MBIE guidelines to carrying out investigations, will help ensure the level of investigation is carried out at the appropriate stage of development, thereby keeping costs appropriate to the level of investment at the time. The cost of increased geotechnical reports through these provisions, and the resultant mitigation work and measures required do add costs (in some cases significant) to development. These are identified in the general policy framework section above. The direct effect on the environment of physical works (for example, retaining river banks subject to lateral spread) to reduce the risk of liquefaction occurring is difficult to quantify. Well-engineered and environmentally sensitive structures can be built but at some cost. Significant research into, and the use of new ground treatment methods and new structure design to reduce risk from liquefaction, will allow development to occur in areas currently considered inappropriate because of the earthquake risk. Conversely current ground treatment and structure design knowledge may

	be insufficient for development to occur in some areas previously occupied or developed. Research into ground treatment methods, structure and infrastructure design, and physical ground conditions will in itself provide some economic growth in the research and consultancy fields, both locally and nationally including increased employment and increased student numbers training at universities in these fields (this is discussed in the general policy framework section above). Opportunities for greater employment from increased development will also result. To achieve the outcome of reducing risk (Objective 5.1.1) the policy and rules framework support the growth of the geotechnical industry in the district, but not without added cost to development through increased information requirements, increased research and development, and the costs of implementation of mitigation measures.. Given the current relatively high cost of ground remediation some specific sites and areas may not be currently economic to develop. However, where ground remediation can be carried out on a wider scale, the economics may be more acceptable.
Policies and rules for slope instability areas ***5.5.1 Policy – Areas subject to intolerable risk to life-safety from potential cliff collapse*** Avoid subdivision, use and development at the top and /or base of cliffs in areas subject to an intolerable risk to life-safety from the effects of cliff collapse. ***5.5.2 Policy – Areas potentially affected by rockfall or boulder roll*** (a) Avoid subdivision, use and development in areas subject to an intolerable risk to life-safety from the effects of rockfall or boulder roll. (b) Control subdivision, use and development in areas subject to life-safety risk from the effects of rockfall or boulder roll, where the life-safety risk can be reduced to a tolerable level. ***5.5.3 Policy – Areas potentially affected by***	**Additional evaluation slope instability hazard - policies and rules** The policies and rules proposed in the Natural Hazards chapter (Option 2) for the slope instability areas are reasonably directive having strong avoidance polices and rules that implement non-complying activity status for new buildings and structures. These rules and the associated planning maps are based on the findings of work undertaken for the Christchurch City Council by GNS in response to the 2010 and 2011 Canterbury Earthquakes. The GNS reports include estimates of life-safety risk (or risk of death) to people living on discrete areas of the Port Hills and also consider the risk to infrastructure. Areas of cliff collapse, rock fall and mass movement have been mapped as a result of these investigations. An intolerable life risk from slope instability is defined in the GNS reports as being those areas identified as having an annual individual fatality risk (AIFR), or risk of death, of 1 in

mass movement (a) Avoid subdivision, use and development in areas subject to an intolerable risk to life-safety from the effects of mass movement. (b) Control subdivision, use and development in areas subject to a heightened risk from the effects of mass movement, where there is a potential for damage to property and infrastructure. ***5.5.4 Policy – Slope Instability in areas not already identified as cliff collapse, rockfall or mass movement (remainder of Port Hills and Banks Peninsula)*** Area not already identified as subject to cliff collapse, rockfall or mass movement, require proposals for subdivision, use and development to be assessed by a geotechnical expert, to evaluate the level of risk to people and property from slope instability hazards, and only allow subdivision, use and development where risk can be reduced to an acceptable level. ***5.5.5 Policy – Hazard mitigation works for slope instability in the Port Hills and across Banks Peninsula*** a. Avoid hazard mitigation works in areas of the Port Hills and across Banks Peninsula where cliff collapse or mass movement is likely to destroy or significantly damage such mitigation works, or where construction or maintenance of mitigation works creates a safety hazard. b. Control hazard mitigation works for slope instability across all other areas of the Port Hills and Banks Peninsula, to ensure that hazard mitigation proposals: (i) are effective; and (ii) do not worsen any existing natural hazard; and (iii) do not transfer or increase the risk of loss or damage to other people, property, infrastructure or the environment. [updated August 2014]	10,000 (10^{-4}) or greater. These areas include Cliff Hazard Management Areas 1 and 2, Rockfall Hazard Management Area 1 and Mass Movement Hazard Management Area 1 and have been mapped on the planning maps as the slope instability management areas where the most stringent rules (non-complying and prohibited activity status) are proposed to apply in Rule 5.10.1. A summary of the GNS modelling and other techniques used to inform the mapping and Rule 5.10 is provided in **Appendix 7**. Included in Appendix 7 is a brief explanation of why the prohibited activity status for new buildings and some other activities has been proposed in Rule 5.10.1 for Cliff Hazard Management Area 1. The CRPS 2013 does not have specific policies on slope instability but its overall Natural Hazards Policy 11.3.5 directs that subdivision, use and development of land shall be avoided if the risk from the natural hazard is considered to be unacceptable. The GNS modelling and reports prepared for the Port Hills after the Christchurch earthquakes provides the basis on deciding which activities can occur on these slope instability areas and which ones should be avoided. The status of activities proposed in Rule 5.10 reflects the work of GNS and the policy direction of the CRPS. The proposed policies and rules in the Natural Hazards chapter in respect to slope instability assist in achieving Objective 5.1.1. The information provided by GNS when reflected in the District Plan provides certainty about the presence of slope instability hazards and the potential risk to life-safety and property including infrastructure for discrete mapped areas of the Port Hills. With this information provisions in the new District Plan can target subdivision and the type of land use and development that needs to be controlled for the purpose of reducing risk to people and property associated with slope instability hazards. For remaining areas of the Port Hills and hilly areas of the district, which includes most of Banks Peninsula, where there is an absence of technical information the proposed provisions achieve Objective 5.1.1 in that they are intended to reduce the risk of natural hazards by requiring

Slope Instability Rules 5.10.1 This rule classifies various activities such as subdivision, earthworks, hazard mitigation works, demolition of buildings, repair of roads and other infrastructure and any other building or structure or activity, within the Port Hills and Banks Peninsula Slope Instability Management Areas. The management areas are identified as Cliff Hazard 1 and 2, Rockfall Hazard 1 and 2, Mass Movement 1, 2 and 3 and the Remainder of the Port Hills and Banks Peninsula. Non-complying activity status is applied to most activities in the Cliff Hazard Management Area 2, Rock fall Hazard Management Area 1 and Mass Movement Management Hazard Area 1, apart from demolition of buildings, repair of roads and infrastructure and hazard mitigation works. Although, in Cliff Hazard Management Area 2 and Mass Movement Hazard Management Area 1 hazard mitigation works other than for infrastructure are a non-complying activity. Some prohibited activities apply to Cliff Hazard Management Area 1 including new dwellings and additions to dwellings, earthworks and hazard mitigation works. All provisions controlling subdivision, use and development in areas at life-safety risk, and potential for significant damage to buildings and infrastructure from known slope instability hazards are mapped and labelled so that these areas can be distinguished and linked to the relevant controls. The remainder of areas of the Port Hills and Banks Peninsula potentially subject to slope instability hazards are also mapped to identify this area and to link to the requirement that a geotechnical assessment is provided at the time a resource consent application for subdivision is lodged, to ensure the presence of slope instability hazards and associated risk is evaluated. For activities other than subdivision, earthworks, hazard mitigation, demolition and repairs of roads and infrastructure, reliance will be placed on the zone rules. Some of these zone rules will be developed in the next phase of the DPR.	geotechnical assessments before development occurs. The proposed provisions also implement Policy 11.3.5 of the CRPS by taking a precautionary approach to the management of subdivision which is frequently the first stage in any land use and development. This approach is taken on the assumption that where there exists similar topography and geology there is also the potential for similar slope instability hazards and associated risk. Where resource consent approval is required for use, development or subdivision, a comprehensive geotechnical assessment of slope instability hazards and associated risk both within and beyond the boundaries of a site will be required through the policies and rules to support the application. This assessment will need to be undertaken by a suitably qualified and experienced Chartered Professional Engineer or a Professional Engineering Geologist (IPENZ Registered). Should the proposal be approved conditions may be imposed to ensure all adverse effects are avoided, remedied or mitigated, for example, conditions on the demolition of a building will ensure removal of the building will not increase the life safety-risk for buildings down slope; whereas conditions imposed on applications to establish hazard mitigation works will enable monitoring, reporting, inspections and maintenance to be imposed. As discussed in the general section these provisions will increase the costs of development. However the provisions will better achieve Objective 5.1.1 of reduced risk to people and property, infrastructure and the environment than the existing operative City Plan and BPDP. The policies and rules of those plans make limited provision for hazard mitigation works and provide limited ability to control the establishment of such works.
Options less or not as appropriate to achieve the Objectives:	
2. Option 1 (Status quo – current policies and rules) **Flooding Policies and Rules** The rules in the operative City Plan deal with	**Appropriateness** **Flooding Policies and Rules** Neither of the current operative plans

flood hazard through the implementation of Flood Management Areas which set minimum floor levels and control filling as well as setbacks from waterways. However, there are no clear policies currently in the Plan to support the establishment of Flood Management Areas and the setting of minimum floor levels for new buildings. These rules flow from a general objective (Objective 2.5), which states: "to avoid or mitigate the actual or potential effects of loss or damage to life, property, or other parts of the environment from natural hazards." The BPDP includes flood management provisions in the form of building line restrictions and minimum floor levels around Te Waihora (Lake Ellesmere) and Wairewa (Lake Forsyth). These rules are supported by a policy as follows: Policy 1B "On areas around Te Waihora (Lake Ellesmere) and Wairewa (Lake Forsyth), shown on the planning maps as flood prone land, the erection of new dwellings and extensions to existing dwellings, including the setting of floor levels, should not be undertaken where it will create a significant risk to life or property, or risk of injury."	provides a clear policy and rule framework to achieve Objective 5.1.1 in terms of flood hazard. In particular the operative City Plan is deficient in providing policy support for the existing Flood Management Areas within Christchurch City. It has a focus on not increasing the flood hazard (2.5.5 Policy: Flooding) rather than reducing risk as required by Objective 5.1.1. It is considered that the proposed policy framework provides more appropriate support for the Floor Level and Fill Management Areas (revised and extended Flood Management Areas) within Christchurch City and is better developed to achieve Objective 5.1.1 in terms of reducing the risks of flood hazards. It is acknowledged that further policy support and rules to deal with flood hazards in the Banks Peninsula part of the district will need to be provided in Phase 2 of the DPR.
Liquefaction policies and rules The identification of natural hazards for planning and development currently exists in the operative City Plan and in the BPDP. However the policies in these plans are general in scope and in application. There are no specific liquefaction/ geotechnical risk policies and rules. The reasons given in the operative City Plan for Objective 2.5 specifically lists seismic activity and liquefaction as a natural hazard within the City. The Subdivision chapter (Part 14) also lists "liquefaction (Living G (Highfield) Zone" in its list of matters for control under Clause 7.1 Natural and Other Hazards. However, this zone (and hence this provision) is a relatively new inclusion to the City Plan. Although there was some reasonably detailed technical information available on liquefaction, this was not used prior to this review to better inform the district plan. The actual extent of liquefaction and magnitude of the liquefaction susceptibility of Christchurch was not well understood when the current plan provisions were written.	**Liquefaction policies and rules** Post-September 2010 liquefaction is considerably better understood. The Canterbury earthquakes have provided a very thorough 'ground-truthing' of previous research and geological/geotechnical interpretation. It is therefore not considered appropriate to continue with the status quo approach of having very little recognition of this hazard in the DPR. The minimal recognition of liquefaction and its consequences, and minimal requirement in the District Plan for more detailed investigations, will not assist in achieving Objective 5.1.1. Given that the current rules and policies are not reflective of current thinking and best-practice within various technical fields and specifically engineering geology and geotechnical engineering, it is considered more appropriate to update the provisions. They also predate New Zealand Standard ISO 31000 Risk Management (2009) which includes the key steps in risk management - identifying and defining the hazard, assessing

	risk and vulnerability, identifying risk management options, and implementing risk reduction measures as appropriate. The explicit recognition of liquefaction in the proposed provisions is considered a more appropriate approach to achieve Objective 5.1.1 than the status quo. Overall the requirement for more detailed and more site-specific investigations with respect to liquefaction will help ensure that future risk is reduced and is best placed to meet Objective 5.1.1. The status quo of no specific liquefaction policies and rules does not assist to achieve this.
Slope instability policies and rules Both the existing City Plan and BPDP give limited recognition to the existence of potential slope instability hazards and the need to ensure any potential risk is assessed prior to subdivision, use and development of land. The main exception is those provisions controlling Low-Moderate or Moderate-High slope instability on parts of Banks Peninsula under the BPDP. The relevant polices for slope instability are: Policies 2.5.1, 2.5.2, 2.5.9, 2.5.11 and 2.5.12 of the operative City Plan, in the Natural Environment chapter, but these policies are very general with minimal mention of slope instability. The explanations and reasons for Policy 2.5.2, state "There are also areas … subject to erosion hazard…particularly…on small areas of the Port Hills, where risk of erosion, rock fall or land slippage is high". Policy 2.5.9 allows for mitigation works as a supplementary measure to regulation of activities, and provision of information. However, there is no specific provision for slope instability hazard mitigation works. The policy appears largely focused on flood mitigation. In the BPDP the relevant policies are Policy 1A, 1C, 1I and 2A and Policy 1H in the Natural Hazards chapter. Policy 1H in particular states "Building and subdivision should not be undertaken in areas of Low-Moderate or Moderate-High slope instability, as shown on the planning maps, unless an engineering/geotechnical report supports the development."	**Slope instability policies and rules** The existing policies in the operative City Plan and the BPDP are poorly worded and do not reflect all of the new information provided in the GNS research. The operative City Plan policies are particularly unhelpful in terms of reducing slope instability hazards. Clearer direction is needed to address the risk from slope instability hazards. While the intent of some of the existing policies can be carried over to the new District Plan, the new policies and rules proposed are considered more appropriate to achieve Objective 5.1.1 particularly given the new information provided by the GNS reports post earthquakes. Policy 1H in the existing BPDP is one policy that can no longer be supported. This policy limits development in areas identified as having Low-Moderate or Moderate-High slope instability. As there are no technical reports (and no willing experts) to justify the identification of these areas which were mapped prior to the 2010-2011 earthquake sequence this policy can no longer be supported. The research undertaken by GNS provides new information that indicates the existence of slope instability hazards and suggests the potential risk associated with these hazards. In the absence of a similar calibre of supporting research behind the Low-Moderate or Moderate-High slope instability controls for parts of Banks Peninsula the existing controls in the BPDP can no longer be retained. Land use and development can occur at present

These plans do provide limited control of filling and excavation activities that could be potentially associated with the creation of some forms of hazard mitigation works but do not specifically provide for slope instability hazard mitigation works within an objective and policy framework of reducing the risk associated with the effects of natural hazards.	under the operative City Plan and in most areas covered by the BPDP without the need for detailed geotechnical assessment of the risk posed by slope instability hazards, both within and beyond the subject site. Given the weak policy base for slope instability hazards in the district plans, currently the Council relies largely on the building consent process. However, the building consent process does not generally require the geotechnical assessment to extend beyond the boundaries of the subject site which is where the slope instability hazard may be located. Consequently, a more robust policy and rule framework supported by new slope instability information will result in better outcomes and is better placed overall to achieve Objective 5.1.1. Hazard Mitigation Provision for hazard mitigation works in the District Plan is seen as an appropriate means of reducing the risk associated with natural hazards and giving effect to Objective 5.1.1. The minimal recognition given to these works in the Operative City Plan or the BPDP is considered inappropriate given the improved knowledge and awareness and interest in implementing options for mitigating risk, such as removal or pinning of rock, bunds and fences. Hazard mitigation works are clearly anticipated, where appropriate, in the proposed policy and rule framework. It is concluded that changes need to be made to the district plans to take account of the new slope instability hazard information for the Port Hills, in order to achieve Objective 5.1.1 and to adequately give effect to Policy 11.3.5 of chapter 11 of the CRPS (see section 2.1). Neither of the current district plans includes provisions recognising areas of the Port Hills subject to life-safety risk from cliff collapse, rockfall and mass movement, and where infrastructure and property is at risk, as identified in technical reports prepared by the GNS from research commissioned by the Council since the 2010-2011 earthquakes.
3. Option 3 (Less directive/conservative policies and rules) **Liquefaction Policies and Rules** This option would involve minimal policy direction and relying on guidelines outside the District Plan to indicate the information requirements for geotechnical assessments. An example would be relying on the MBIE	**Appropriateness** **Liquefaction Policies and Rules** Reference to guidelines outside the Plan is proposed in Option 2 to support the approach, but relying on the guidelines only may mean that resource consent planners, policy planners and others involved in preparing applications may

guidelines such as the Revised Guidance on Repairing and Rebuilding Houses Affected by the Canterbury Earthquake Sequence: Parts A – D. It could also involve not having specific assessment matters on liquefaction. Removing the policies and the liquefaction assessment line would also be less directive. This is reasonably close to the status quo position (Option1).	not be aware or attribute much significance to the guidelines. Incorporating some of the MBIE guideline material within matters for discretion in the rules gives them some statutory weight in assessing subdivisions and resource consent applications that they would otherwise not have. Using various guidelines could work but it is a weaker approach. Without a clear policy direction and the rules proposed on liquefaction it is considered it will be more difficult to achieve Objective 5.1.1, and give effect to the CRPS, particularly Policy 11.3.3 and LURP Action 42. The proposed approach (Option2) is considered to be appropriate and gives due consideration to the impacts and consequences of recent and 'relevant' (in the context of risk and probability and consequences) earthquakes. A less directive approach would not provide the certainty that is currently needed for land development and building in the district post-earthquakes.
Slope instability Policies and Rules The policies and rules proposed in the Natural Hazards chapter (Option 2) for the slope instability areas are reasonably directive having strong avoidance polices and rules that implement non-complying activity status for subdivision, new building and structures in Cliff Hazard Management Area 2, Rockfall 1 and Mass Movement 1 Hazard Management Areas and prohibited activity status for these activities in Cliff Hazard Management Area 1. The Council could seek to achieve the requirements of the RMA and control the effects of the use, development and protection of land for the purpose of avoiding or mitigating slope instability hazards by relying on policy guidance in the new District Plan supported by non-regulatory methods. This approach could rely on the provision of information to create public awareness of the presence of slope instability hazards and the associated life-safety risk and would depend on individual property owners making informed choices about land use, development and subdivision based on the GNS research. Where control is required reliance could be placed on the Building Act and by relevant sections of the RMA and by guidelines outside the Plan.	**Slope Instability Policies and Rules** The most significant limitation of this approach would be that the Council could not comply with the full requirements of the CRPS particularly Policy 11.3.5 and its prioritised hierarchy of avoidance where the risks are considered to be unacceptable and taking a precautionary approach to the consequences of natural hazards where there is uncertainty. It is also questionable whether this approach would be effective in achieving the new Objective 5.1.1. Firstly the Building Act cannot be used to fully address the avoidance or mitigation of slope instability hazards as there may be hazards beyond the site that any application for building consent approval may not need to consider. While a geotechnical assessment can be required it may not always be reasonable to require one beyond the site to which the building application applies. The GNS research shows that many properties are subject to life-safety risk and risk of significant damage to properties and infrastructure from slope instability hazards on land in the wider catchment. Relying on the Building Act alone could limit broader assessments required to effect robust decisions on life-safety and the potential for significant damage to property and infrastructure. The proposals in Option 2 are a more effective means of achieving Objective

	5.1.1. Overall, Option 2 provides a framework for more appropriate land use planning decisions on the Port Hills and elsewhere on Banks Peninsula than Option 3. This is particularly the case in relation to matters such as intensification, hazard mitigation works and new building over wider areas of slope instability. Subdivision is a process that creates the opportunity and expectation for subsequent land use and development to occur. It is important that any site limitations associated with risk from slope instability hazards are recognised as early as possible in the land development process. Section 106 of the RMA provides the opportunity to decline any application for subdivision approval where the land or any structure is likely to be subject to damage from erosion, falling debris, subsidence, slippage, or where subsequent use is likely to accelerate or worsen this damage. Reliance on s 106 has the limitation that slope instability hazards in the wider catchment with the potential to adversely affect a site may not be considered. The implications of development of the subject site on slope instability hazards and risk to neighbouring sites may not be fully considered potentially leading to life-safety risk for people within and beyond the subject site. Relying on minimal policy and supporting non-regulatory methods such as guidelines could have a number of implications including less robust assessments of the risk and in particular inadequate assessment of the effects on neighbouring sites. This would mean there is less confidence around the ability of this option to meet Objective 5.1.1 to reduce risk, particularly where there is a life-safety risk. The uncertainty associated with this approach may result in higher costs than those associated with the implementation of targeted controls. Overall, the option of a minimal-regulatory approach will mean the Council does not achieve its responsibilities under the RMA and CRPS and will create additional uncertainty and costs at a time when the community most needs direction and could leave the landowners exposed to slope instability hazards and associated life-safety risk or risk of damage to infrastructure and property.
Flood Hazard Policies and Rules Policies and rules which are less-directive could be devised to allow a variety of approaches to	**Flood Hazard Policies and Rules** **Appropriateness** In the Natural Hazard chapter, the assessment

flood hazards rather than adopting the minimum floor level approach in Floor Level and Fill Management Areas. This approach could see less- directive polices, retain the recognition of Floor Level and Fill Management Areas, but include a variety of tools to deal with the flood level prescribed rather than specifically requiring raised floor levels. This would require the identification of mitigation measures including structural and non-structural measures which improve resilience to flooding-related damage. Examples given are flood resistant construction (dry proofing) in areas of higher risk and the use of water resistant materials (wet proofing) in areas of lower risk, including: a. tanking the house – water proofing just above the level of frequent flooding (note that the event being planned for in the Natural Hazards chapter is a less frequent but more extreme event, "major storm event"; b. bunding - either raised mounds or sand bags; and c. property re-grading to improve drainage of flood waters away from the house. Local area schemes: include diversions, bunding and pumping, typically located on the street or on land with drainage easements. Provides wider benefits in terms of addressing the most vulnerable parts but also those considered less vulnerable, preserving occupancy rates, community, health and quality of life. Relocation – short-term relocation to rental accommodation or relocation of dwelling to another site. **Retreat: This option was not considered in this review process. It may be considered in more detail in Phase 2.**	matters for resource consents in Floor Level and Fill Management Areas cover similar proposed mitigation measures, so they are expected to form part of the solution in some cases. These types of alternatives are considered possible and practical but they are not a complete solution and do not in themselves give effect to the specific direction in the CRPS Chapter 11, Policy 11.3.2, to mitigate the 1 in 200 year storm event within the district by raising floor levels above the 0.5% AEP. Local area schemes could work but it is unlikely they can be designed to be cost-effective for a 1 in 200 year event. Proposed long-term flood defence schemes will not necessarily be designed to prevent flooding in more extreme events. While some flood defences could be designed in the future for a larger event such as 1 in 100 year event, in most cases it is unlikely they will be designed for events much beyond the 1 in 50 year flood.
Risk of Acting or Not Acting	
It is considered there is sufficient information on which to base the policies and rules without the risks being significantly over or understated. The risks of not acting are significant and include possible loss of life, injury and damage to property and infrastructure if natural hazard risks are not reduced. By not acting in the plan on natural hazards the community would become more vulnerable to their effects. Individual risk acceptance is normally higher than that for the community and so gradually over time development without any plan	

provisions would become more vulnerable to natural hazards.

The technical information available now on the nature of slope instability, flooding and liquefaction and its effects on Christchurch is considerable. Given the level of interest (research and development) in these issues for Christchurch, the level of (any) uncertainty about these natural hazard occurrences and consequences is likely to continue to reduce.

More information and certainty about the occurrence and consequences of liquefaction would not mean the proposed plan provisions are any more or less relevant or appropriate. The provisions provide an approach that is relevant at this point in time and in the foreseeable future and can be updated if required when new information becomes available.

The risk modelling on the Port Hills is robust but has bands of risks rather than lines per se. It is also the best available information to date and it is considered the proposed polices and rules are at the appropriate level given this. This is explained in more detail in Appendix 7. For example, the confidence limitations in the modelling is the main reason to date for retaining non-complying activity status for activities such as new buildings in Cliff Hazard Management Area 2 and limiting prohibited activity status to just four areas where the risk level has been calculated to be in the order of 10^{-1} to 10^{-2}, (extremely high risk) within Cliff Hazard Management Area 1.

PROVISIONS (POLICY, RULE, METHOD) <u>MOST APPROPRIATE WAY</u> TO ACHIEVE THE OBJECTIVES

Relevant objective:

5.1.2 Objective- Awareness of Natural Hazards

Increased public awareness of the range and scale of natural hazard events that can affect the district.

Provision(s) most appropriate	**Effectiveness and Efficiency**
Option 2 **(Strengthened policies and rules)** *5.2.7 Policy - Awareness of natural hazards* a. Ensure people are informed about the natural hazards relating to their properties and surrounding area. b. Encourage property owners to incorporate additional measures into the rebuild of earthquake damaged buildings beyond existing use rights to avoid or mitigate natural hazards affecting their property. [updated August 2014] These policies are partly implemented by including natural hazards on the planning maps. The planning maps showing the location of flooding, ponding and slope instability hazards at a property level. The identification of two liquefaction assessment areas in the district is also	**Effectiveness** *)* i. Informing people and the community about natural hazards is an effective and cost-efficient means of enabling people to apply that information to their circumstances in order to reduce their risk from natural hazards. ii. These provisions will be effective in achieving Objective 5.1.2 as they identify areas potentially affected by natural hazards. This can reduce risk by communicating where at-risk areas are and enable people to seek more information. iii. A more aware community through identification of hazards on the planning maps may increase demand from property owners for experts and lawyers with knowledge in the natural hazard industry. iv. The second policy acknowledges that the proposals in the DPR do not affect a property owners right to continue to

identified on the planning maps. The purpose of this is to alert property owners that assessment of this issue will be required prior to subdivision and some other land uses.	occupy and maintain/repair and in many cases rebuild their existing home regardless that it may fall within proposed natural hazard overlay provisions. However, it also acknowledges that there is an opportunity to provide natural hazard information (such as the information available in the District Plan, on LIMs and on the Councils website) to encourage property owners to be aware of the natural hazards on their site and to adopt additional measures (for example: raising floor levels) to mitigate those natural hazards. This policy will assist in achieving both Objective 5.1.1 and 5.1.2.
Options less or not as appropriate to achieve the Objectives and policies:	
Option 1 (Status quo – current policies and rules) There are no similar polices in the operative City Plan or the BPDP. There is minimum mapping of hazards in either plan. Reliance is placed on information contained in LIM reports.	**Appropriateness** In the post-earthquake environment it is considered inappropriate to not have polices and planning maps supporting increased awareness of natural hazards on individual properties and the district as a whole. Objective 5.1.2 is more difficult to achieve without the supporting polices and maps.
Option 3 (Less directive/conservative policies and rules) This would involve not having planning maps and specific polices to enable increased awareness and is similar to Option 1. Information maps from scientific reports and specific guidelines on dealing with hazards on properties could be provided as an alternative.	**Appropriateness** In the post earthquake environment it is considered inappropriate to not have polices and planning maps supporting increased awareness of natural hazards on individual properties and the district as a whole. Objective 5.1.2 is more difficult to achieve without the supporting polices and planning maps as part of the district Plan. The proposed Option 2 approach is considered more appropriate.
Risk of Acting or Not Acting	
It is considered there is sufficient information on which to base the policies and rules without the risks being significantly over or understated.	
PROVISIONS (POLICY, RULE, METHOD) <u>MOST APPROPRIATE WAY</u> TO ACHIEVE THE OBJECTIVES	
Relevant objective: ***5.1.4 Objective – Repair of earthquake-damaged land*** Repair of earthquake damaged land used for residential purposes is facilitated as part of the recovery.	
Provision(s) most appropriate	**Effectiveness and Efficiency**
Option 2 (Strengthened policies and rules) ***5.3.5 Policy – Repair of earthquake damaged land*** Facilitate recovery by enabling property	**Effectiveness** i. Policy 5.3.2 flows from the provisions placed in the operative district plan in 2013 by the Minister of Earthquake Recovery under s27 of the CER Act.

owners to make immediate repairs to earthquake damaged land for residential purposes in areas at risk of flooding where these repairs will have minimal adverse effects. Rule 5.8.2 - Repair of land used for residential purposes damaged by earthquakes within a Floor Level and Fill Management Area. The rule provides for up to 300mm above ground filling and 600mm below ground, limited to 10m³ volume of filling above ground per site for residential zones and 25m³ per site for commercial and industrial zones.	**Efficiency** It is considered efficient to place these rules in the Natural Hazards chapter in respect to Floor Level and Fill Management Areas as the operative plan will be superseded by this new plan and it is important that these provisions remain enabling of the repair of earthquake damaged residential land to achieve Objective 5.1.4 and LURP Action 2.
Option less or not as appropriate to achieve the Objectives and policies:	
Option 1 (Status quo – current policies and rules) Option 1 and 2 are the same as the provisions in the proposed Natural Hazards chapter in respect to the operative City Plan but reformatted. No provisions for Banks Peninsula are provided in either Option 1 or Option 2.	**Appropriateness** The transfer across of the provisions of the operative City Plan is considered appropriate at this time as the review of the s27 (Phase 2 land repair rules) was not complete at the time of writing.

6. SUMMARY OF CONSULTATION

Timetable of Consultation Undertaken

a. 15 March, Living With Hazards - Our Changing Environment forum, Salvation Army hall, 150 people attended;
b. 18 March, Shirley-Papanui, Papanui Baptist Church, attendance not recorded;
c. 19 March, Fendalton- Waimairi. Aurora Centre, 33 people attended;
d. 19 March, Hagley Ferrymead, Woolston Club, 20 people attended;
e. 25 March, Spreydon Heathcote, Cashmere Club, 4 people attended;
f. 26 March, Akaroa, Duvauchelle hall, 5 people attended;
g. 26 March, Port Hills Natural Hazard, Mt Pleasant Bowling Club, 20 people attended;
h. 27 March, General Stakeholders, Civic Offices, 26 people attended;
i. 27 March, New Brighton, South New Brighton Community Hall, attendance not recorded;
j. 28 April – Rehua marae – meeting with MKT; and
k. Taylors Mistake hazards and baches meeting.

An online survey was available during the consultation period. The results of the Survey Monkey can be found in **Appendix 8**.

Summary of the issues are provided in the table below

	ISSUE	VIEWS ESPRESSED	HOW OFTEN?	COMMENT	RECOMMENDED RESPONSE
1.	Need for certainty about what the Council is going to do about Sea Level Rise, and what are high flood hazard areas. All natural hazard issues should be addressed together.	When will areas be identified for retreat and by whom? Will people lose their property value? Consider coastal erosion, sea level rise and managed retreat now in the first phase of the DPR; all natural hazards should be addressed together	7	These are difficult issues which will take some time to work through. The Council already mitigates by using 0.5m Sea Level Rise in Flood Management Areas, and has indicated its preference for using 1m sea level rise. Further work is underway to identify high hazard flood areas in terms of depth and velocity of flooding, for Phase 2 of the Natural Hazards chapter. Ongoing work around Sea Level Rise will also inform the Coastal chapter in Phase 2 of the DPR.	Use 1m Sea Level Rise in identifying Flood Management Areas. Remainder of Sea Level Rise issues to be addressed in Phase 2 of the DPR.
2.	Concern about flooding issues generally and what the short and long-term solutions are.	Localised flooding issues in several parts of Christchurch other than Flockton Basin. Need for works such as dredging to increase capacity of rivers, and other physical works, e.g. more stopbanks.	8	Flooding issues are being addressed in the short term via the Mayoral Task Force on flooding, and the Land Drainage Recovery Plan, e.g. the Task Force is to provide a recommended programme of actions and costs with regard to properties where	No change, as DPR can only focus on longer term reduction of damage to property.

				floodwaters have entered houses. The Task Force has already been authorised to provide for dredging and an improved maintenance programme in the Heathcote River. The DPR can only deal with longer term solutions by requiring raised floor levels upon redevelopment.	
3.	Banks Peninsula flooding/sea level rise	Sea level rise/flooding needs to be given more attention for Banks Peninsula. Require new development to be located in lower flood risk areas, and require raised floor levels in flood prone areas.	4	Some mapping of the potential effects of Sea Level Rise on parts of Banks Peninsula has already been undertaken but it is agreed that there is a need for more attention to be given to flooding issues generally on the Peninsula in Phase 2 of the DPR. To date there has been no flood modelling in the former Banks District and a programme for priority areas will need to be developed. Under the Natural Hazards chapter policies, raised floor levels are still required in Banks Peninsula.	Further work in Phase 2 of the DPR.
4.	Ability of infrastructure to cope with intensification	Concerns about ability of infrastructure to cope with stormwater with the intensification proposed in draft Residential chapter.	11	Will need to be addressed outside of the District Plan in a separate process. There will be further, more detailed planning for residential intensification areas, and any intensification will be coordinated with infrastructure improvements.	No change
5.	Sparks Road plan change area and flooding.	Area between Lincoln and Sparks Roads proposed for development but is already prone to flooding.	9	Provisions relating to the Sparks Road 'plan changes' will be included in the Residential chapter. Stormwater management is already a significant focus for this area. There will need to be filling to above 1 in 200 year flood levels, coordinated with	No change

				geotechnical ground strengthening. Careful management of works will be required due to high water tables in this area.	
6.	Specific stability mapping requests.	Requests to remove particular properties for hazard categories.	2	Further checking work comparing actual ground conditions to model results (ground truthing), has been completed and adjustments made to the boundaries of Cliff Hazard and Rockfall Hazard 1 areas.	Minor mapping changes.
7.	Utilities within hazard areas.	Clarify whether Utilities chapter will exempt utilities from having to comply with Natural Hazards rules.	1	Planning provisions for all utilities will be reviewed in Phase 2 of the Review and this will include consultation with utility operators. It is considered appropriate not to provide an exception for utilities from the natural hazards land instability rules but ongoing discussion is required given the utilities work still to be completed…	No change.

1. At the public meetings there was clear recognition of the need to plan for hazards as a result of Canterbury's experience. There was also general support expressed for the approaches taken to date, for example, the concept of raising floor levels to mitigate flooding damage. Many people sought understanding of how the proposed rules would affect their properties.

2. Many of the public and stakeholder-written and online comments sought coverage of further topics in the chapter. To the extent that there was a common theme, it was around a need for greater certainty, and a desire for quick answers as to how the Council and the community at large should best manage all natural hazards.

3. These are large and complex questions which will take some time for both the Council and the community to work through, and which extend beyond the District Plan. The questions touch on appropriate combinations of engineering and planning methods, other regulatory responses, for example, under the Building Act, and political and legal questions as to appropriate mechanisms to determine collective courses of action. Not the least are the wider questions of affordability, and how the costs of reducing risk from hazards should be spread.

APPENDIX 1: LINKAGES BETWEEN ISSUES, OBJECTIVES AND POLICIES

AUGUST 2014

LINKAGES BETWEEN PROVISIONS

Strategic Directions	Natural Hazard Objectives	Natural Hazards Policies	Natural Hazards Rules
3.6.2 Objective - Development form and function requires an integrated pattern of development and well-functioning urban form that, amongst other things, ii. avoids natural hazards or adequately remedies or mitigates the risks 3.6.5 Objective - Natural Hazards. The risk to people, property and infrastructure from natural hazards is avoided or reduced to acceptable levels	5.1.1 Objective - Reduced risk Reduced risk to people, property, infrastructure and the environment from the effects of natural hazards, including: a. intense rainfall events; b. liquefaction; c. cliff collapse; d. tsunami; e. inundation from the sea; f. coastal erosion; g. exacerbation of hazards through climate change…sea level rise; and h. multiple hazards. .	General natural hazard policies 5.2.1 Policy – Avoid development where there is unacceptable or intolerable risk 5.2.2 Policy – Critical infrastructure 5.2.3 Policy – Restrict land use to avoid or mitigate hazards 5.2.4 Policy – Precautionary approach 5.2.5 Policy –Worsening, adding or transferring hazard 5.2.6 Policy – Natural features providing hazard resilience Flooding policies 5.3.1 Policy – High flood hazard 5.3.2 Policy – Flood protection works 5.3.3 Policy - Protection of flood storage and overflow areas 5.3.4 Policy – Flood damage mitigation by raising floor levels	5.8 Flood Hazard Rules 5.8.1 Residential Zones –Activities and Earthworks in Floor Level and Fill Management Areas 5.8.1.1 Permitted activities 5.8.1.2 Restricted discretionary activities 5.8.1.3 Discretionary, non -complying and prohibited activities 5.8.3 Commercial and Industrial Zones - Activities and Earthworks in Floor Level and Fill Management Areas 5.8.3.1 Permitted activities 5.8.3.2 Restricted discretionary activities 5.8.3.3 Discretionary, non complying and prohibited activities 5.9 Liquefaction Rules 5.9.1 Permitted activities - Liquefaction Assessment Areas 1 and 2 5.9.2 Restricted Discretionary Activities Liquefaction Assessment Areas 1 and 2 5.9.3 Restricted Discretionary Activities Liquefaction Assessment Area 1 5.9.4 Discretionary, non complying and prohibited activities – Liquefaction Assessment Areas 1 and 2 5.10 Port Hills and Banks Peninsula Slope Instability Rules 5.10.1 Activity status for Port Hills and Banks Peninsula Slope Instability Management Areas 5.10.2 Remainder of Port Hills and Banks Peninsula Slope Instability Management Areas - RD1, RD2 and RD3 Matters for discretion

		Geotechnical risks including liquefaction (flat areas): 5.4.1 Policy –Liquefaction susceptibility 5.4.2 Policy – Management of geotechnical risks on flat land Slope instability policies: 5.5.1 Policy – Areas subject to an intolerable risk to life-safety from potential cliff collapse 5.5.2 Policy – Areas potentially affected by rockfall or boulder roll	5.10.3 Slope Instability Management Areas – D5 to D23 Assessment Matters for Land Use Resource Consents 5.10.4 Slope Instability Management Areas –D1-D12 Assessment Matters for Subdivision or Earthworks Resource Consent Applications 5.11 General procedures - Information Requirements 5.11.1 Information requirements for all plan changes 5.11.2 Additional information requirements for all resource consent applications for subdivision 5.11.3 Additional information requirements for applications for resource consent for land use activities in flat areas where a geotechnical report is required. 5.11.4 Additional information requirements for applications for resource consents within Port Hills and Banks Peninsula Slope Instability Management Areas.
		5.5.3 Policy – Areas potentially affected by mass movement 5.5.4 Policy – Slope instability in areas not already identified as cliff collapse, rockfall or mass movement (remainder of the Port Hills and Banks Peninsula) 5.5.5 Policy – Hazard mitigation works for slope instability in the Port Hills and across Banks Peninsula 5.6 Interim Coastal Hazards Policies (to be further considered in Stage 2 of the DPR) 5.6.1 Policy – Climate Change and	

		sea level rise 5.7 Policy - Multiple Natural Hazard Areas	
	5.1.2 Objective Awareness of natural hazards. Increased public awareness of the range and scale of natural hazard events that can affect the district.	5.2.7 Policy - Awareness of natural hazards	Planning Maps
	5.1.3 Objective – Repair of earthquake damaged land. Repair of earthquake damaged land used for residential purposes is facilitated as part of the recovery	5.3.5 Policy – Repair of earthquake damaged land	5.8.2 Repair of land used for residential purposes damaged by Earthquakes within a Flood Management Area (provisions previously introduced under s 27 CER Act to the operative Plan). 5.8.2.1 Permitted activities 5.8.2.2 Restricted discretionary activities 5.8.2.3 Discretionary, non complying and prohibited activities 5.8.2.4 Exemptions to Rules 5.8.2.1 and 5.8.2.2

APPENDIX 2: BIBLIOGRAPHY

Natural Hazards Bibliography
General

Document Title/Date	Author/s	Overview of Document	Relevant sections for Natural Hazards Review (where specified)	Web link (if known/applicable)
Recovery Strategy for Greater Christchurch (2012)	CERA			
LURP Dec 2013	ECan and strategic partners			
Ch 6 of the CRPS including Map A showing greenfield priority areas (Appendix 1 of Dec LURP)	Ecan			
Chapter 11 of the CRPS - Natural Hazards	Ecan			http://ecan.govt.nz/publications/Plans/crps-chapter11.pdf
Christchurch City Council - District Plan (2005)	CCC			
Banks Peninsula District Plan	BPDC			
Draft Canterbury Civil Defence Emergency Management Plan May 2013		Principles of Emergency Management. Hazard/risk matrix with likelihood/consequences of particular hazards as assessed for Canterbury		

Managing Natural Hazards in New Zealand – Towards more resilient Communities: A thinkpiece" interim report - 10 April 2014	Enfocus Ltd, various contributors	A report for local and central government and others with a role in managing natural hazards		
Risk Based Land Use Planning for Natural Hazards reduction - Sep 2013- GNS Misc Series 67	Risk Based Land Use Planning for Natural Hazards Risk Reduction - Sep 2013- GNS Misc Series 67			GNS website
Planning for Risk - Incorporating Risk based Land Use Planning into a District Plan - Aug 2013 - GNS Misc Series 63	GNS	Model District Plan Natural Hazards chapter		http://www.gns.cri.nz/Home/Our-Science/Natural-Hazards/Risk-Society/Societal-Resilience/Policy-and-Planning

Natural Hazards Bibliography
Flooding

Document Title/Date	Author/s	Overview of Document	Relevant sections for Flooding Review (where specified)	Web link (if known/applicable)
Flooding Specific Documentation				
S35 monitoring reports for CCC and Banks DP	Response Planning	Comments on Practice with Filling and Excavation provisions and waterway setbacks		
Investigation into the River and Tidal Flood Protection needs for Christchurch - Avon River Stage 1 report	GHD	Engineering response to extreme flooding scenarios and 1m SLR post earthquake changes to flood susceptibility.		
Investigation into the River and Tidal Flood Protection needs for Christchurch - Styx River Stage 1 report	GHD	Engineering response to extreme flooding scenarios and 1m SLR post earthquake changes to flood susceptibility. Stopbank options for 4		
Investigation into the River and Tidal Flood Protection needs for Christchurch - Heathcote River Stage 1 report	GHD	Engineering response to extreme flooding scenarios and 1m SLR post earthquake changes to flood susceptibility. Global option = tidal		
Investigation into the River and Tidal Flood Protection needs for Christchurch -Estuary and Sumner Stage 1 report	GHD	Engineering response to extreme flooding scenarios and 1m SLR post earthquake changes to flood susceptibility. Global options incl tidal		
Project charter for above reports	CCC	Brief May 2012		
Flood Risk in Christchurch briefing 11 Dec 2013	CCC - Helen Beaumont	PowerPoint covering regulatory responses - Building Act, RMA, land damage and EQC and Land Drainage		
Dudley Creek/Flockton Basin presentation to residents, September 2013	CCC - Graham Harrington, Tom Parsons	PowerPoint covering Council's response to increased flooding in this area to date.		
Land Drainage Recovery Programme Residents Questions from Flockton meetings, September 2013	CCC - Tom Parsons	Response to questions raised at Flockton basin meetings		

Land Drainage Recovery Programme Management Plan Draft May 2013	CCC - Mike Gillooly	Sets out three year investigation and scoping programme for land drainage recovery - 52 new projects.		
LDRP- Project charter Project 50 - Post earthquake filling of land - project charter Nov 2013	Aecom for CCC - Mike Gillooly	Establishing the cumulative effects of filling in the floodplain, and filling building platforms - postulating various extents of filling.		
LDRP- Project charter Project 52 -Floor Levels and Building platform policy - project charter Nov 2013	Aecom for CCC - Mike Gillooly	Interrelated with Project 50 - assessment of planning implications due to filling of sections using GD013 i.e. 1 in 50 years ARI level plus freeboard. Looking at different extents of filling within sections, e.g. building footprint, building footprint plus 1.8m, whole section. Intended as input to DP Review		
CCC - BCA Guidance Document GD013- Building on land subject to Natural hazards	CCC - Patrick Schofield, Mike Gillooly, Judith Cheyne	Sets out Council's approach to building in flood prone areas and guidelines to avoid a hazard notice under section 73 of the Building Act		CCCwebsite
File note of experience to date with FMA - consents - Jan 2014	Glenda Dixon	No site specific assessment where applicants are offering interim min floor level from CERA website		
Email on use of freeboard in 2003 FMA	Tony Oliver	States that it is justifiable to stretch modelled water surface beyond "wet areas" to meet ground, as so many		
Northland Regional Policy Statement 2012	Northland Regional Council	An "award winning RPS" .Considers only 10-year and 100-year flood hazard areas. Uses 500mm freeboard for residential buildings and 300mm for commercial/industrial.	Section 7 Natural Hazards.	On-line
Hamilton District Plan 2012	Hamilton City Council	Three general flood hazard areas based on levels of risk, including overland flow paths and three geographically specific flood hazard areas. Uses 1 in 100 year storm event. Mention of	Section 22 Natural Hazards	On-line

Proposed Kapiti District Plan 2012	Kapiti Coast District Council	Comprehensive approach to hazards, Flood mapping based on 1 in 100 flood event = likely hazard event, identifies 9 different flood hazard categories - no mention of freeboard.	Section 9.2 Flood Hazard	on-line
Western Bay of Plenty District Plan 2012	Western Bay of Plenty District Council	Hazard mapping including flooding, coastal protection areas (coastal erosion). 2009 s32: Uses 1 in 100 year rainfall and 1 in 20 year ARI sea level as max coastal flooding scenario, but adds in climate	Section 8 Natural Hazards	http://www.westernbay.govt.nz/Documents/Publications/DistrictPlan/Waihi%20Beach%20Floodable%20Areas/Report_Waihi_Beach_Flood_Mapping_Tonkin_Taylor.pdf
Tauranga City Plan 2013	Tauranga City Council	Flood hazard provisions- minimum floor levels in Flood Hazard Plan Area based on possible harbour inundation - situated lower than 2.5-2.9 above Moturiki datum. RD to build in these areas.	Chapter 8 Natural Hazards	http://econtent.tauranga.govt.nz/data/city_plan/ch/8/8_natural_hazards_provisions.pdf

Natural Hazards Bibliography
Liquefaction

Document Title/Date	Author/s	Overview of Document	Relevant sections for Liquefaction Review (where specified)	Web link (if known/applicable)
Liquefaction Specific Documentation				
Review of liquefaction assessment hazard information in Eastern Canterbury, including Christchurch City and parts of Selwyn, Waimakariri and Hurunui Districts	Ecan Technical report R12/83, Dec 2012	Includes Fig 2.1, liquefaction assessment area map for the Eastern Canterbury project area. Hardcopy has disk with GIS shapefiles for this figure	Line between damaging liquefaction unlikely and liquefaction assessment needed, which is advanced by Ecan as a basis for planning controls. Will need to fall back on this as a basis for liquefaction rules as MBIE unwilling to endorse our use of TC categories (see below)	
MBIE - notes on TC information for CCC, Nov 2013	Pam Johnston, MBIE compiled these after phone conference and meeting with her and Mike Stannard, MBIE	Explains MBIE reservations about the direct use of TC categories in planning controls - generalised to property boundaries, not technically robust enough to be used in hearings, will be replaced with depth weighted LSN (liquefaction severity number) in due course but not yet.		
Hutt City Plan Change 29 - Petone Mixed Use Activity Area	June 2012 - at appeal	Provisions inserted after submission from GNS and WRC but still very general - require natural hazards to be added as a matter of discretion for all new buildings in area so they are assessed as part of resource consent process. This includes mention of potential fault	Liquefaction risk seems to be standardised across this whole area	
GHD memo reviewing other district plan provisions	Oct-13	Note this has mention of liquefaction as a hazard in determining urban growth options in Marlborough DP , Hutt City provisions		
Christchurch fact finding report - Liquefaction and lateral spreading	Hill Young Cooper	Consideration of liquefaction and lateral spreading hazards in the zoning and development of the eastern suburbs for Christchurch from 1977 to 22 Feb 2011		

Management of Earthquake risk by CRC and CCC- Obligations and Responses under RMA -Nov 2011	Enfocus	Commissioned as input into Royal Commisssion. Investigation of manner in which earthquake risk issued was dealt with in planning documents of CRC and CCC, obligations under RMA and steps taken by Councils.		
Ditto - Further comment on Enfocus report and Council's official response to Enfocus report	CCC			
Minutes from TLA Planners Liquefaction workshop Sep 2013	Marion Gadsby - Ecan	Discusses MBIE approach to TCs and Ecan report 2012 which is a return to a broader brush approach for Greater Chch including areas which do not have a technical Category (TC) (Ian McCahon). Appropriate management is a balance between risk and cost of investigations (av $15,000 per site). Debate about whether liquefaction is covered by s106 but precautionary approach.		
Emails re effect of intensification or ground strengthening on liquefaction potential of adjoining sites March 2014	Marion Gadsby and other geotechs	Too many variables- would need to look at on a case by case basis		
Email re definition of liquefaction line on Banks Peninsula, March 2014	John Begg, GNS	Use of 20m contour line		

Natural Hazards Bibliography
Port Hills and Banks Peninsula Slope Instability

Document Title/Date	Author/s	Overview of Document	Relevant sections for Port Hills and Land Instability Review (where specified)	Web link (if known/applicable)
Port Hills and Banks Land Instability Documentation				
GHD memo reviewing other district plan provisions	GHD Oct-13	Mention of Wanganui District Plan Change 25: Natural Hazards re slope instability provisions. High and moderate risk for slope instability and		
Western Bay of Plenty District Plan 2012	Western Bay of Plenty District Council	Land Stability hazard areas. Seems to include an area of residual risk	Section 8 Natural Hazards	
Definition of geoprofessional - email discussion	Glenda Dixon & Ian Wright, CCC	Background to use of term in slope instability rules.		
Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Pilot study for assessing life-safety risk from cliff collapse. Consultancy Report 2012/57; March 2012 FINAL	GNS Science (Massey et al)			http://www.ccc.govt.nz/homeliving/civildefence/chchearthquake/porthillsgeotech/porthillsgnsreports.aspx
Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Life-safety risk from cliff collapse in the Port Hills. Consultancy Report 2012/124; March 2012 FINAL	GNS Science (Massey et al)			http://www.ccc.govt.nz/homeliving/civildefence/chchearthquake/porthillsgeotech/porthillsgnsreports.aspx
Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Pilot study for assessing life-safety risk from rockfalls (boulder rolls).Consultancy Report 2011/311 March 2012 FINAL	GNS Science (Massey et al)			http://www.ccc.govt.nz/homeliving/civildefence/chchearthquake/porthillsgeotech/porthillsgnsreports.aspx
Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Life-safety risk from rockfalls (boulder rolls) in the Port Hills. Consultancy Report 2011/123 March 2012 FINAL	GNS Science (Massey et al)			http://www.ccc.govt.nz/homeliving/civildefence/chchearthquake/porthillsgeotech/porthillsgnsreports.aspx

Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Additional assessment of the life-safety risk from rockfalls (boulder rolls).Consultancy Report 2012/214 September 2012 FINAL	GNS Science (Massey et al)		http://www.ccc.govt.nz/homeliving/civildefence/chchearthquake/porthillsgeotech/porthillsgnsreports.aspx
Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Stage 1 report on the findings from investigations into areas of significant ground damage (mass movements).Consultancy Report 2012/317 August 2013 FINAL	GNS science (Massey et al).		http://www.ccc.govt.nz/homeliving/civildefence/chchearthquake/porthillsgeotech/porthillsgnsreports.aspx
Slope Hazard Susceptibility Assessment Akaroa Harbour Settlements (Job no:51152/ver1.0).March 2008	Tonkin & Taylor Ltd		
Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Risk assessment for Redcliffs. GNS Science Consultancy Report 2014/78, 2014.	GNS Science Consultancy (Massey et al)		To be made available on CCC website 22 August 2014
Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Risk assessment for Quarry Road. GNS Science Consultancy Report 2014/75,.2014.	GNS Science Consultancy (Massey et al)		To be made available on CCC website 22 August 2014
Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Risk assessment for Maffeys Road. GNS Science Consultancy Report 2014/79, 2014.	GNS Science Consultancy (Della Pasqua et al)		To be made available on CCC website 22 August 2014o
Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Earth/Debris flow risk assessment for Defender Lane. GNS Science Consultancy Report 2014/67, 2014.	GNS Science Consultancy (Della Pasqua et al)		To be made available on CCC website 22 August 2014o
Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Debris avalanche risk assessment for Richmond Hill, GNS Science Consultancy Report 2014/34, 2014	GNS Science Consultancy (Massey et al)		To be made available on CCC website 22 August 2014o

Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Risk assessment for Cliff Street. GNS Science Consultancy Report 2014/73, 2014	GNS Science Consultancy (Massey et al)		To be made available on CCC website 22 August 2014o
Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Risk assessment for Deans Head. GNS Science Consultancy Report 2014/77, 2014 – DRAFT FINAL	GNS Science Consultancy (Massey et al)		To be made available on CCC website 22 August 2014o

Natural Hazards Bibliography
EQ Fault Lines

Document Title/Date	Author/s	Overview of Document	Relevant sections for Earthquake Fault line review (where specified)	Web link (if known/applicable)
Earthquake Fault Line Specific Documentation				
Proposed Kapiti Coast District Plan 2012 & Plan Change 61	Kapiti Coast District Council	Very detailed approach to Fault Avoidance Areas based on Recurrence Interval classes, Building Importance Categories and Fault Complexity. See Table 9.3 risk based matrix table for fault hazard resulting in different land use activity classes.		
Wellington City District Plan and Plan change 22 2004	WCC	Hazard (fault line) area through Thorndon (narrow band) and wider hazard (ground shaking) area. Critical facilities require consent as an RDA in Ground shaking area where otherwise permitted (Suburban centre and Central Area zones only?) Aim is to locate critical facilities as far as possible from hazard areas.	See e.g. 7.3.6 Suburban centres ground shaking areas assessment matters e.g. engineering report that structure will perform safely under hazard conditions	
Minutes from TLA Planners Earthquake Fault Lines workshop Sep 2013	Marion Gadsby, Ecan	Where active faults are identified, fault rupture hazard avoidance zones 20m wide. Definition of avoidance zones requires an active earthquake fault trace i.e. rupture at surface, and mapping at 1:10000 scale. Can't be done in Chch as no active faults with surface evidence and location is only inferred. NB only quarter to half of NZ's earthquakes on known faults.		
Planning for Development of land on or close to Major Faults: Guideline	MFE 2003	Planning for fault rupture hazard		

Planning for Development of land on or close to Major Faults : A study of the adoption and use of Active Fault Guidelines	GNS 2005			

Natural Hazards Bibliography
Multiple Hazards

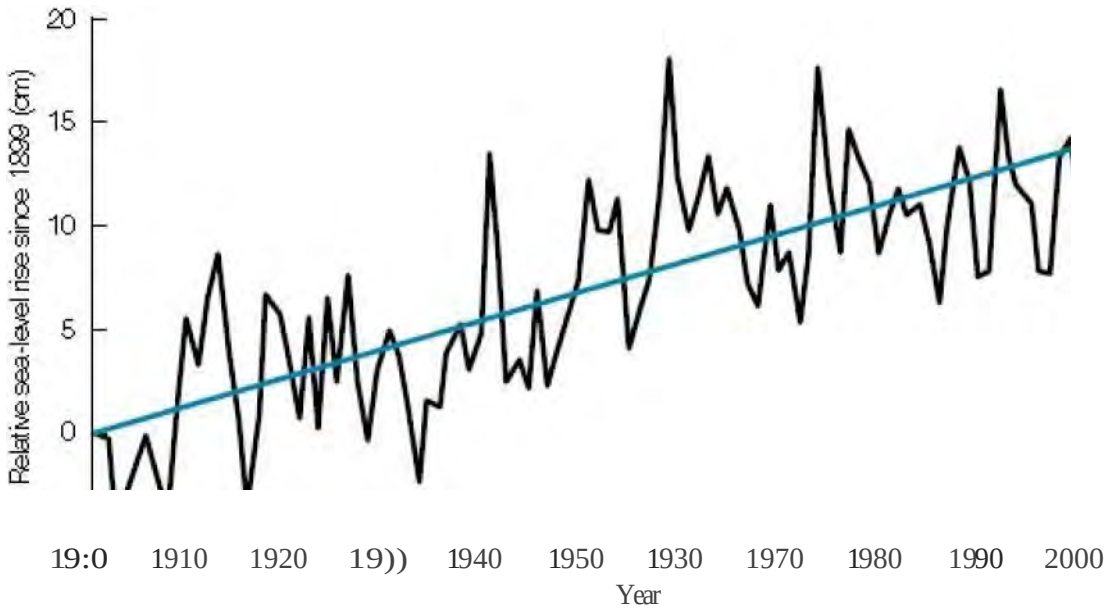
Document Title/Date	Author/s	Overview of Document (2-3 sentences)	Relevant sections for Multiple Hazard (where specified)	Web link (if known/applicable)
Multiple Hazard Specific Documentation				
Kapiti District Plan		Hazard mapping with different hazards as overlays		

Natural Hazards Bibliography
Coastal Hazards

Document Title/Date	Author/s	Overview of Document	Relevant sections for Multiple Hazard Review (where specified)	Web link (if known/applicable)
Coastal Hazard Specific Documentation				
Tauranga City Plan		Coastal erosion risk zones for 50 years and 100 years		
Western Bay of Plenty District Plan		Coastal hazard mapping		
Kapiti District Plan		Coastal erosion lines		

D

Avon River Sea Level Rise Investigation



AUGUST 2014

Christchurch

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CHRISTCHURCH
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Christchurch City Council Report March 2014

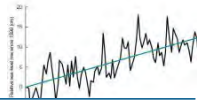
AUGUST 2014

This report has been prepared under the DHI Business Management System certified by DNV to comply with ISO 9001 (Quality Management)

Avon River Sea Level Rise Investigation

Prepared for Christchurch City Council

Represented by Mr Graham Harrington



Annual mean relative sea-level data [black line] from the Port of Auckland, Waitemata Harbour, and the sea-level trend line [straight blue line] (1899–2007).

Project manager Greg Whyte

Project number	44800601
Approval date	8/04/2014
Revision	4.0
Classification	Restricted

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CONTENTS

1 Introduction

The Christchurch City Council (CCC) presently considers the effects of 0.5m Sea Level Rise (SLR) for setting house floor levels, however the reasonable useful life of the post-earthquake rebuild housing stock may be 100 years The latest science is suggesting a 1m SLR is very likely in 100 years. It may be appropriate therefore for the City Council to set floor levels in building consents allowing for the effects of 1m SLR.

In this project the Avon Catchment is being used as a study area to understand the additional flooding risk of 1m Sea Level Rise (SLR) and the necessary adjustment of design floor levels to adapt to this risk as it emerges.

This report outlines the science behind SLR, the responses by other main centres in New Zealand, the modelling methodology and the alterations to design floor levels in various areas in the lower Avon Catchment if the effects 1m SLR are addressed.

2 Background

2.1 Why allow for SLR?

Sea level rise is one of the most direct links to global temperature rise. Geological evidence of past sea levels has been used to reconstruct conditions during prior interglacial periods to get a picture of how sea levels are changing. (DHI, 2012) This work shows that sea levels are increasing and this must be accounted for by local and regional authorities.

Sea level rise is driven by many different factors, but mainly:

- Increasing sea temperature, which causes thermal expansion of the oceans;
- Melting of the Arctic/Antarctic ice caps and glaciers worldwide; and
- Rapid reduction in areas of Arctic/Antarctic sea ice during the summer, which causes increased absorption of heat in the ocean (DHI, 2012).

The Intergovernmental Panel on Climate Change (IPCC,2014) report released in September 2013 reveals even greater rates of sea level rise than predicted in earlier versions. Improved data collection and modelling accuracy have largely improved confidence in sea level rise predictions and indicate that is “very likely” (90–100% probability) that mean sea level rise during the 21st century period will exceed the rate of that observed during 1971 – 2010. It is “virtually certain” (99–100% probability) that sea level rise will continue beyond 2100 and its magnitude will depend on future emissions.

A series of scenarios predict global mean sea level to rise between 0.44 (0.28-0.61) and 0.74 (0.52-0.98) by 2100 (IPCC, 2014). The annual absolute sea-level rise over the 20th century for New Zealand is around 2.1 mm per year. This is at the high end of the observed global average absolute sea-level rise of 1.7 ± 0.5 mm per year over the 20th century (MfE, 2008). The trends observed in New Zealand, however, are still consistent with those observed globally (e.g. Cole, 2011).

The Ministry for the Environment (MfE, 2008) recommends for planning and decision timeframes out to 2100 that:

1. a base value sea-level rise of 0.5 m relative to the 1980–1999 average be used, **along with**

2. an assessment of potential consequences from a range of possible higher sea-level rise values. At the very least, all assessments should consider the consequences of a mean sea-level rise of at least 0.8 m relative to the 1980–1999 average.

Following new research (IPCC 2014) there is now strong argument emerging that future sea level rise may be considerably higher than previously thought, and consequently, many local governments have adjusted their policies accordingly.

Auckland Council planning and policy must now take account of the “1m projected sea level rise” (The proposed Auckland Unitary Plan, 2013; based on a 100 year planning horizon and policy advice from NIWA).

Sea level monitoring in Wellington Harbour since 1990 indicates that sea level will rise 0.8m by 2090, or 1m by 2115 (the NZ Coastal Policy Statement requires planning timeframes of at least 100 years). Similar sea-level rise values are used in planning in most areas in Australia and the United Kingdom. A report prepared for the Greater Wellington Regional Council by NIWA in 2012 suggested working to a 1 metre increase in sea-level by 2115 (with a bounded flexibility covering a range of 0.7 – 1.4m). Additionally they recommended that vulnerability studies include sea-level rises of 0.5 (low scenario), 1, 1.5 and 2m (very high scenario) to cover the range of plausible estimates of potential sea-level rise (Bell and Hannah, 2012).

Climate change projections for Dunedin predict sea level to rise by 0.3m by 2040 and by 0.8 - 1.6m by 2090 (based on work from IPCC, 2007; MFE, 2008; and Fitzharris, 2010). Therefore Dunedin has decided to plan for a minimum of +0.8 and a maximum of +1.6 of sea level rise by 2090.

A report by Tonkin & Taylor (T&T 2013) for Christchurch concluded that “future studies involving tsunami, inundation and erosion hazards should consider the effect of a SLR of 1.0 metre to the year 2115”. As stated in the report a 1.0 metre SLR is generally in line with the current state of knowledge presented in the 2008 MfE guidelines and the Royal Society of NZ Emerging Issues paper.

2.2 CCC Policy Change

The purpose of this study is to quantify the effect of applying a 1 metre SLR to the Avon River model versus a 0.5 metre SLR, in terms of the increase in the number of floor levels at risk of flooding. This will assist CCC in considering a policy change to increase an allowance for sea level rise from 0.5 metre to 1.0 metre. For a number of years the City Council has been preparing for Climate Change by investigating the effects of predicted rainfall and tide level increases will have on the City and accounting for these increases when approving plan changes and setting building development levels. The current policy on climate change is to plan for a +16% increase in rainfall and a 0.5m increase in the tide level in the next 100 years.

2.3 Model Description

The Avon River flood model is a computational model that uses a standardised “design” rainfall storm to simulate the potential flooding during a storm event in the Avon catchment. The model combines measured surface level data, river and stream cross sectional data and some piped infrastructure data to represent the stormwater drainage system.

The catchment itself, which represents the area where rainfall will fall and collect into the river system, encompasses an area that can be broken into three distinct reaches, the Upper, Middle and Lower Avon. The Upper Avon includes all tributaries upstream of Mona Vale, which are on gravels of an old bed of the Waimakairi River. The Middle reaches of the Avon River span from Mona Vale to Kerrs Reach where the river is fairly entrenched but with localised low areas in the floodplain. The Lower Avon extends from Kerrs Reach to the Avon-Heathcote Estuary which is affected by tidal events and tidal flooding.. The Avon River has in the past been a flood channel for the Waimakariri River with a low lying floodplain that has poor drainage. The catchment outflows at the point where the Avon river passes under Bridge St, flowing into the Avon-Heathcote estuary.

The water levels at this outflow point in the model are controlled by a synthesised varying tide level where the peak of the tide coincides with the peak of the flooding in the lower Avon. The Avon River Hydraulic model is being progressively updated by DHI for CCC, this study uses model version labelled “D13”. More comprehensive details of the Avon River hydraulic model can be found in the Avon River Model Status Report, (GHD, 2013).

3 Modelling Methodology

An additional 0.5 metre to the tide level equates to an addition of 0.5 metre throughout the entire tide series, as the assumption is that the tide level is permanently increased by Climate Change. The 0.5 metre does not allow for storm surge which could occur during a severe weather event.

The simulations compared were based on the 200 year ARI with Climate change rainfall, using the land levels after the December 2011 Earthquake, with the lower Avon temporary stopbanks “removed” and a 20 year ARI design tide . The 200 year ARI (annual recurrence interval) represents a rainfall event that, statistically, will happen once in every 200 years or has 0.5% chance of occurring in any one year period. The model includes a combination of 9 hour (Upper Catchment), 18 hour (Middle and Lower Catchment) and 24 hour (Cranford Basin) rainfall durations throughout the catchment. These durations are the critical duration used for the various parts of the Avon River catchment. The Climate Change adjusted rainfall is an addition of 16% rainfall depth to the standard design rainfall depth and the actual depth of rainfall is listed in Table 3-1. The post December earthquake data representing the land surface, river and associated tributary cross sections was used where available, however in some areas new surveys were not completed. The removal of the temporary stopbanks represents the situation where the surface level, where the stopbanks are, is set to the level of the surrounding terrain as if the stopbanks were flattened. It is assumed that on average the house floor levels in the Avon catchment are 300 millimetres above the lowest property parcel level.

Model Boundary Data	Values
200 year 18 hour rainfall depth +16%	156.5 mm
Peak tide level 20 year +0.5m	11.369m (CDB datum[1])
Peak tide level 20 year +1m	11.869m (CDB datum)

Table 3-1 Model Boundary Data Values

[1] Christchurch Drainage Board datum, 9.043m above the Lyttleton datum, which is approximately 0 at mean sea level.

4 Results and Discussion

The supporting flood maps, Figures 4-1, 4-2 and 4-3 show the relative difference in flood risk between the 0.5 metre SLR scenario and the 1 metre SLR. The effects of adopting a 1 metre SLR can be seen as far upstream as Manchester Street in the CBD. The Snellings Drain area has maximum flood risk levels increase by 0.1-0.2 metre. Both the City Avon Corridor and the Lower Dudley area have flood risk level increases of up to 0.2 metre. The Avondale area has flood risk level increases of 0.3-0.4 metre. Porritt Park has flood risk level increases of between 0 and 0.4 metre. The Bexley and South New Brighton areas can expect flood risk level increases of 0.4-0.5 metre. The worst affected area Burwood could expect flood risk level increases of 0.5-0.6 metre

Figure 4-1 Flood Risk Extent and Depth Difference Map – Central City

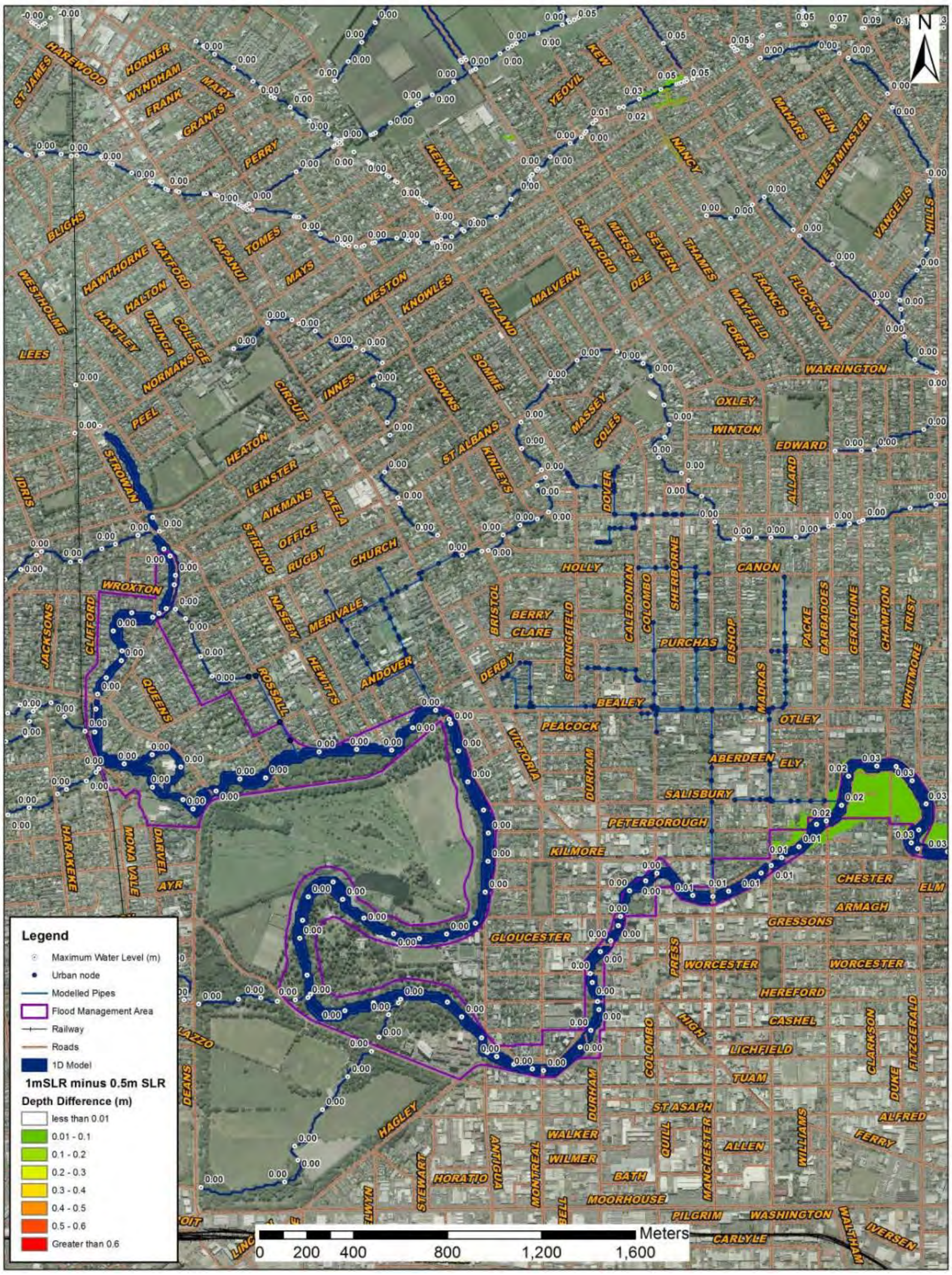

Figure 4-2 Flood Risk Extent and Depth Difference Map – Avonside

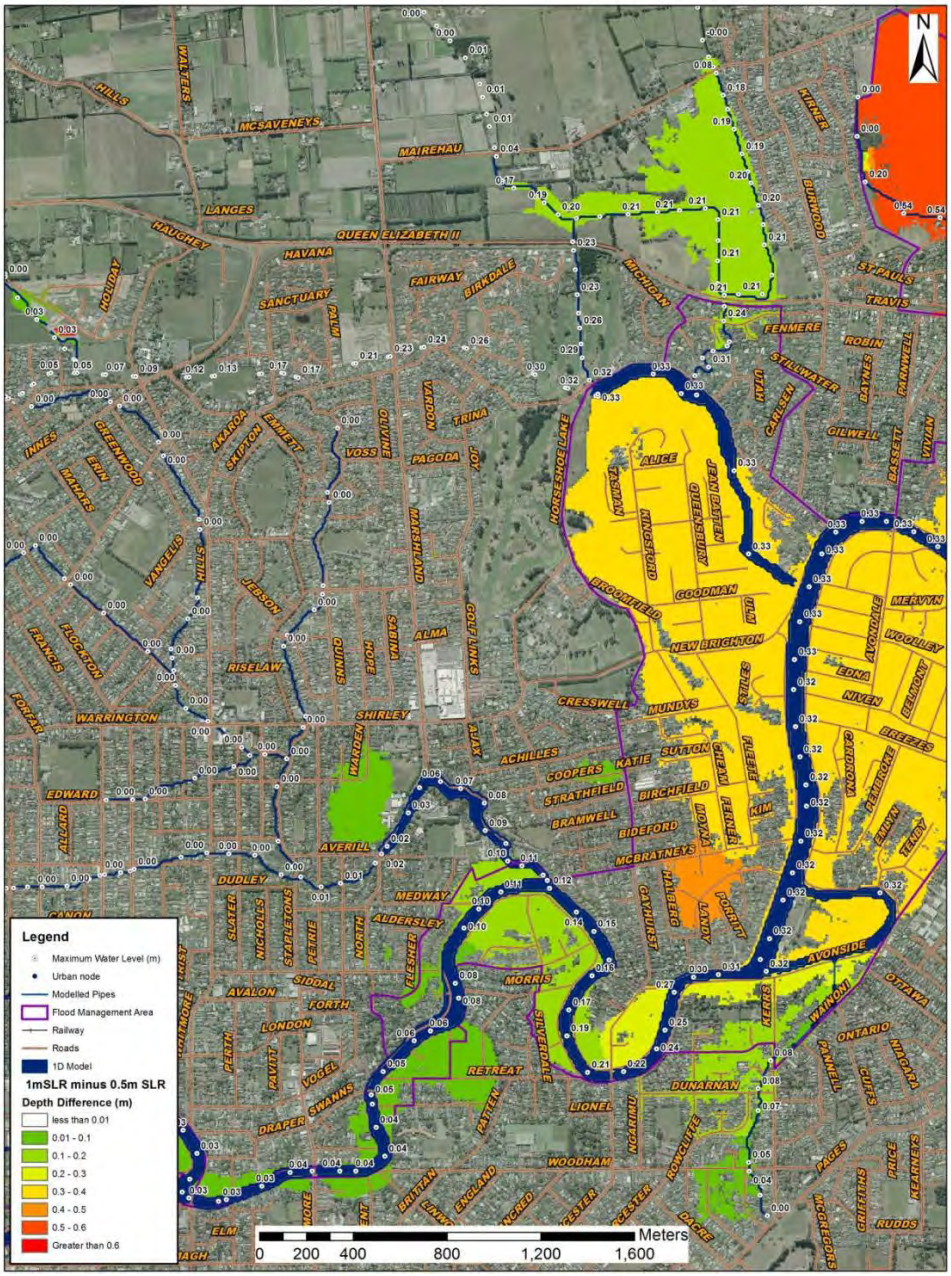

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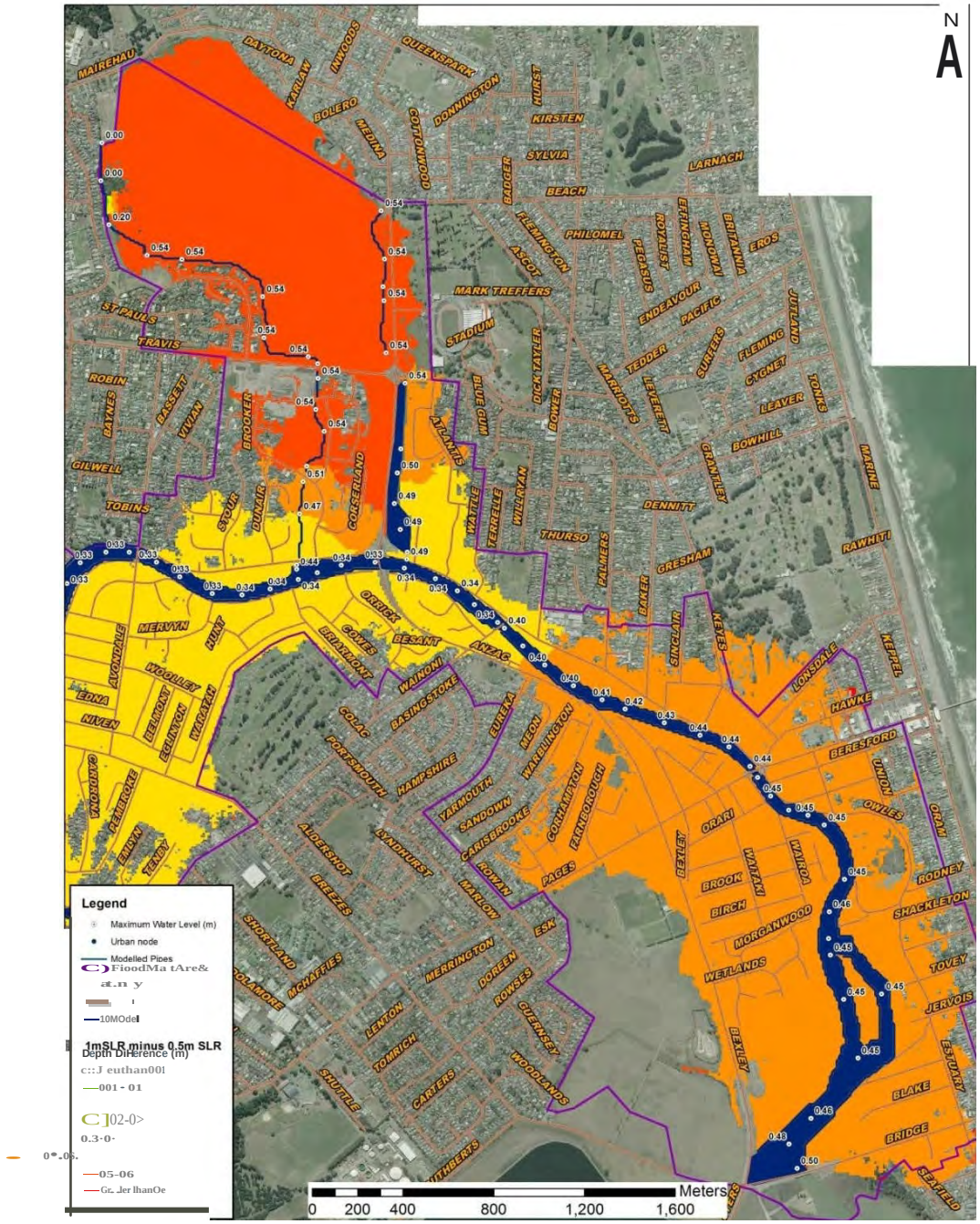
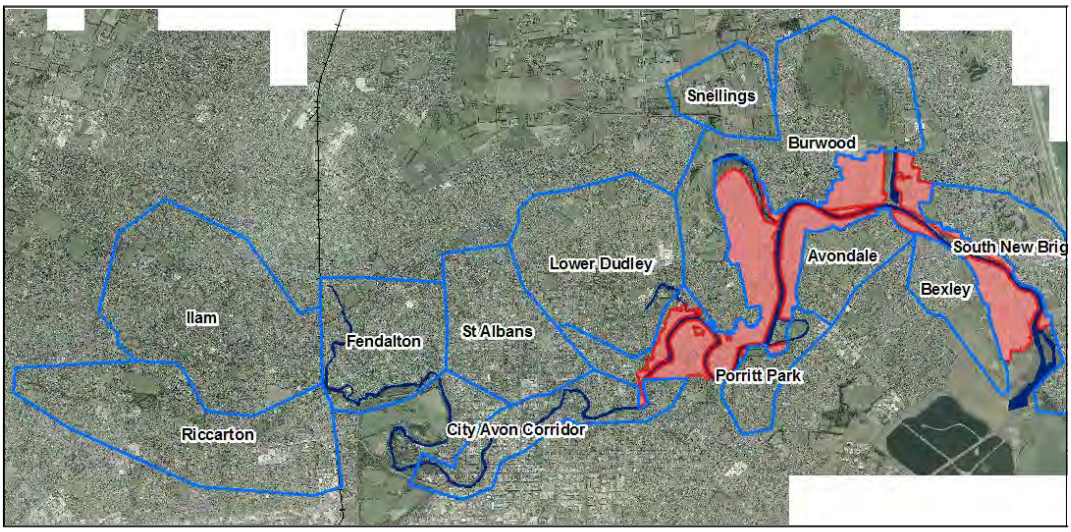
Figure 4-3 Flood Risk Extent and Depth Difference Map - Lower Avon



For each property in the Avon catchment an assessment has been made as to whether the model results show the property is at risk of flooding or not. This assessment of property levels at risk has been translated to floor levels at risk by assuming floor levels are 300 millimetres above the lowest property parcel level.

Table 4-1 presents the number of floor levels at risk in the respective areas, (Figure 4-3), and
the increase in the number of floor levels at risk caused by the increase to the SLR prediction. A total of 2064 additional properties are at risk by adopting a SLR of 1 m, when compared to SLR of 0.5 metre. As expected, areas that are further downstream are most affected by an increase in SLR. The worst affected area is South New Brighton (additional 616 properties), followed by the Burwood area (583 additional properties), followed by the Red Zone, Porritt Park and Avondale. The increase in all other areas is relatively minor.

Figure 4-3 Property Analysis Boundaries Affected by Increasing SLR to 1 metre



Area	0.5m SLR properties at risk	1m SLR properties at risk	0.5m SLR properties at risk >300 mm flood depth	1m SLR properties at risk >300mm flood depth	Increase in no. properties affected>300 mm flood depth	% of Increasein no. properties
Avondale	785	840	690	829	139	7
Bexley	467	515	429	504	75	4
Burwood	575	1,063	270	853	583	27
City Avon Corridor	734	765	540	559	19	1
Lower Dudley	1,526	1,537	763	767	4	<1
South New Brighton	1,167	1,766	984	1,600	616	30
Porritt Park	438	554	225	371	146	7
Snellings	70	74	59	70	11	1
Red Zone	4,455	4,742	4,120	4,591	471	23
Total	10,217	11,856	8,080	10,144	2,064	100

Table 4-1 Change in Properties and Floor Levels at Risk when 1 m SLR allowance is used instead of 0.5 m SLR

5 Conclusions

The impact of adopting an increase in sea level rise predictions for the Avon catchment from 0.5 metre to 1.0 metre on flood risk is reasonably significant. A total increase of 2064 properties will require an increase in building development levels with tidal reaches and areas close to the estuary worst affected. The South New Brighton area is the worst affected with 30% of the 2064 properties and could expect flood levels to increase by 0.4-0.5 metre. The next most affected area is Burwood with 27% of the total increase which could expect an increase of 0.5-0.6 metre. The Red Zone properties total 471 or 23% of the total increase. These three areas account for 80% of the total number of properties which may require an increase in building development levels due to a change in SLR from 0.5 metre to 1.0 metre. The Porritt Park area has a total of
146 properties which would be subject to higher development levels due to an increase in flood depth of 0 to 0.4 metre.

Given the high level of certainty of SLR being 1m or thereabouts in 100 years - and the major post-earthquake rebuild of houses which should have a useful life of at least 100 years - it would be reasonable to plan for 1m SLR when setting floor levels in Christchurch and thus minimise
the flooding risk during the useful life of this housing stock.

6 References

- Bell R.G and Hannah J, 2012 Sea-level variability and trends: Wellington Region.
  Prepared for Greater Wellington Regional Council by NIWA and Vision NZ Ltd.

- 2011 Climate Change Predictions Policy: Corporate policy – Sustainability Advisor

- Fitzharris, B., 2010, Climate Change Impacts on Dunedin, report prepared for the
  Dunedin City Council

- Cole, T. (2011). An acceleration in New Zealand's sea level record? MSurv thesis, University of Otago

- IPCC, 2014, Climate Change 2013: The Physical Science Basis; Working group contribution to the fifth assessment report of the intergovenmental panel on climate change. Chapter 13 Sea Level Change. https://www.ipcc.ch/report/ar5/wg1/

- Ministry for the Environment, 2008 Climate Change Effects and Impacts Assessment: A Guidance Manual for Local Government in New Zealand. https://www.mfe.govt.nz/publications/climate/climate-change-effect-impacts-assessments-may08/index.html#

- Tonkin & Taylor, (2013) Effects of Sea Level Rise for Christchurch City

- GHD, 2013 Stormwater Modelling Consolidation Avon River Model Status Report

- DHI 2012, Marine Climate Change Guidelines, How to Achieve Sustainable Adaptation in Marines Areas

APPENDIX 4: CLIMATE CHANGE CASE STUDY

<link>

Natural Hazards - Assessment of the impacts of sea level rise on floodplain management planning for the Avon River

APPENDIX 5: ECONOMIC IMPACT ANALYSIS

Explanation to table for Section 32 Analysis for Natural Hazards impact assessment

Approach:
The analysis of costs and benefits has been undertaken in accordance with the MfE guidance on s 32 analysis. Given the time constraints the analysis is undertaken at a qualitative level using expert judgements about the impacts and the magnitude of the impacts. Where possible, quantitative evidence from past studies has been used to establish financial costs and benefits. These impacts have also been peer-reviewed to ensure a degree of consistency.

Impacts have been assessed using a scale of impacts from minor to significant. A minor impact is considered to be one that is localised, very short term or has very minor consequences across the entire community. A significant impact is one that would have large and measurable consequences across the whole community as well as consequences that may last a long period of time. Where the scale of the impacts is significant or where the impacts are likely to be felt across a large area then a quantitative assessment of the relevant costs and benefits would be required.

Background research used to inform the assessment:

CLIMATE CHANGE CASE STUDY: Assessment of the impacts of sea level rise on floodplain management planning for the Avon River.
Simon Harris (December, 2003)

Most of the damage estimates relate to housing (95%). Base floor level assumption was 11.4m. None of the minimum floor level provisions showed a net benefit when compared to the 11.4m current policy. However, very sensitive to discount rate, damage estimates and timing and does not include a number of non-quantified or intangible damages.

Costs of achieving a required floor level can be estimated by Christchurch City Council quantity surveyors for a variety of construction methods and building types/sizes.

Damage estimates for each scenario are converted to equivalent average annual damages (AAD). AAD occurs by estimating the average damage for each probability interval – i.e. 4% of the mean of the 20 and 100 year scenarios (conceptualised as integrating the area under a probability-damage curve).

Costs of damage:

A: Urban properties (Table 5, p. 11)
Weighted damage estimate
0 - 0.1m = $900 (section)
< 0.4m = $900 (garage)
< 0.45m (house) $27,300 (house), $33,300 (chattels)
< 1m $35,600 (house), $41,600 (chattels)
> 1m $41,600 (house), $47,500 (chattels)

B: Council infrastructure
Roads – insignificant
Drains and sewers – allowance of $20,000 to $100,000 for a 0.4m sea level rise (no allowance for environmental damage associated with raw sewage discharge)
Pumping stations - $10,000/stn

C: Telephone
$200/cabinet for every 200 houses flooded

D: Electricity
If warning then little damage expected as can be switched off. Cleanup per kiosk is $200 for every 30 houses flooded to greater than 0.6m

If power remains on then substantial damages expected $13k/small kiosk, $160k/substation and $1m for Pages Road substation

Cable damage difficult to assess as normally in high water table. 10-20% increase in jointing faults costings $5,000/11,000kV line and $1000 per 400kV line.
E: Traffic diversion costs
$1km of diversion

Excluded costs:

Tangible not quantified	Disruption
	Loss of income (time off work for residential)
	Indirect damages exceed damages – disruption to business
	Emergency response to flooding
	Loss of land value and insurance associated with frequent flooding – higher excesses
Intangible	Fear, anxiety, physical injury, ill health
	Loss of memorabilia
	Community tensions

There is an issue of the appropriate discount rate - Harris uses 8% but there is a lot of sensitivity to discount rate in results.

ASSESSMENT OF DAMAGES ASSOCIATED WITH FLOODING OF THE AVON RIVER – a report prepared for the Drainage and Waste Management Unit, CCC
Brown Copeland & Co (Nov. 1995)

The NPV of flooding in Avon River floodplain is estimated to cost between $0.75m - $2.55m (assumes 0.1 m sea level rise). This assumes 95% of damage is houses. Other costs include evacuation and disruption costs, damage to telephone and power infrastructure, cleanup costs and damage to Christchurch City Council pump stations and traffic diversion costs. Intangible costs of raw sewage and distress, disease not included. Up to 13,000 people will be affected by the most extreme flood event.

The discount rate has a significant effect on the NPV.

PROPOSED VARIATION 48 TO THE PROPOSED CIYTY PLAN – MANAGEMENT OF THE FLOOD HAZARD IN CHRISTCHURCH – assessments of the variation and summary of the evaluation made under section 32 of the Resource Management Act 1991. –

Damages from floodwaters inundating properties increase significantly when floodwaters enter buildings. The likelihood of this occurring has increased in recent years with buildings now being constructed on lower concrete floors as opposed to piles. Economic analysis has shown that when floodwaters enter homes the average damage costs is $30,000. This cost increases to $77,000 once the water exceeds 0.5m in depth and to $89,000 if the depth of the water exceeds 1m.

Summary of s. 32 economic assessment of proposed changes to the District Plan - Natural Hazards

DPR Ref	Current Plan requirement	Proposed Plan requirements	Community group impacted	Extent of impact	Costs	$cost	Benefits	$benefits
1. Expansion of Flood Management Areas								
	Existing floor levels in FMAs i.e. 1 in 200 year levels plus 400mm freeboard, or 11.8m above CCC datum, whichever is the higher. Filling restrictions in FMAs and ponding areas. Carrying forward of City Plan provisions on repair of earthquake damaged land under CER Act – permitted activities for some filling and excavation in FMAs. Avoidance of new habitable buildings in high hazard areas in Waimakariri Stop bank Floodplain. Flood Control areas around Lake Ellesmere and Lake Forsyth.	Requiring buildings in Floor Level & Fill Management Areas to be restricted discretionary activities/ permitted activities, so long as floor levels are met	Community	Minor	Potential risks to residential intensification objectives in District Plan	Minor		
				Moderate			Certainty about the potential flood impacts following clarity of the extent of the Floor Level & Fill Management Areas (through prescribed higher floor levels)	Moderate Average damage costs have been estimated at (1991) [1] when floodwaters enter homes $30,000 water depth exceeds 0.5m = $77,000 water depth exceeds 1.0m = $89,000
				Moderate			Buildings with higher floor levels will reduce the consequent potential economic costs that are associated with the inundation of buildings	Moderate
				Minor			Compared to other options, will not exacerbate drainage issues as sections will not be raised	Minor

		Amending boundaries of existing FMAs, defining new Floor Level & Fill Management Areas, and expansion of them based on LiDAR changes in ground levels post earthquakes	Residents – rebuilds, renovations, repairs	Moderate	Increased construction costs for higher foundation levels during construction/renovations/rebuilds	For a 150m^2 dwelling the cost of achieving minimum floor levels above ground level (2008)[2]: 0.4m $17.7k 1.0m $27.4k 2.0m $44.6k 2.5m $51.1k		
			Residents – existing	Very minor	Impacts on amenity values and noise during construction	Very minor		
			Residents - in newly identified Floor Level and Fill Management Areas	Minor	Insurance premiums are likely to increase	Minor-moderate		
				Moderate	Potential loss in house values	Moderate		
			CCC (ratepayers)	Moderate	Potential increase in stormwater budget required by expansion of flood areas to be serviced.			
			Insurance companies	Moderate			Cost of flooding risk is now more explicitly associated with properties in an Floor Level & Fill Management Areas	Moderate
				Minor-moderate	Inclusion of properties within Floor Level and Fill Management Areas may increase cost of risk through reinsurers			

[1] Christchurch City Council, *Proposed Variation 48 to the Proposed City plan, Management of the Flood Hazard in Christchurch – assessment of the variation and summary of the evaluation made under S 32 of the RMA 1991*.

[2] Harris Consulting (2008), Minimum *Floor Levels for residential development between the primary and the secondary Waimakariri River stopbank system*, Final report prepared for Environment Canterbury and Christchurch City Council.

DPR Ref	Current Plan requirement	Proposed Plan requirements	Community group impacted	Extent of impact	Costs	$cost	Benefits	$benefits
2. Liquefaction Assessments								
	Current geotechnical assessment guidelines for subdivisions Applicants to demonstrate to Council's satisfaction that sufficient mitigation measures are being proposed to meet the requirements of s. 106 of the RMA Carrying forward recent approach of requiring assessment of geotechnical site suitability including liquefaction susceptibility, before new areas are rezoned or given resource consents for subdivision or land use, but with more specificity of what is required at what stage	Greater information requirements and restricted discretion matters for subdivision activities. Additional restricted discretion in respect to liquefaction susceptibility of sites where intensification proposals are on sites greater than 1500m2 in Residential zones. General site suitability characterisation at Outline Development Plan stage If there is liquefaction potential, requiring more detailed and closely spaced investigations at zoning stage, including consideration of possible lateral spread Detailed liquefaction susceptibility assessment at subdivision stage according to MBIE guidelines	Developers	Minor-moderate	Bringing forward of assessments at earlier stages of the development	Minor-moderate (QS Estimates)		
				Minor	Compliance costs in having to provide information to the Council at a much earlier stage	Minor		
				Minor - moderate	Possible ODP land offsets in subdivisions that result in reduced yield and increased costs from development	Very minor		
				Minor	Potential increase in negotiation costs through the consent process	Minor		
				Moderate	Insurance cover may be withdrawn on results			
				Minor - Moderate			Certainty for developer at ODP stage around CCC requirements due to bringing forward the site suitability assessments	Minor-moderate
			CCC	Minor	Increased compliance costs in assessing site suitability assessments	Very Minor		
			Residents - homebuyers	Moderate			Provides consistency and certainty to buyers	Moderate
				Moderate			Risk of liquefaction known to buyers prior to purchase	Moderate
			Insurance industry	Moderate			Lower level of risk transferred to insurers	Moderate
3. Land instability								
	Existing slope instability mapping for Banks Peninsula	Mapping of areas of the Port Hills subject to new land use restrictions based on land instability Avoid any new development in	CCC	Minor	Increased compliance costs in making site suitability assessments			
				Moderate	Increase in Infrastructural costs ~~associated with remediation or~~ relocation works in District Plan	Moderate (localised)		

		areas at risk from cliff collapse Avoid or control residential and other people-intensive uses in areas of the Port Hills subject to risk of rock fall or boulder roll, land damage or mass movement, depending on the level of risk Use an annual individual fatality risk of 1 in 10,000 as an acceptable level of life risk The resource consents within Port Hills and Banks Peninsula Slope Instability Management Areas should show the geological and geotechnical constraints across the site and the relationships between the site and the natural hazard on the site itself.			identified Hazard Areas outside '"Residential Red Zone"			
				Significant	Compensation liability on affected properties due to prohibited use order	Significant		
			Residents – property owners in District Plan identified Hazard Areas outside 'Residential Red Zone'	Moderate	Loss of property and development rights	Moderate		
			Community	Minor	Loss of productive land that had been available for housing	Minor		
				Moderate- significant			Life safety risk reduced	Moderate - significant
				Minor-moderate			Sterilisation of land that removes future risks	Minor-moderate
				Moderate			Market certainty and information for affected areas	Moderate
			Geotechnical professionals	Minor			Increase in business activity	Minor
			Homebuyers	Moderate			Risk of slope instability is known prior to purchase (increase in certainty)	Moderate
			Insurance industry	Moderate			Lower level of risk transferred to insurers	Moderate

APPENDIX 6: MODELLING FOR FLOOR LEVEL AND FILL MANAGEMENT AREAS

Modelling for Floor Level and Fill Management Areas

Background

It had been evident since flood modelling workwas undertaken by consultants for the Council on the main river systems in 2008 that Flood Management Areas as mapped prior to 2003 with early LiDAR only and little ground-truthing were inaccurate in extent. Some of the ponding area mapping such as that for the Lower Styx ponding area was particularly inaccurate, as it dated back to 1995. However because of the large number of households affected and the lengthy process to get the Variation operative, it had not been considered practical to undertake plan change(s) to correct the boundaries. Instead it had been decided to await the District Plan Review (DPR).

Several new sets of LiDAR after major earthquake events in 2011 indicated that ground surfaces had, as a cumulative outcome, changed much more significantly than as a result of the 2010 earthquake, especially in proximity to the Avon River around which major liquefaction had occurred in the 2011 events.

Revised flood modelling incorporating allowances for climate change

The DPR incorporates remapping of the revised extent of 1 in 200 year flooding for most of the city. The computer based flood models used by Council engineers and consultants to predict flood extent and depth (generally MIKE models in various versions) have been gradually revised and refined over recent years. Apart from areas adjoining rivers, there has been new modelling of side catchments leading into the main river systems, and new areas beyond the main stem of the river systems such as Flockton Basin have been included.

Since the earthquakes, revised flood modelling has been undertaken using the most up-to-date LiDAR as part of the Land Drainage Recovery Programme. The earthquakes have changed the patterns of flooding and exacerbated the flood risk in some parts of the city through tilting of the Avon-Heathcote estuary, with the land to the south rising by about 0.5m and that to the north dropping by an average of 0.2 to 0.3m, but with settlement of land by up to 0.5m in some areas. Lateral spread, liquefaction and stream bed heave have combined to reduce the capacity of some streams and rivers to carry high flows without breaching their banks. Revised modelling takes account of these ground surface changes.

The two mapped flood control areas under the Banks Peninsula District Plan are being rolled over into the reviewed Christchurch District Plan, until flood modelling can be undertaken, and there is a new Flood Management Area near the existing Lansdowne area at Halswell, which has been mapped as a result of recent ECan modelling, which will also be included.

Instead of a straight alternative criteria of 1 in 200 year flooding or 11.8m above Christchurch City Council datum (whichever is higher), which was the original basis for defining FMAs, the more refined (and more conservative) criteria used in recent years has been used in the DPR to define Floor Level and Fill Management Areas in the Planning Maps. This is based on areas where floor raising would be required to be above the greater of:

a. a 1 in 200 year rainfall event combined with a 1 in 20 year tidal event, or
b. a 1 in 200 year tidal event combined with a 1 in 20 year rainfall event, or
c. 12.3m above Christchurch City Council datum (the latter is still relevant in a few cases as a higher level, where there are low points in the modelled water surface).

Included is a freeboard of 400mm and an allowance for 1m sea level rise.

In addition climate change and likely increased intensity of rainfall events is taken into account by increasing the design rainfall depths by 16 percent (8 percent per degree change in temperature) in accordance with MFE guidance.

Modelled 1 in 200 year water extents were used directly for ponding areas. There is a new ponding area in this review over the Cranford Basin, which had not been modelled in the 1995 Plan or Variation 48.

Mapping of Floor Level and Fill Management Areas

Use of freeboard

In 2003 for Variation 48, freeboard was added to the modelled 1 in 200 year water surface to account for uncertainty in relation to the ground surface, as this mapping was carried out prior to much more detailed LiDAR ground surface mapping. Flood Management Areas were then defined by stretching the water level plus at least a component of freeboard out to the nearest property boundary or road.

In 2013, two options were explored for defining the revised Floor Level and Fill Management Areas:

a. Adding 250mm freeboard to the modelled water surface then "stretching" levels out sideways.

   The method used was to take this out horizontally until either ground surface is reached or for 60m distance, whichever comes first. This creates a 'dry Floor Level & Fill Management Area' buffer area beyond the water.

   Some editing of the raw modelling data was undertaken in order to reduce some of the detail, for example detached areas of less than 1000m^2 were deleted and holes of less than 1000m^2 filled in.

   Stretching of Floor Level & Fill Management Areas to add in buffer areas at the edge, but where the depth of modelled water is zero, can be considered justified from a conservative modelling perspective as it takes into account local rainfall, blockages, and other effects such as vehicle wash up, which may result in water within this area. It may not be possible to say 'there is no actual flooding' in the mapped edge areas, as models contain numerous assumptions and uncertainties. However this approach results in an increase in the area covered by the Floor Level & Fill Management Areas in the Christchurch situation, because of the relative flatness of the city.

b. Not adding freeboard to the modelled water surface.

   This approach can be justified by the fact that ground surface mapping via LiDAR is considerably more accurate and detailed than previous mapping of ground surfaces. Not adding freeboard is a more accurate representation of the geographic extent of the likely hazard, which is a more straightforward approach for the general public in interpreting the planning maps and for insurance companies' assessment of risk. The primary influence on the accuracy of the modelling results is the size of the grid used for data points, and extending the Floor Level and Fill Management Area sideways may not improve the robustness of the water level data. Where buildings are located within the 'dry Floor Level & Fill Management Areas', they will need to be 150mm clear of the ground, which may be sufficient to mitigate any risk of shallow flooding in this area. However, this approach leaves no room for uncertainties mentioned in Option a. relating to waves generated by vehicles and other modelling uncertainties and is a less conservative approach.

   Some editing of the raw modelling data would still be undertaken as for Option a. in order to reduce some of the detail (delete detached areas of less than 1000m^2 and fill in holes of less than 1000m^2.

Filling post-LiDAR information included in model

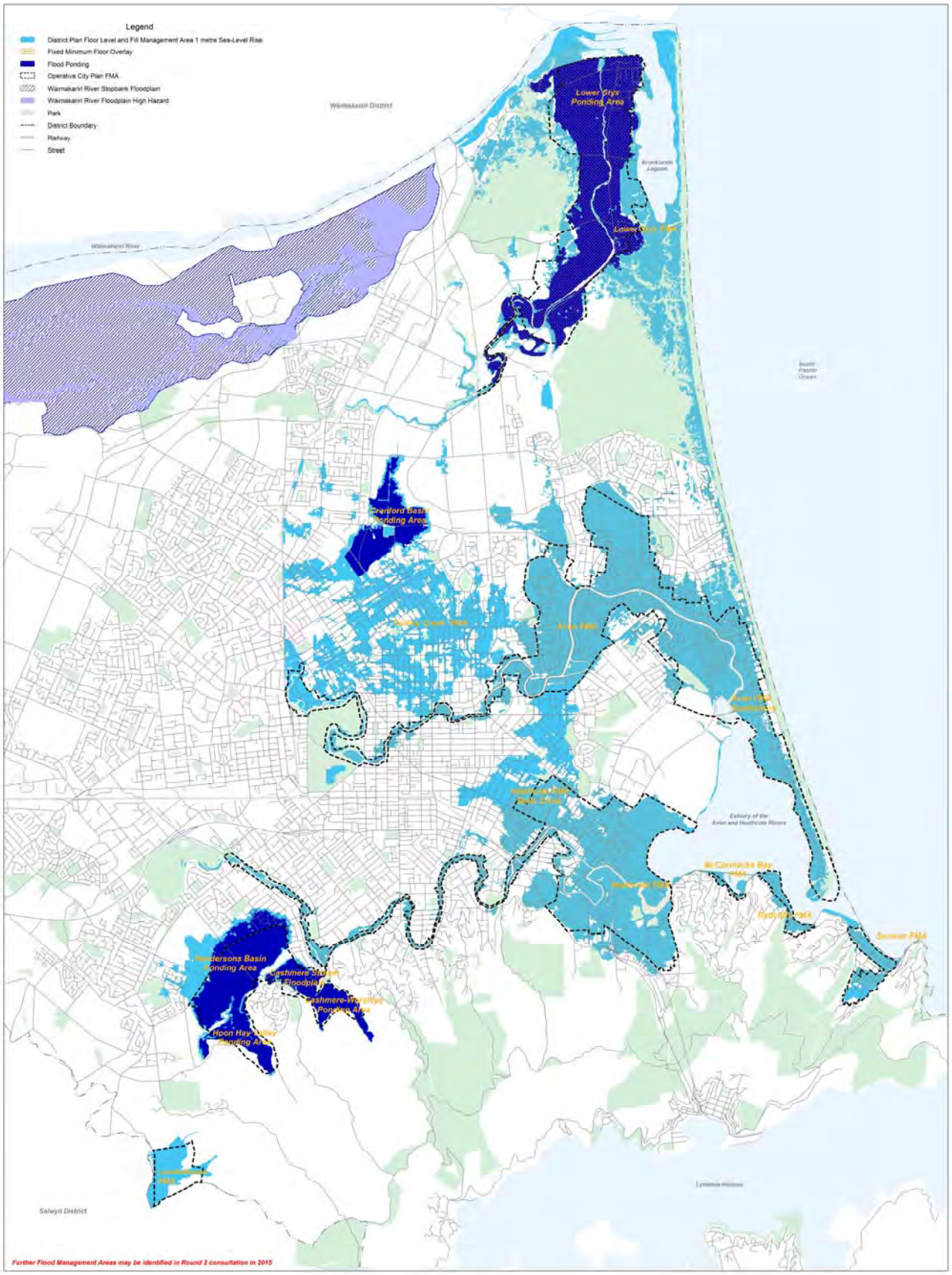
Some areas have been deleted from the Floor Level and Fill Management Areas on the Planning Maps due to known recent filling that post dates the LiDAR information:

1. Small area in northern part of Preston's Subdivision.

Minimum floor level web site

As a result of numerous enquiries about likely floor levels and a desire for more of this information to be more accessible, since mid-2012 the likely extent of the remodelled 1 in 200 year water surface and the default 'interim' floor levels required above that (in the absence of site specific information) have been made available to the public, insurance companies and developers on the Council's Floor Level website. Floor levels for 1 in 50 year flood events are provided across most of the city, and 1 in 200 year levels within the currently identified Floor Level and Fill Management Areas. The 1 in 50 year levels provide minimum floor levels for developments outside Floor Level and Fill Management Areas and guide rebuilds under existing use rights within the Floor Level and Fill Management Areas (which still need to comply with Building Act requirements).

See Floor Level and Fill Management Areas Overview Map over page.


Legend
District Plan Floor Level and Fill Management Area 1 metre Sea-Level Rise
Fixed Minimum Floor Overlay
Flood Ponding
Operative City Plan FMA
Waimakariri River Stopbank Floodplain
Waimakariri River Floodplain High Hazard
Park
District Boundary
Railway
Street
Lower Styx Ponding Area
Cranford Basin Ponding Area
Henderson Basin Ponding Area
Cashmere Stream Floodplain
Cashmere-Worsleys Ponding Area
Hoon Hay Valley Ponding Area
Waimakariri River
Selwyn District
Further Flood Management Areas may be identified in Round 2 consultation in 2015
Christchurch City Council
District Plan Review
Floor Level and Fill Management Areas

APPENDIX 7: RISK MODELLING ON THE PORT HILLS AND BANKS PENINSULA

Risk Modelling For Mapping Slope Instability on the Port Hills and Bank Peninsula

A series of detailed technical reports on earthquake-related slope instability on the Port Hills have been prepared by GNS Science for the Christchurch City Council. The reports were prepared in response to the 2010-2011 Canterbury earthquakes and contain recommendations for the Council on how to address the risk from cliff collapse and rockfall (also referred to as boulder roll) and mass movements. The findings of the reports on cliff collapse and rockfall have been used by CERA and the Christchurch City Council to assist with decisions on zoning, planning and infrastructure development, and regulatory matters. In addition to the reports there are about 400 separate maps to assist the reader of the reports in their interpretation of the report findings. A separate approach for mass movement areas was adopted and is explained further below.

In all cases for mapping slope instability areas on the Port Hills it should be noted that ground truthing also informed the modelling and is reflected in the mapped results.

For a detailed explanation of the risk modelling see GNS Consultancy Report 2012/57 (pp18-19 and pp70-83).

Cliff collapse

GNS Science produced a model for cliff collapse, which was used to inform the cliff collapse management proposed in this chapter. A summary of the GNS cliff collapse model taken from the GNS report follows[1].

Cliff collapse is considered a type of landslide involving many boulders, triggered by earthquakes (taking into account expected changes in seismic activity in the Port Hills region over time) and by other non-seismic triggering events such as rainfall and spontaneous collapse. Terms such as “cliff-top recession” are used to describe the result of landslides from the top and face of cliffs, and “debris avalanche” to describe the landslide process that inundates land at the cliff foot (referred to as “toe”) with countless boulders. The two are collectively referred to as cliff collapse.

The model uses an ‘annual individual fatality risk’ (AIFR) to describe the probability or likelihood that a particular person will be killed by cliff collapse in any one year at their place of residence. For most locations, the probability of a life-threatening cliff collapse is imprecisely determined and is very small, but must be assessed against internationally accepted life risk criteria. Decisions based around models using AIFR must be defensible, and so they must be consistent with the internationally accepted guidelines. For all the GNS models provided for the Port Hills, the use of the 1 in 10,000 risk line has been set as the level of acceptable risk. This level of risk is equivalent to the risk associated with travelling in a motor vehicle.

The reported fatality risks are obtained through a quantitative risk estimation method that follows appropriate parts of the Australian Geomechanics Society framework for landslide risk management (AGS, 2007)[2]. It provides risk estimates suitable for use under AS/NZS ISO31000: 2009.

For debris avalanches and cliff-top recession the risk analysis comprises the following steps:

1. Consider the full possible range of triggering events (for example, earthquakes, rain) in terms of a set of earthquake triggers and a set of non-seismic triggers;
2. Choose a small set of representative events for each type of trigger spanning the range of severity of events from the smallest to the largest;

[1] GNS Science Consultancy Report 2012/124, May 2012 FINAL

[2] Australian Geomechanics Society 2007. Practice Note Guidelines for Landslide Risk Management. Journal and News of the Australian Geomechanics Society 42(1): 63–114.

3. For each representative event, estimate:

For debris avalanches:

   a. the frequency of the event and the volume of material produced;
   b. the number of boulders reaching/passing a given Fahrboeschung angle (distance) down the slope and the probability of one of N boulders hitting a person at that location on the slope;
   c. the probability that a person is present on the slope as the boulder moves through it;
   d. the probability that a person will be killed if present and hit by one or more boulders.

4. Combine 3(a) – (d) for debris avalanche to estimate the annual individual fatality risk for individuals at different locations below the cliff or at the cliff edge contributed by each representative event;

5. Sum the risks from all events to estimate the overall risk;

6. Enter the risk values at each Fahrboeschung zone into a Geographical Information System programme and interpolate between the risks estimated for each zone to produce contours of equal risk on a map.

For cliff-top recession:

7. No systematic mapping of the cliff tops outside the pilot study areas has been carried out since the 22nd February 2011 earthquakes. Field inspections of some of the cliffs made by GNS Science and members of the Port Hills Geotechnical Group (a consortium of geotechnical engineers contracted to Christchurch City Council (the Council) to assess slope instability in the Port Hills) identified a few locations where about 1-2 m of the cliff edge had recessed. A conservative approach to the amount of cliff-top recession was adopted where the annual individual fatality risk was modelled from a limited amount of field investigations.

The expected confidence limits on the assessed risk levels are estimated to be marginally higher than an order of magnitude (higher or lower), in terms of the absolute risk levels presented in this report. That is, an assessed risk of 1 in 10,000 per year could reasonably range from 1 in 1,000 per year to 1 in 100,000 per year. In other words at a site specific level the GNS model may over or under estimate the level of risk as not every property was ground truthed. This is reflected in the mapping of areas as broad bands, and justifies the range in the status of the activities proposed in the rules (Rule 5.10.1). The confidence limits are also the main reason to date for not ascribing prohibited activity status to activities such as new buildings in cliff collapse areas. Further work is being completed that may identify areas in the future where there is enough confidence to implement prohibited activity status.

Further detailed work was completed in July 2014 at the Councils request which identified four areas within the Cliff Hazard Management Area where the level of risk indicated that prohibited activity status for most development activities (for example: buildings, subdivision and earthworks) was more appropriate than non-complying status. The four areas where a prohibited activity status has been assigned are the cliff collapse areas at:

   i. Peacocks Gallop
   ii. Wakefield Ave
   iii. Redcliffs
   iv. Brittan Terrace Area - Lyttelton

Each of these areas has:

   a. evidence of land damage either at the cliff top or cliff face (regression lines);
   b. significant collapse, with a big talus slope (evidence of high risk of future collapse);

c. a height greater than 15m; and
d. sufficient width to show a different activity status from the rest of the area affected by slope instability.

The risk in these four areas was identified as being 10^{-1} to 10^{-2} (extremely high risk) and was verified with on-the-ground site investigations (see maps on the following pages).

Rockfall

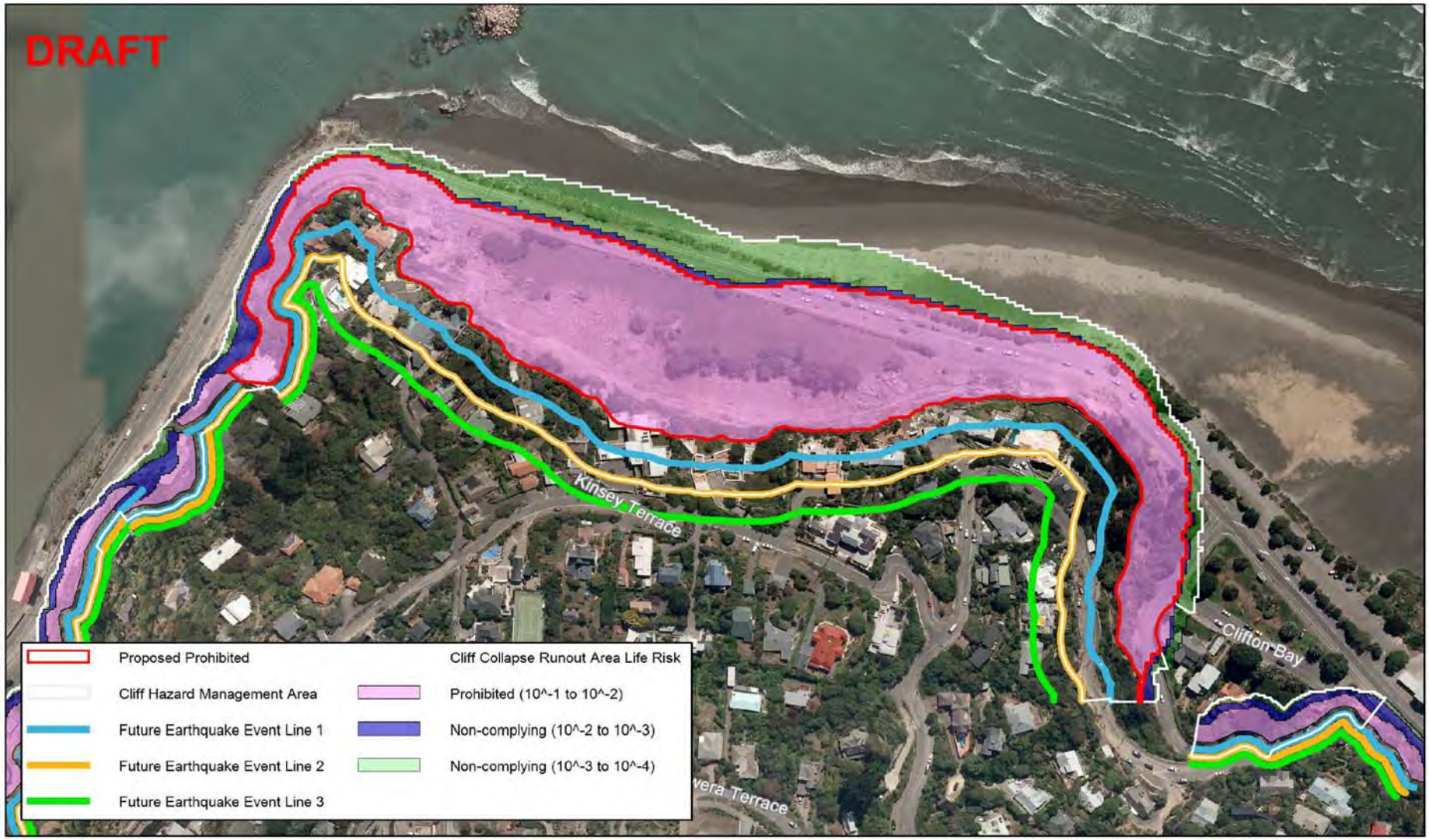
Two models developed by GNS have been used to inform the rockfall management proposed for this chapter. A summary comparison of GNS rockfall models follows.

The 2010-2011 earthquakes caused rock in the Port Hills to become more broken, relaxed and dilated, making it more susceptible to failure under both earthquake and non-earthquake conditions. It is therefore very likely the amount of rockfall over the next 20 to 50 years will be significantly greater than has been reported or observed historically.

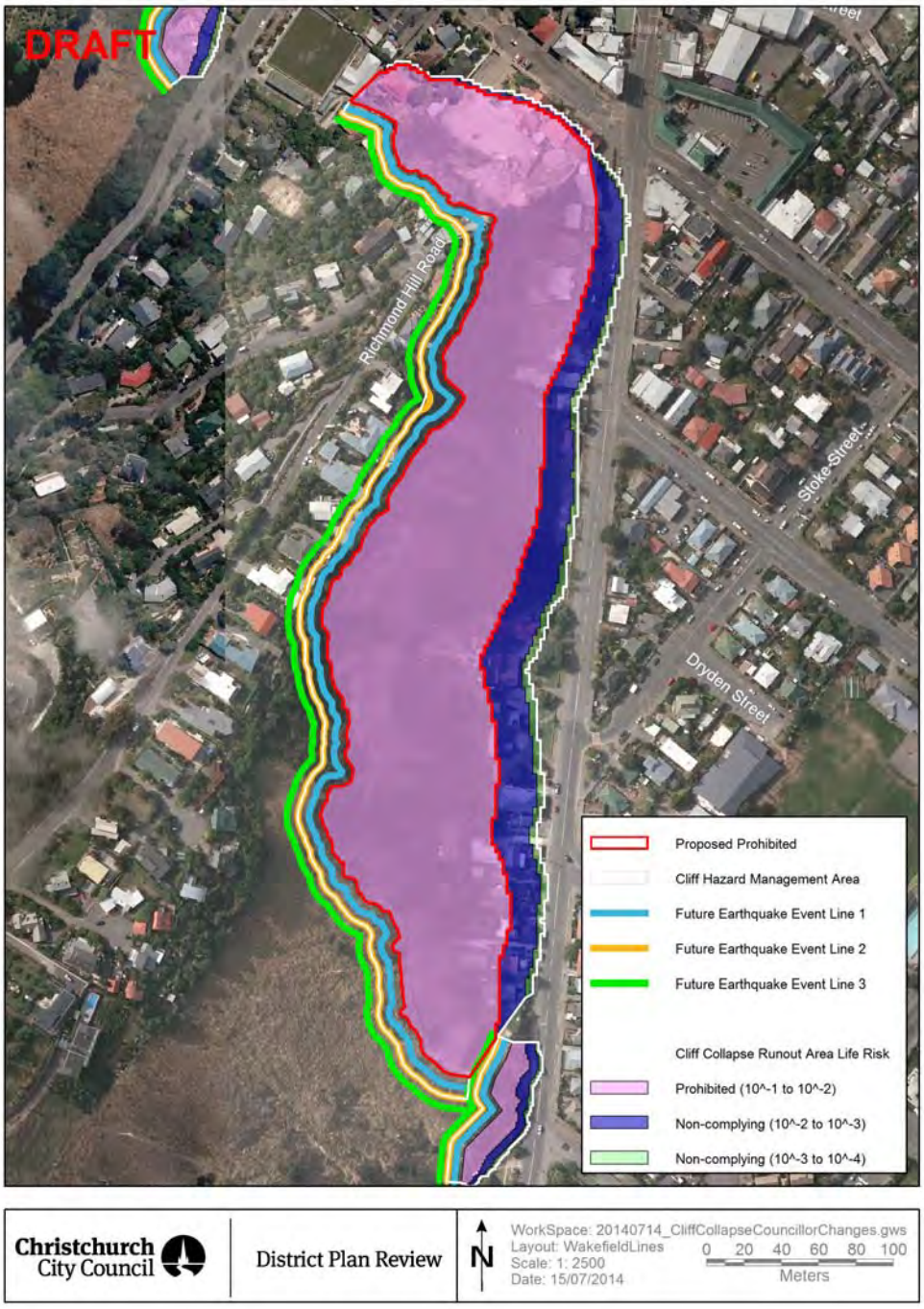
The models use "annual individual fatality risk" (AIFR) to describe the probability or likelihood that a particular person will be killed by a rockfall in any one year at their place of residence. For most locations, the probability of a life-threatening rockfall is imprecisely determined and is very small, but must be assessed against internationally accepted life risk criteria. Decisions based around models using AIFR must be defensible, and so they must be consistent with the internationally accepted guidelines. The models assume a 1 in 10,000 risk line has been set as the level of acceptable risk. This level of risk is equivalent to the risk associated with travelling in a motor vehicle.

Rockfall may be caused by earthquake or rainfall event or by spontaneous collapse of a cliff or outcrop. Each type of event has a different "return period"[3]. Rainfall events sufficient to trigger rockfalls can be expected to occur more frequently than earthquake events. Rainfall trigger events will have less severe consequences (cause fewer rocks to fall) than earthquake trigger events. The risk from earthquake is expected to reduce through time as the seismicity reduces although the risk of a rainfall or spontaneous trigger event will remain much the same through time. Rockfall may also occur as a 'random' event due to a number of processes including weathering and hydraulic or vegetation 'jacking'.

[3] The probability that events such as rainfall or earthquake events will occur is often expressed as a return period. The inverse of probability (generally expressed in %), it gives the estimated time interval between events of a similar size or intensity. For example, the return period of a flood might be 100 years; otherwise expressed as its probability of occurring being 1/100, or 1% in any one year. This does not mean that if a flood with such a return period occurs, then the next will occur in about one hundred years' time - instead, it means that, in any given year, there is a 1% chance that it will happen, regardless of when the last similar event was. Or, put differently, it is 10 times less likely to occur than a flood with a return period of 10 years (or a probability of 10%).


DRAFT
Kinsey Terrace
Clifton Bay
Proposed Prohibited
Cliff Hazard Management Area
Future Earthquake Event Line 1
Future Earthquake Event Line 2
Future Earthquake Event Line 3
Cliff Collapse Runout Area Life Risk
Prohibited (10^-1 to 10^-2)
Non-complying (10^-2 to 10^-3)
Non-complying (10^-3 to 10^-4)
Christchurch City Council
District Plan Review
Proposed Prohibited Cliff Hazard Management Area Peacocks Gallop
N
WorkSpace: 20140714_CliffCollapseCouncillorChanges.gws
Layout: PeacocksGallopLines
Scale: 1: 2500
Date: 15/07/2014
0 20 40 60 80 100
Meters

Proposed Prohibited Cliff Hazard Management Area Wakefield



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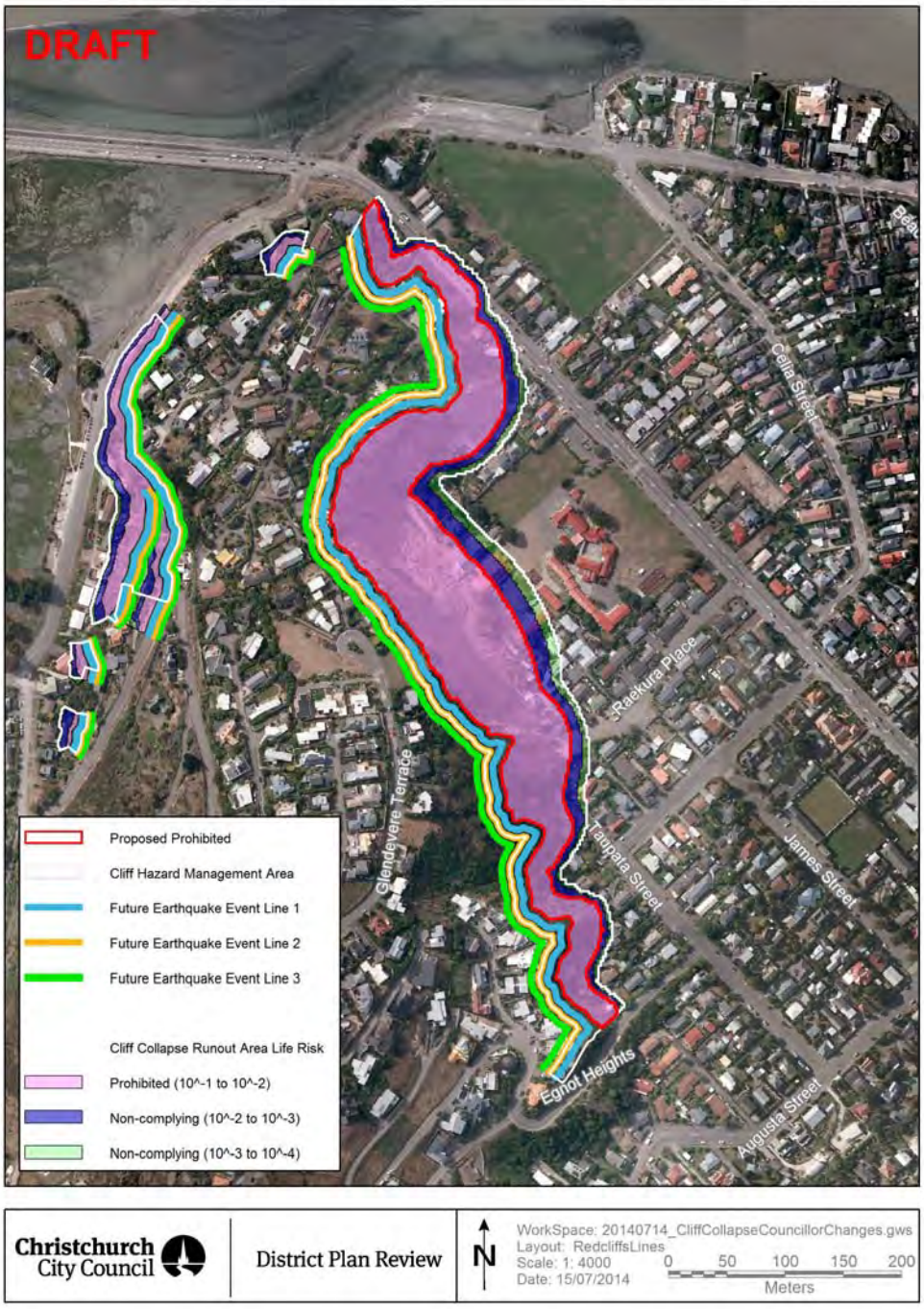
WorkSpace: 20140714_CliffCollapseCouncillorChanges.gws
Layout: WakefieldLines
Scale: 1: 2500
Date: 15/07/2014

0 20 40 60 80 100
Meters

Proposed Prohibited Cliff Hazard Management Area Redcliffs



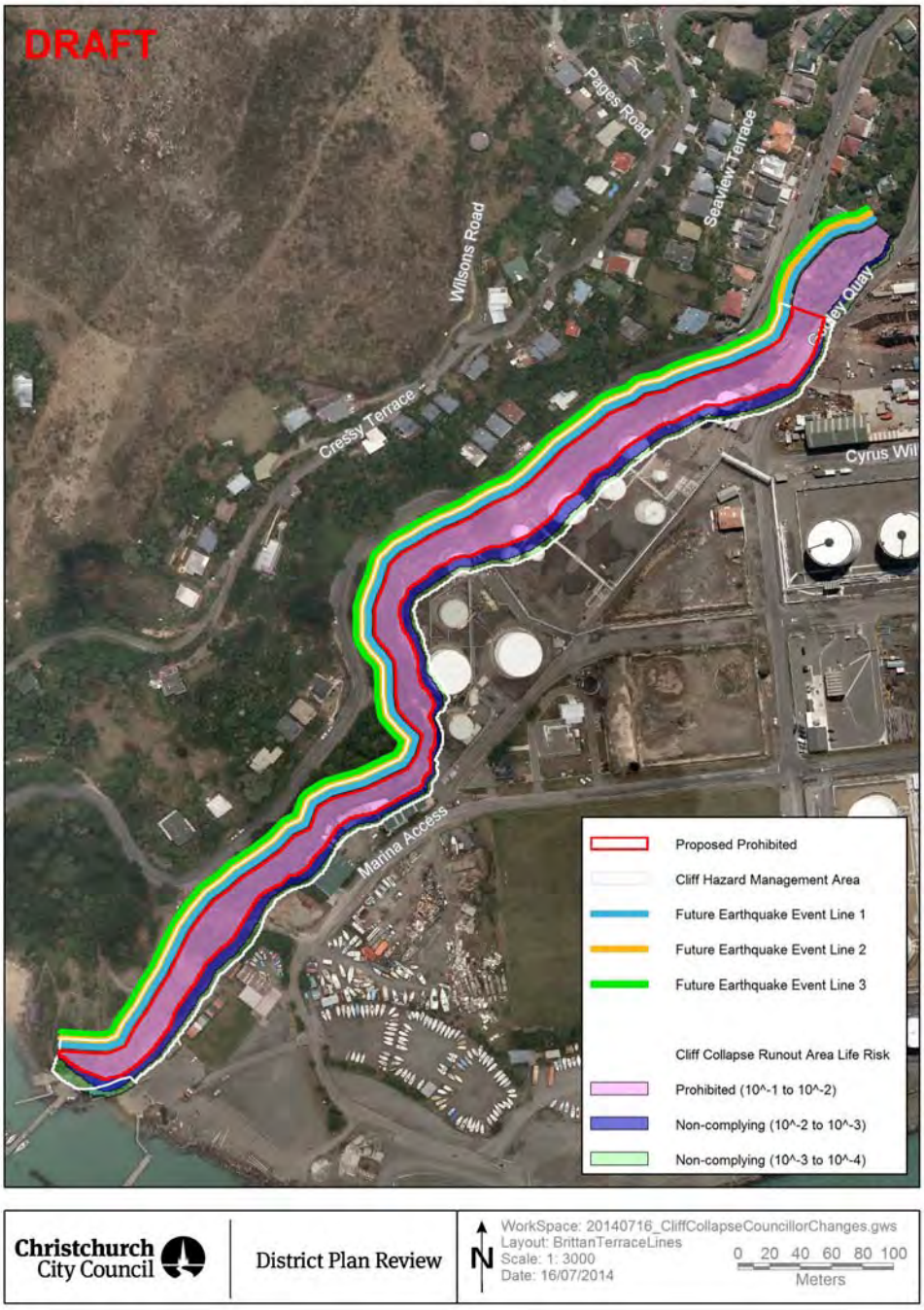
Christchurch City Council | District Plan Review

N

WorkSpace: 20140714_CliffCollapseCouncillorChanges.gws
Layout: RedcliffsLines
Scale: 1: 4000
Date: 15/07/2014

0 50 100 150 200
Meters

Proposed Prohibited Cliff Hazard Management Area Brittan Terrace



The risk estimates reported by GNS Science were obtained using a quantitative (numerical) risk assessment method that follows appropriate and relevant parts of the Australian Geomechanics Society (AGS) framework for landslide risk management. GNS considered all possible triggering events (earthquake, rainfall, spontaneous collapse) and modelled a set of 'representative events' that covered the reasonable range of severity of each type of event.

For each representative event the methodology used estimated the:

1. frequency of the event and the numbers of boulders produced;
2. proportion of boulders reaching or passing a given distance down the slope;

3. probability of a person at that distance downslope being in the path of one or more boulders;
4. probability that a person is present in the path of a boulder when it reaches them (= temporal spatial probability of being hit); and
5. probability that the person will be killed if present in the path of the boulder (= vulnerability or probability of being killed if hit).

A seismicity factor was introduced to the model to acknowledge that (based on world-wide data) aftershocks can be expected to show an overall decrease in frequency and severity with time following a major earthquake. The revised New Zealand Seismic Hazard Model indicates a 50 percent reduction in rockfall risk due to this factor between 2012 and 2016. It should be noted this is a reduction in the probability of rockfall and does not change the consequences (i.e. distances to which falling rocks will roll and bounce down slope will remain much the same regardless of the reasons for the rockfalls).

Model comparison

Two models prepared by GNS have been used to develop the management regime for areas at risk from rockfall hazard. Both assume a 2016 seismicity model and a number of other variables but differ in respect of two variables – occupancy and aftershocks. Occupancy refers to exposure to the risk (temporal spatial probability) which is expressed as a proportion of time spent in the home (% occupancy). Aftershocks refers to the degree of exposure to aftershock risks i.e. no aftershocks means that people self-evacuate or are evacuated such that they are not exposed to on-going risk. These differing variables are represented in the following table.

	Rockfall Model 1 (see GNS Science Consultancy Report 2012/214 September 2012)	**Rockfall Model 2** (see GNS Science Consultancy Report 2012/213 May 2012; and reissued report July)
Occupancy	67% occupancy of the house (i.e. means that someone is at home 16 hours of 24 hours per day)	100% occupancy of the house (i.e. always someone at home)
Aftershocks	Aftershocks **not** included (people will be evacuated after an event).	Aftershocks **included** (people will not be evacuated after an event).

For most locations, the probability of a life-threatening rockfall is imprecisely determined and is very small, but must be assessed against internationally accepted life risk criteria. Decisions based around models using AIFR must be defensible, and so they must be consistent with the internationally accepted guidelines. The models assume a 1 in 10,000 risk line has been set as the level of acceptable risk in all cases.

Rockfall Model 1 assumes people will be evacuated after a major event and does not acknowledge higher risks for those who spend more time at home, such as people working from home or operating home occupations or offices, the aged or infirm, sick people or caregivers with young families.

Rockfall Model 2 does not assume people will be evacuated after a major event and acknowledges higher risks for those who spend more time at home, (such as the people working from home or operating home occupations or offices, aged or infirm, sick people, or caregivers with young families)

A number of risk scenarios have been considered with the research concluding the factor that most affects the future risk from boulder roll is the reduction in seismicity with time (see GNS report 2011/311). The net effect of this will be an overall reduction in risk over time and a realignment of the risk profile to make rainfall-induced rockfall or spontaneous rockfall proportionally more significant triggers for boulder roll. However, the cause of the rockfall does not change the possible consequences that need to be considered.

Technical factors to consider (amongst a range of other factors e.g. legislative directions in the RMA and supporting statutory documents) in determining the appropriate approach to guide future planning for development may include that:

a. a 100 percent occupancy is an 'absolute' assumption – only a low percentage of houses will be occupied at all times however 67 percent occupancy will probably not reflect the actual situation (it means that, on average, all houses are unoccupied 8 hours per day). A more likely scenario is somewhere between these values;

b. following a significant earthquake event, most people will self-evacuate or be evacuated from the highest risk areas;

c. the vulnerability of a person (if hit) is quite likely to be greater than 50 percent; and

d. the risk lines determined from the models are neither precisely defined nor site-specific.

Mass movement

Following the 22 February 2011 earthquakes, members of the Port Hills Geotechnical Group identified several areas in the Port Hills where extensive cracking of the ground had occurred. In many areas these cracks were thought to represent localised relatively shallow inelastic deformation of the ground in response to the earthquake sequence. In other areas however, the density and pattern of cracking and the amounts of displacement across cracks clearly indicated that some areas had moved as a mass (mass movement). Mass movement is defined as the geomorphic process by which material (rock and soil) move down-slope, typically as a mass, under gravity (Cruden and Varnes, 1996)[1]. GNS Science presented their preliminary findings to the Council as the Stage 1 Report[2].

The Stage 1 report:

1. provides a current list of the areas susceptible to significant mass movement;
2. provides the current interpreted boundaries of these areas; and
3. carries out a preliminary simple hazard exposure assessment to prioritise the areas with regards to future investigations and what type of investigations are required.

The information provided in the Stage 1 Report is therefore of a preliminary nature and subject to change. The Council has commissioned GNS Science to undertake further investigations into these areas. To prioritise the mass movements with regards to future investigations, each mass movement has been categorised (Class I, II or III) using a relative hazard exposure matrix, based on the nature of the hazard and the consequence of the hazard occurring. Class I by their definition may pose a significant life risk to residents due to their ability to run-out and inundate areas below the source. Class II and III are not associated with a life risk as the mass movements move in a very limited

manner, typically less than 1m across the entire feature. The Council has worked closely with MBIE to provide guidelines on how best to build in the Class II and III 'toe-slump' areas[3].

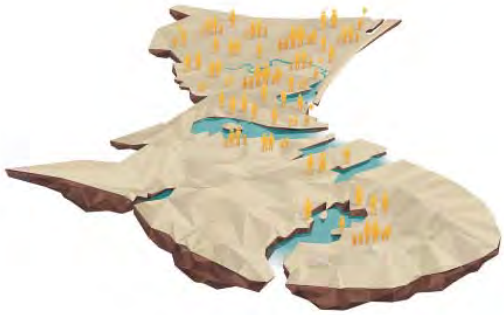
The Mass Movement Hazard Management Areas 1, 2 and 3 in the Natural Hazards chapter correspond to the Class I, II and III areas in the GNS Reports.

At the time of writing, GNS Science had just finalised the eight Class I site – specific reports identifying geotechnical slope stability issues and potential areas of intolerable life risk[4]. Based on the information the Council received many of the initial Class I areas as defined in the Stage I report have been changed. The Council has undertaken a review of the relevant mapped areas in the Natural Hazards chapter and approved the required changes to clearly reflect the latest GNS information. The information provided continues to support the decision to retain non-complying activity status for some activities, such as new dwellings, rather than the more restrictive prohibited activity status.

1. Cruden, D.M., Varnes, D.J. 1996. Landslide types and processes. Landslide: investigation and mitigation. Turner, K.A.; Schuster, R.L. (eds.). Special report, Transportation Research Board, National Research Council, 247. Chapter 3, 36–75.
2. GNS Science Consultancy Report 2012/317, 16 July 2013 FINAL
3. MBIE Guidance for building in toe slump areas of mass movement in the Port Hills (Class II and Class III), Supplementary guidance to 'Guidance on repairing and rebuilding houses affected by the Canterbury earthquakes', December 2012.
4. See updated August 2014 GNS Reports on the Council's website and Appendix 2 Bibliography.

APPENDIX 8: COMMUNITY CONSULTATION FOR NATURAL HAZARDS, SURVEY MONKEY RESULTS

Finding the Balance
Let's plan now
for a better future



District Plan Review

Community Consultation for Natural Hazards

Monitoring and Research Team
May 2014

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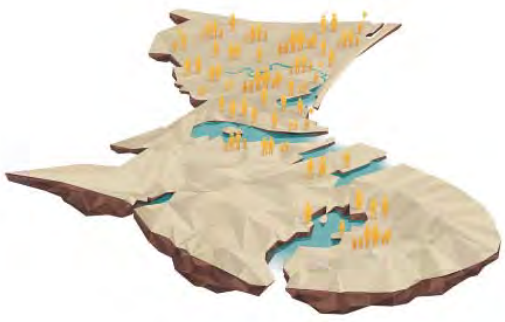
Let's plan now for a better future



Survey Methodology

An online survey was used to collect respondent comments for the Natural Hazards chapter of the District Plan Review Consultation:

Method	Dates In-field	Sample
Survey Monkey online survey: Survey link published via advertisements, online, social media, through networks, etc	21 March to 23 May 2014	Self-selected sample open to the public living in any location

Questionnaire

See Appendix One for a copy of the questionnaire

Respondents

Combined total respondents to 23 May 2014: **165**

Respondent Locations: Number and Percent of Respondents

Respondent Locations		
Answer Options	**Response Percent**	**Response Count**
Burwood / Pegasus	18.8%	31
Fendalton / Waimairi	11.5%	19
Hagley / Ferrymead	17.0%	28
Riccarton / Wigram	11.5%	19
Spreydon / Heathcote	16.4%	27
Shirley / Papanui	13.3%	22
Banks Peninsula	10.9%	18
I don't know which ward	0.6%	1
Outside of Christchurch District	5.5%	9
answered question		165

Respondent Age Groups: Number and Percent of Respondents

In which of the following age group do you belong?		
Answer Options	**Response Percent**	**Response Count**
Under 18 years	0.0%	0
18-24 years	5.6%	9
25-49 years	45.3%	73
50-64 years	32.9%	53
65 years and over	16.1%	26
answered question		161

Property Type Owned: Number and Percent of Respondents

Type/s of Properties Owned		
Answer Options	**Response Percent**	**Response Count**
House (that you live in or rent out to others)	79.4%	127
Commercial property (e.g. shop, business or office)	3.1%	5
Industrial property	1.3%	2
Farm property	3.1%	5
I don't own a property	16.9%	27
Other (please specify)	3.1%	5
	answered question	160

Awareness of Range and Scale of Natural Hazards that Affect Home, Work and Local Community

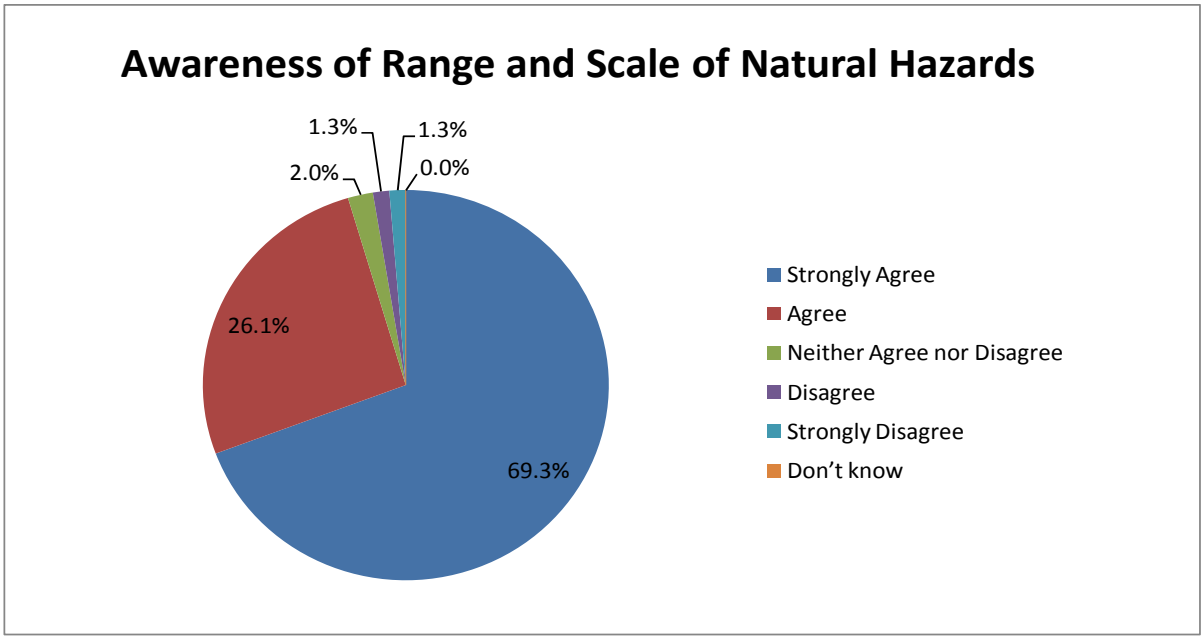
Core Question: How much do you agree or disagree with the following: It's really important that I am aware of and know about the range and scale of natural hazards in the district that affect my home, work and local community.

Statistics

- ***Almost all (95%) respondents agree they should be aware of the range and scale of natural hazards that affect their home, work and local community.***
- ***Reasons why respondents want this information varied:*** 50% said it makes them feel more in control if they know the facts and risks; 47% said it helps them make property.
- ***Of the few who disagreed, the reasons included:*** that the information is too confusing and that the modelling isn't accurate about their areas so won't help inform their decision making.

Agreement Rating Awareness of Range and Scale of Natural Hazards: Number and Percent of Respondents

Awareness of Range and Scale Natural Hazards AGREEMENT RATING		
Answer Options	Response Percent	Response Count
Strongly Agree	69.3%	106
Agree	26.1%	40
Neither Agree nor Disagree	2.0%	3
Disagree	1.3%	2
Strongly Disagree	1.3%	2
Don't know	0.0%	0
answered question		153



Reasons Given By Those Who Agree with Awareness of Range and Scale of Natural Hazards: Number and Percent of Respondents

Why did you say that? AGREE RESPONSES		
Answer Options	**Response Percent**	**Response Count**
I need detailed information so I can make property decisions	46.9%	67
I will feel more in control if I know the facts and what the risks are	50.3%	72
The information and modelling that's been done will help inform better decisions for the future	39.2%	56
It's vital information that affects our whole district's well-being	45.5%	65
Other (please specify)	4.2%	6
answered question		143

Reasons Given By Those Who Disagree with Awareness of Range and Scale of Natural Hazards: Number and Percent of Respondents

Why did you say that? DISAGREE RESPONSES		
Answer Options	**Response Percent**	**Response Count**
The information is too confusing – I just want to get on with my life	66.7%	2
Information isn't going to make any difference	33.3%	1
The modelling that's been done isn't accurate about my area and won't help inform	66.7%	2
More information will scare people unnecessarily and slow down development	0.0%	0
Other (please specify)	66.7%	2
answered question		3

Open Ended Analysis

- **Other reasons for agreeing:** important to plan for a resilient city; important that all the information is accessible by all people so they can assess the risks themselves.

- **Other reasons for disagreeing:** prefer to inform themselves and decide risk to take; fatalism in that there is rick all around us / too over-protective. Similar comments from those who neither agreed not disagreed or who didn't know how they felt about this proposal.

Natural Hazard Risks Concerning People the Most

Core Question: Which of the following natural hazard risks concern you most? [choose up to TWO]

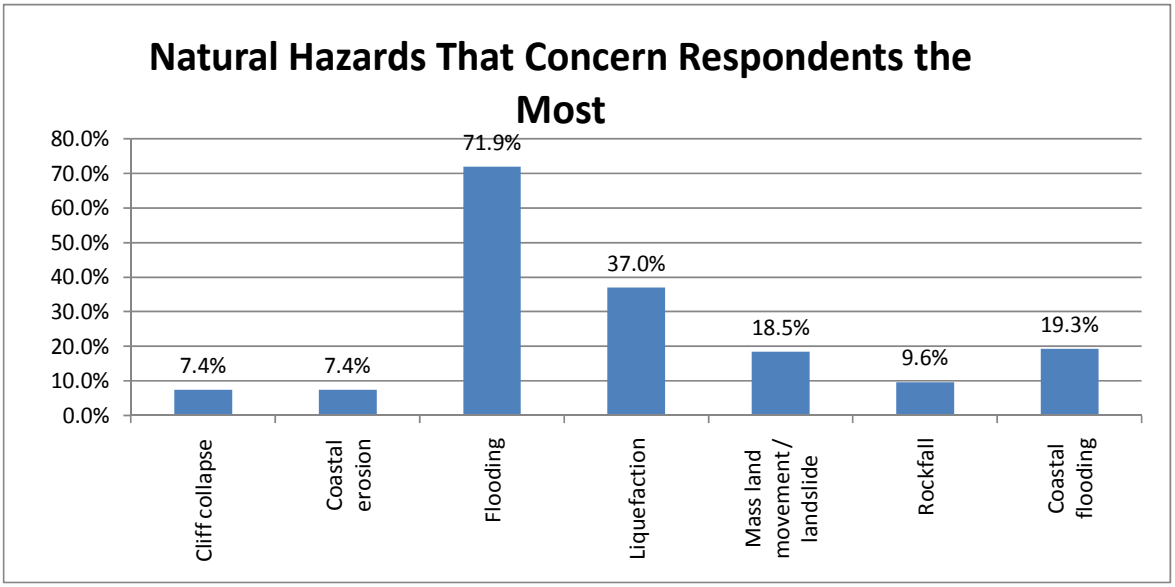
Statistics

- ***Two natural hazards that concerned respondents the most:*** the majority (72%) mentioned flooding, followed by liquefaction (37%).

- ***Almost half (46%) said one of the main reasons for concern was damage to property:*** Other common concerns were loss of home (31%) and loss of life (31%).

Natural Hazards Concerning Respondents Most: Number and Percent of Respondents

Natural Hazards Concerning Respondents Most		
Answer Options	**Response Percent**	**Response Count**
Cliff collapse	7.4%	10
Coastal erosion	7.4%	10
Flooding	71.9%	97
Liquefaction	37.0%	50
Mass land movement / landslide	18.5%	25
Rockfall	9.6%	13
Coastal flooding	19.3%	26
Other (please specify)	11.9%	16
answered question		135



Open Ended Analysis

- **Other natural hazards causing concern:** earthquakes (including Alpine Fault), Council flood mitigation strategies, slips caused by heavy rainfall; strong winds and heavy rainfall; Waimakariri flooding.

Core Question: What concerns you most about the natural hazards you chose above? [choose up to TWO]

Reasons Given for Concern About Specific Natural Hazards: Number and Percent of Respondents

Reasons for Concerns About Natural Hazards		
Answer Options	**Response Percent**	**Response Count**
Damage to property	46.0%	63
Decreased land values	14.6%	20
Decreased property values	24.8%	34
Increased cost / inability to get insurance	21.2%	29
Increased building costs to meet higher building standards	6.6%	9
Loss of home	30.7%	42
Loss of life	30.7%	42
Loss of local community	15.3%	21
Other (please specify)	9.5%	13
	answered question	137

Open Ended Analysis

- **Other concerns associated with natural hazards:** reduces quality of life (including disruption to lifestyles associated with hazard events and associated inconvenience and stress); cost to city in managing hazard events; loss of property values; poor response from local government; damage and disruption to city infrastructure (roads, storm water and sewerage systems); loss of recreation areas.

Minimisation of Risk Through District Plan Policies

Core Question: How much do you agree or disagree with the following: The policies in the District Plan need to ensure that the risks from natural hazards to homes, businesses and local communities are minimised.

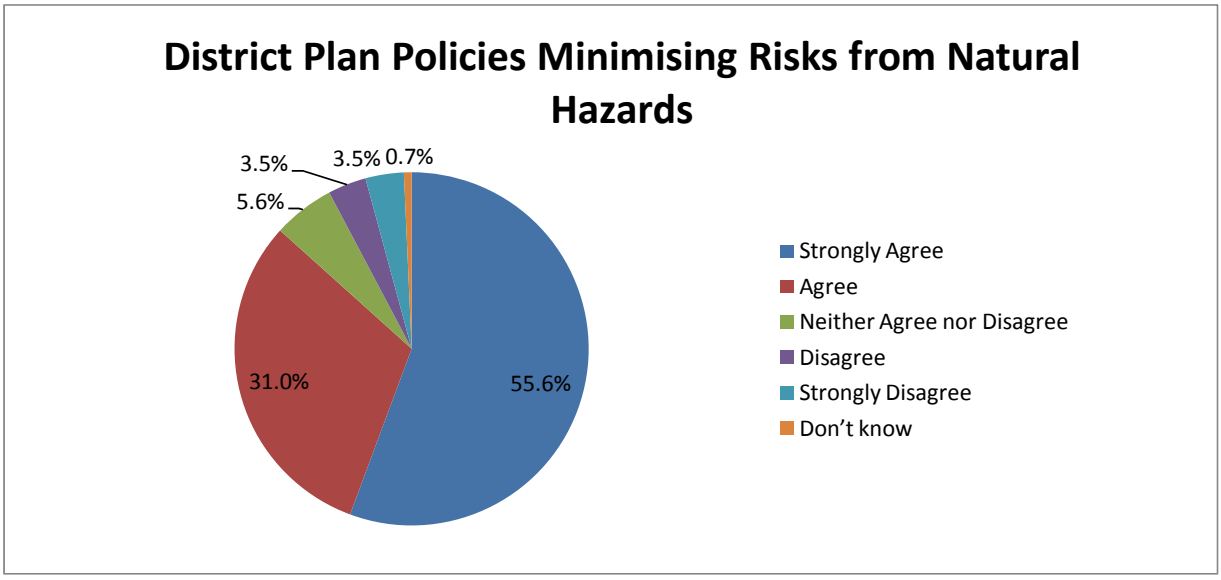
Statistics

- ***The majority (87%) of respondents agreed that the policies in the District Plan Review should ensure that risks from natural hazards to homes, businesses and local communities are minimised:*** 57% strongly agreed.

- ***Just over half (56%) said an important reason for this was that development should be discouraged in hazardous areas:*** 45% said there needs to be a greater focus on mitigating risk in planning. Of those few respondents who disagreed, 60% said it was peoples' own responsibility to decide if the risks are too great and is not the Council's responsibility.

Agreement Rating District Plan Policies Minimising Risks from Natural Hazards: Number and Percent of Respondents

District Plan Review Policies Must Minimise Risk from Natural Hazards AGREEMENT RATING		
Answer Options	Response Percent	Response Count
Strongly Agree	55.6%	79
Agree	31.0%	44
Neither Agree nor Disagree	5.6%	8
Disagree	3.5%	5
Strongly Disagree	3.5%	5
Don't know	0.7%	1
answered question		142



Reasons Given by Those Who Agree with Minimising Risk from Natural Hazards Through District Plan Review: Number and Percent of Respondents

Why did you say that? AGREE RESPONSES		
Answer Options	Response Percent	Response Count
Development should be discouraged in hazardous areas	55.5%	66
Mitigating risk should be the #1 priority in land use decisions	39.5%	47
There needs to be a much greater focus on mitigating risk in planning	45.4%	54
The Council must take every step possible to minimise risks	42.0%	50
Other (please specify)	5.0%	6
answered question		119

Reasons Given by Those Who Disagree with Minimising Risk from Natural Hazards Through District Plan Review: Number and Percent of Respondents

Why did you say that? DISAGREE RESPONSES		
Answer Options	Response Percent	Response Count
It will cost too much to minimise risk as much as possible	40.0%	4
We need to accept some element of risk with some land use	40.0%	4
It's people's own responsibility to decide if the risks are too great, not the Council's	60.0%	6
This is an over-reaction	40.0%	4
Other (please specify)	10.0%	1
answered question		10

Open Ended Analysis

- **Other reasons for agreeing:** important for maintenance of infrastructure.

- **Other reasons for disagreeing or neither agreeing nor disagreeing:** over reaction to risks and threats; community needs to make its own mind about level of acceptable risk.

Raising Floor Levels to Mitigate Flood Risk

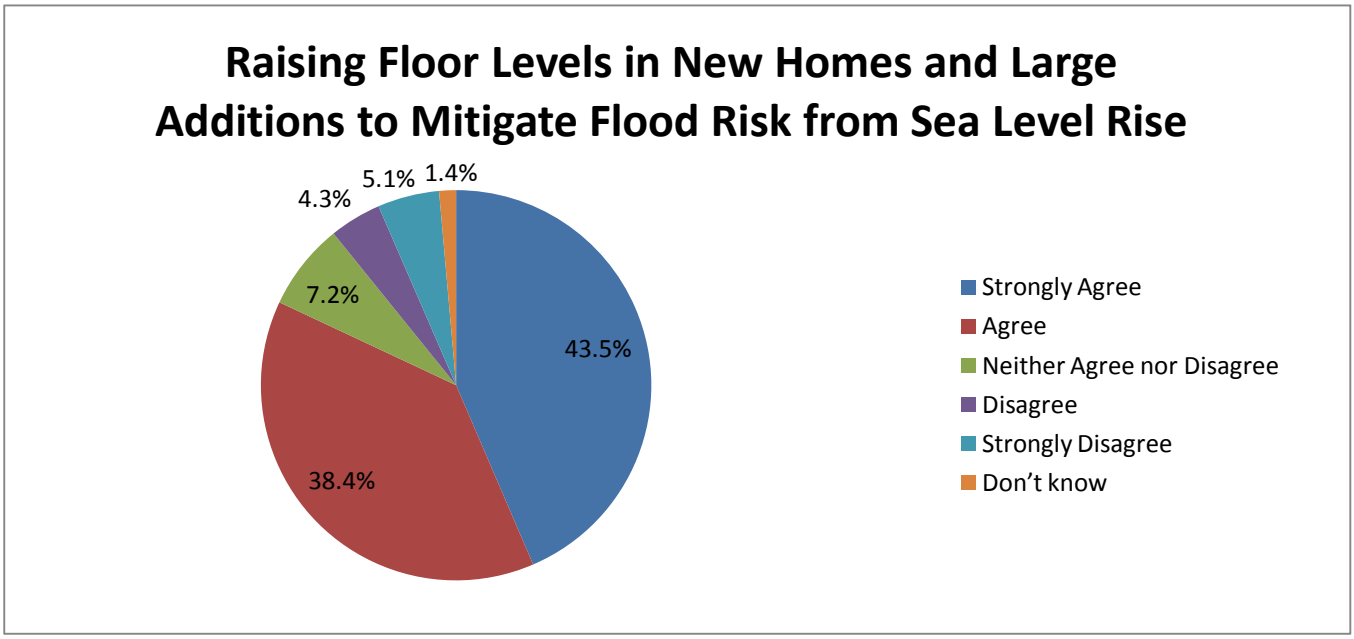
Core Question: How much do you agree or disagree with the following: It's a good idea to require raised floor levels in new homes and large additions to homes, in areas likely to be affected by major flood events (up to a 1 in 200 years' event).

Statistics

- ***The majority (82%) agreed with raising floor levels in new homes and large additions in flood prone areas:*** The most common reason given was that this was a sensible approach to minimising damage from flood water. Respondents also said it important to plan ahead for flooding events (62%).
- ***Only 9% of respondents disagreed with raising floor levels:*** the main reasons given for disagreeing were that respondents felt it would make no difference to minimising risks in the area they lived or owned land I and that it would be too expensive to implement. Of those who were undecided or didn't know whether it was a good idea, most said they needed more information before being able to make a decision.

Agreement Rating Raising Floor Levels to Mitigate Flood Risk from Sea Level Rise: Number and Percent of Respondents

Raising Floor Levels to Mitigate Flood Risk from Sea Level Rise AGREEMENT RATING		
Answer Options	Response Percent	Response Count
Strongly Agree	43.5%	60
Agree	38.4%	53
Neither Agree nor Disagree	7.2%	10
Disagree	4.3%	6
Strongly Disagree	5.1%	7
Don't know	1.4%	2
answered question		138



Reasons Given by Those Who Agree with Raising Floor Levels to Mitigate Flood Risk: Number and Percent of Respondents

Why did you say that? AGREE RESPONSES		
Answer Options	**Response Percent**	**Response Count**
This is a sensible approach to minimising damage from flood water	80.9%	89
This would work in the local area I want to live in/own land	9.1%	10
The Council needs to put in place rules like this to make my home/neighbourhood liveable	21.8%	24
We need to plan ahead for this sort of event	61.8%	68
Other (please specify)	9.1%	10
	answered question	110

Reasons Given by Those Who Disagree with Raising Floor Levels to Mitigate Flood Risk: Number and Percent of Respondents

Why did you say that? DISAGREE RESPONSES		
Answer Options	**Response Percent**	**Response Count**
The Council shouldn't be telling me what to do	25.0%	3
This will make no difference to minimising the risks in the area I live/own land	41.7%	5
This is too expensive to implement	41.7%	5
This will ruin the character and appeal of my neighbourhood	25.0%	3
This is an over-reaction	33.3%	4
Other (please specify)	25.0%	3
	answered question	12

Open Ended Analysis

- **Other reasons for agreeing:** should be extended to existing houses in flood prone areas; this is important for ensuring that Christchurch residents can get insurance for their properties.

- **Other reasons for disagreeing:** fix the cause of the problem not the symptoms; still left with infrastructure issues and challenges.

Planning for Sea Level Rise

Core Question: How much do you agree or disagree with the following: It's wise for the Council to plan for sea level rise of up to 1.0 metre over the next 100 years.

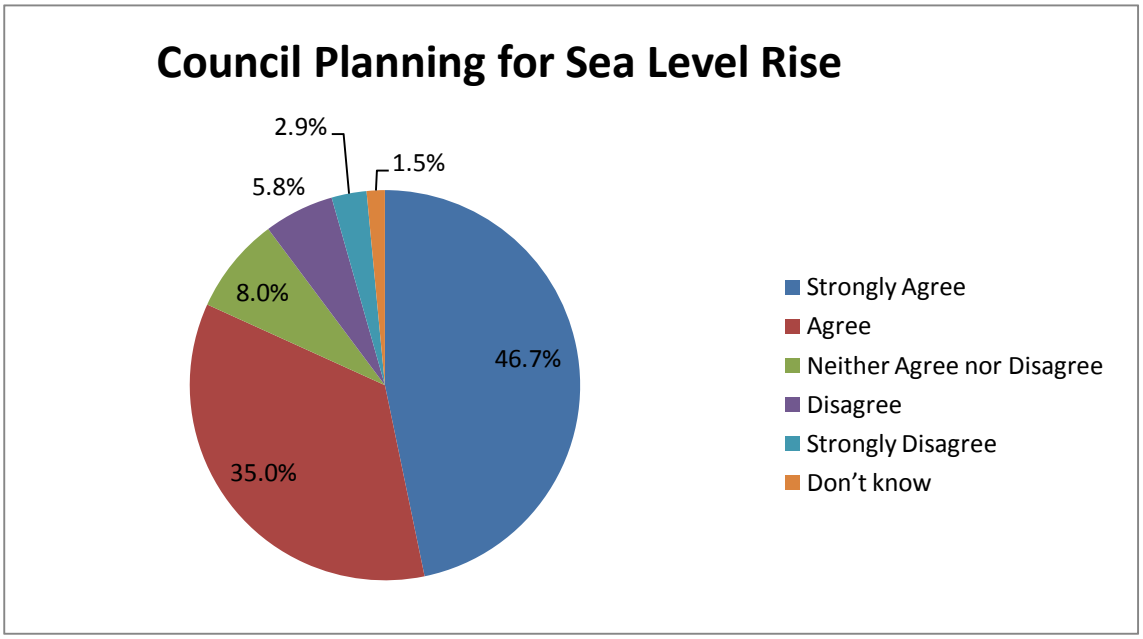
Statistics

- ***The majority (82%) agreed the Council should be planning for sea level rise of up to one metre over the next 100 years.*** Many (71%) said we should be thinking of future generations.

- ***Only 9% of respondents disagreed with planning for sea level rise.*** The majority of these respondents either said there was not enough evidence of sea level rise or didn't agree with the evidence (64%) or saw planning as an overreaction and unnecessary (46%).

Agreement Rating for Council Planning for Sea Level Rise: Number and Percent of Respondents

Council Planning for Sea Level Rise AGREEMENT RATING		
Answer Options	**Response Percent**	**Response Count**
Strongly Agree	46.7%	64
Agree	35.0%	48
Neither Agree nor Disagree	8.0%	11
Disagree	5.8%	8
Strongly Disagree	2.9%	4
Don't know	1.5%	2
	answered question	137



Reasons Given by Those Who Agree with Council Planning for Sea Level Rise: Number and Percent of Respondents

Why did you say that? AGREE RESPONSES		
Answer Options	**Response Percent**	**Response Count**
We should consider future generations	70.6%	77
This would help protect the local area I want to live in/own land	22.0%	24
This will give me reassurance about my neighbourhood in the future	23.9%	26
We need to plan ahead like this	64.2%	70
Other (please specify)	3.7%	4
	answered question	109

Reasons Given by Those Who Disagree with Council Planning for Sea Level Rise: Number and Percent of Respondents

Why did you say that? DISAGREE RESPONSES		
Answer Options	**Response Percent**	**Response Count**
This is an over-reaction and unnecessary	45.5%	5
This will make no difference to minimising the risks in the area I live/own land	9.1%	1
The effect of this will be too expensive and shouldn't be considered	9.1%	1
There is not enough/I don't believe evidence proving this will occur	63.6%	7
Other (please specify)	36.4%	4
	answered question	11

Open Ended Analysis

- **Other reasons for agreeing:** important for the insurability of Christchurch; need to also consider other mitigation strategies at the same time eg. sea walls, public landscaping and drainage systems.

- **Other reasons for disagreeing:** need to be planning for a higher level of rise given risks from tsunamis and extreme weather events; surface flooding is the real issue, not coastal sea rise; global warming is a flawed science.

Planning for Natural Hazard Risk Prior to Residential and Other Development

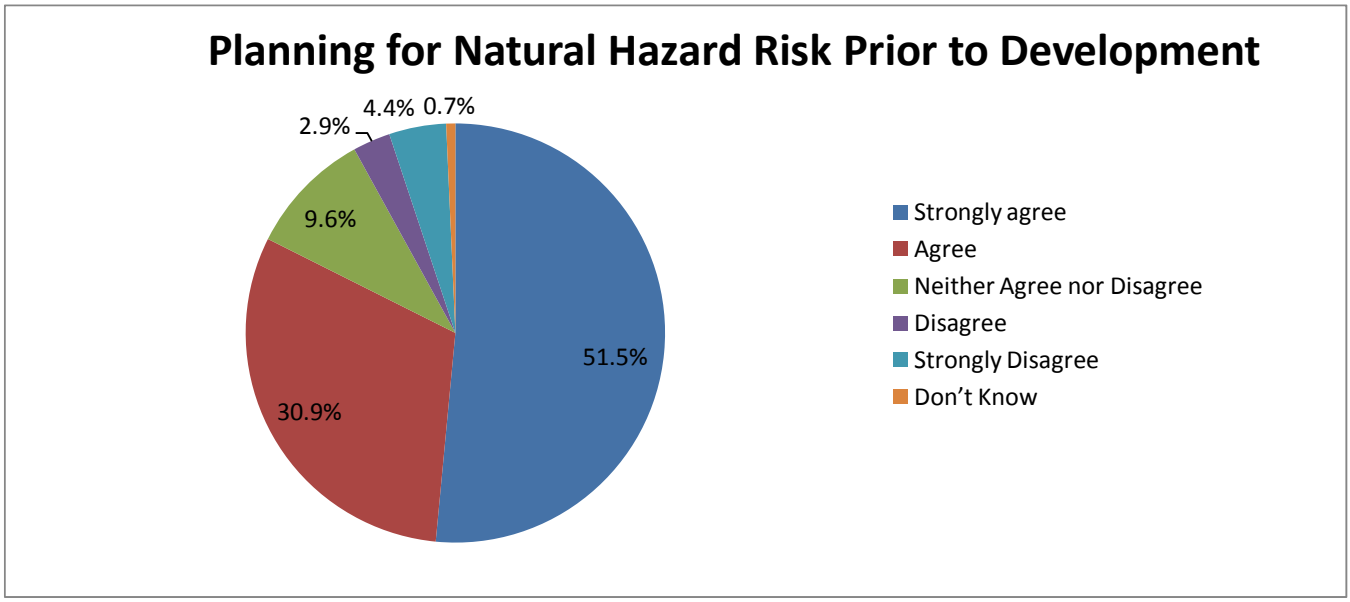
Core Question: How much do you agree or disagree with the following: We need to allow residential or other development on land where risks from natural hazards can be adequately mitigated, but it's important to avoid subdivision and further development on land where there is life-safety risk (cliff collapse, rockfall or boulder roll).

Statistics

- ***The majority (82%) said we should allow development in areas where risk from natural hazards could be mitigated but avoid development in areas where risks are life threatening.*** Three in five (62%) said we need to stop building in areas where there is or could be safety risks and a similar proportion (59%) said it would be good to have clear directions on areas where it is not safe to build.
- ***Only 7% disagreed with prior planning around natural hazard risk.*** Of those who disagreed, the most common reason was that it would be too difficult to regulate this and anticipate the risks adequately (63%).

Agreement Rating for Council Planning for Natural Hazard Risk Prior to Development: Number and Percent of Respondents

Planning for Natural Hazard Risk Prior to Residential and Other Developments AGREEMENT RATING		
Answer Options	Response Percent	Response Count
Strongly agree	51.5%	70
Agree	30.9%	42
Neither Agree nor Disagree	9.6%	13
Disagree	2.9%	4
Strongly Disagree	4.4%	6
Don't Know	0.7%	1
answered question		136



Reasons Given by Those Who Agree with Council Planning for Natural Hazard Risk Prior to Development: Number and Percent of Respondents

Why did you say that? AGREE RESPONSES		
Answer Options	Response Percent	Response Count
This sounds a responsible approach	48.2%	53
This will be effective in managing risks in my neighbourhood	7.3%	8
It will be good to have clear direction on areas where it's not safe to build	59.1%	65
We need to stop building on areas where there is/could be life-safety risks	61.8%	68
Other (please specify)	4.5%	5
answered question		110

Reasons Given by Those Who Disagree with Council Planning for Natural Hazard Risk Prior to Development: Number and Percent of Respondents

Why did you say that? DISAGREE RESPONSES		
Answer Options	Response Percent	Response Count
This will be ineffective in my local area	12.5%	1
This doesn't go far enough to avoid risks	50.0%	4
This is too restrictive - let landowners make up their own mind about use	50.0%	4
It will be too hard to regulate this and anticipate the risks adequately	62.5%	5
Other (please specify)	12.5%	1
answered question		8

Open Ended Analysis

- **Other reasons for agreeing:** important to limit development in areas prone to cliff collapse; important for avoiding loss of life and for fiscal and legal reasons to protect Council and ratepayers.

- **Other reasons for neither agreeing nor disagreeing or not knowing:** fear the Council will use the information for not delivering services to some locations when the real reason is the state of the Council's finances; hazard assessment an art not a science and is often not that accurate and sometimes risk is overstated; people deserve to exercise choice and take responsibility for risk themselves.

Appendix One: Questionnaire

Christchurch is growing and changing, so the Christchurch City Council is reviewing its district plans. The District Plan Review aims to make the district a good place to live, work and do business.

Since September 2010 we have all learnt a lot about the impact of natural hazards on our district, homes and lives. Whenever possible, we need to anticipate and respond to hazards such as:

- flooding and the effects of sea level rise
- liquefaction occurring as a result of ground being shaken by earthquakes, and
- cliff collapse, rockfall and mass movement of sloping land.

We would like to hear what you think about what's being considered as part of the District Plan Review on how these natural hazards can be managed. Your answers will be collated but kept anonymous.

Anyone who lives in the Christchurch City district is welcome to complete this survey. More than one person livingat an address can complete the survey, but each person needs to do their own copy of it.
Firstly some questions about you. This will help us understand the views of different groups in the community.

I own property and / or live in the following Ward area/s (tick all that apply)

Burwood / Pegasus

Fendalton / Waimairi

Hagley / Ferrymead

Riccarton / Wigram

Spreydon / Heathcote

Shirley / Papanui

Banks Peninsula

I don't know which ward

Outside of Christchurch District

I own the following kind of property in this area/s (tick all that apply)

House (that you live in or rent out to others)

Commercial property (e.g. shop, business or office)

Industrial property

Farm property

I don't own a property

Other (please specify)

In which of the following age group do you belong?

Under 18 years

18-24 years

25-49 years

50-64 years

65 years and over

Natural hazards bring risks to people, property and infrastructure (e.g. roads, sewerage systems and water supply).

How much do you agree or disagree with the following:

1. It's really important that I am aware of and know about the range and scale of naturalhazards in the district that affect my home, work and local community.

Strongly Agree

Agree

Neither Agree nor Disagree

Disagree

Strongly Disagree

Don't know

Why did you say that? (tick your TWO MOST IMPORTANT reasons)

I need detailed information so I can make property decisions

I will feel more in control if I know the facts and what the risks are

The information and modelling that's been done will help inform better decisions for the future

It's vital information that affects our whole district's well-being

Other (please specify)

Why did you say that? (tick your TWO MOST IMPORTANT reasons)

The information is too confusing – I just want to get on with my life

Information isn't going to make any difference

The modelling that's been done isn't accurate about my area and won't help inform

More information will scare people unnecessarily and slow down development

Other (please specify)

Why did you say that? (just one response)

I don't understand the issues but I'm not very interested

Information isn't going to make any difference to my circumstances

I don't have an opinion either way

Other (please specify)

2. Which of the following natural hazard risks concern you most? [choose up to TWO]

Cliff collapse

Coastal erosion

Flooding

Liquefaction

Mass land movement / landslide

Rockfall

Coastal flooding

Other (please specify)

3. What concerns you most about the natural hazards you chose above? [choose up to TWO]

Damage to property

Decreased land values

Decreased property values

Increased cost / inability to get insurance

Increased building costs to meet higher building standards

Loss of home

Loss of life

Loss of local community

Other (please specify)

How much do you agree or disagree with the following:

4. The policies in the District Plan need to ensure that the risks from natural hazards to homes, businesses and local communities are minimised.

Strongly Agree

Agree

Neither Agree nor Disagree

Disagree

Strongly Disagree

Don't know

Why did you say that? (tick your TWO MOST IMPORTANT reasons)

Development should be discouraged in hazardous areas

Mitigating risk should be the #1 priority in land use decisions

There needs to be a much greater focus on mitigating risk in planning

The Council must take every step possible to minimise risks

Other (please specify)

Why did you say that? (tick your TWO MOST IMPORTANT reasons)

It will cost too much to minimise risk as much as possible

We need to accept some element of risk with some land use

It's people's own responsibility to decide if the risks are too great, not the Council's

This is an overreaction

Other (please specify)

Why did you say that? (just one response)

I don't understand how much this is a problem

I need to know more about what's proposed before I form an opinion

I don't have an opinion either way

Other (please specify)

Some parts of the district are susceptible to flooding from heavy rainfall, rivers and the sea. There are various ways that these risks can be managed – e.g. raising floor levels.

How much do you agree or disagree with the following:

5. It's a good idea to require raised floor levels in new homes and large additions to homes, in areas likely to be affected by major flood events (up to a 1 in 200 years' event).

Strongly Agree

Agree

Neither Agree nor Disagree

Disagree

Strongly Disagree

Don't know

Why did you say that? (tick your TWO MOST IMPORTANT reasons)

This is a sensible approach to minimising damage from flood water

This would work in the local area I want to live in/own land

The Council needs to put in place rules like this to make my home/neighbourhood liveable

We need to plan ahead for this sort of event

Other (please specify)

Why did you say that? (tick your TWO MOST IMPORTANT reasons)

The Council shouldn't be telling me what to do

This will make no difference to minimising the risks in the area I live/own land

This is too expensive to implement

This will ruin the character and appeal of my neighbourhood

This is an overreaction

Other (please specify)

Why did you say that? (just one response)

I don't understand what is proposed

I need to know more about what's proposed before I form an opinion

I don't have an opinion either way

Other (please specify)

How much do you agree or disagree with the following:

6. It's wise for the Council to plan for sea level rise of up to 1.0 metre over the next 100 years.

Strongly Agree

Agree

Neither Agree nor Disagree

Disagree

Strongly Disagree

Don't know

Why did you say that? (tick your TWO MOST IMPORTANT reasons)

We should consider future generations

This would help protect the local area I want to live in/own land

This will give me reassurance about my neighbourhood in the future

We need to plan ahead like this

Other (please specify)

Why did you say that? (tick your TWO MOST IMPORTANT reasons)

This is an overreaction and unnecessary

This will make no difference to minimising the risks in the area I live/own land

The effect of this will be too expensive and shouldn't be considered

There is not enough/I don't believe evidence proving this will occur

Other (please specify)

Why did you say that? (just one response)

I don't understand what is proposed

I need to know more about what's proposed before I form an opinion

I don't have an opinion either way

Other (please specify)

It's proposed to avoid residential development and subdivision in areas of the Port Hills where there is unstable land (cliff collapse and rockfall).

How much do you agree or disagree with the following:

7. We need to allow residential or other development on land where risks from natural hazards can be adequately mitigated, but it's important to avoid subdivision and further development on land where there is lifesafety risk (cliff collapse, rockfall or boulder roll).

Strongly agree

Agree

Neither Agree nor Disagree

Disagree

Strongly Disagree

Don't Know

Why did you say that? (tick your TWO MOST IMPORTANT reasons)

This sounds a responsible approach

This will be effective in managing risks in my neighbourhood

It will be good to have clear direction on areas where it's not safe to build

We need to stop building on areas where there is/could be lifesafety risks

Other (please specify)

Why did you say that? (tick your TWO MOST IMPORTANT reasons)

This will be ineffective in my local area

This doesn't go far enough to avoid risks

This is too restrictive – let landowners make up their own mind about use

It will be too hard to regulate this and anticipate the risks adequately

Other (please specify)

Why did you say that? (just one response)

I don't understand what is proposed

I need to know more about what's proposed before I form an opinion

I don't have an opinion either way

Other (please specify)

Are you willing to participate in future online surveys about issues facing the district?

Please click on the SUBMIT button when you have finished the survey.

Thank you for completing this survey. Please add your email details if you would like receive District Plan Review updates.

Yes (please ensure you have supplied your email address above)

No