CONFIDENTIAL AND PRIVILEGED

EARTHQUAKE COMMISSION

Explanatory notes for EQC residential land settlement for Residential Red Zone

FLAT LAND (KNOWN SEVERE LATERAL SPREADING AREAS)

February 2018

EXECUTIVE SUMMARY

1 This paper summarises the decisions made by the Earthquake Commission (**EQC**) to settle certain claims for natural disaster damage to residential land caused by the Canterbury earthquake sequence (**CES**) under the Earthquake Commission Act 1993 (the **EQC Act**) where the land claim has been assigned to Land Information New Zealand (**LINZ**) as part of the creation of the Residential Red Zone (**Crown RRZ Claims**).

2 EQC's liability for the Crown RRZ Claims arises under section 19 of the EQC Act and the Direction to the Earthquake Commission Pursuant to Section 112 of the Crown Entities Act 2014 dated 29 October 2015 (the **Ministerial (Land) Direction**).

3 EQC's assessment of its liability for the Crown RRZ Claims is:

3.1 undertaken in accordance with the principles, policies and methodologies described in this paper, consistent with:

(a) EQC's obligations under the EQC Act; and

(b) the principles, policies and methodologies applied to settle land claims in the Residential Green Zone, where applicable; and

3.2 based on the available information to EQC. Where information has been provided by LINZ, EQC has assumed that the information is accurate subject to limited quality assurance reviews.

4 The Crown RRZ Claims can be grouped into three categories:

4.1 **Flat Lands (Excluding Known Severe Lateral Spreading Areas)**: properties located outside the Port Hills area of Christchurch that suffered one, or a combination, of visible land damage and increased vulnerability to future hazards as a result of subsidence caused by the earthquake sequence.

4.2 **Flat Lands (Known Severe Lateral Spreading Areas)**: properties located outside the Port Hills area of Christchurch that suffered a combination of visible land damage and increased vulnerability to future hazards as a result of subsidence caused by the earthquake sequence *and* that have been positively identified as having vulnerability to severe lateral spreading at 500 year return period levels of earthquake shaking.

4.3 **Port Hills**: properties located in the Port Hills area of Christchurch that suffered certain forms of visible land damage such as rock fall, cliff collapse and retaining wall damage.

5 This report addresses only the Flat Lands (Known Severe Lateral Spreading Areas) category. Separate documentation has been provided to LINZ concerning the Flat Lands (Excluding Known Severe Lateral Spreading Areas) and Port Hills categories.

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(A) BACKGROUND TO CROWN RRZ CLAIMS SETTLEMENT

Overview of Crown RRZ Claims

6 EQC provides statutory insurance for residential buildings and residential land (where the buildings have private fire insurance), for damage that occurs as the direct result of a natural disaster.

7 Between 4 September 2010 and 23 December 2011, the Canterbury region was struck by a series of earthquakes of magnitude 3 or greater (the **Canterbury earthquake sequence**). EQC received numerous claims in respect of separate parcels of residential land arising from natural disaster damage from the Canterbury earthquake sequence.

8 In 2011, the Government, initially through the Canterbury Earthquake Recovery Authority (**CERA**), declared certain properties affected by the Canterbury earthquake sequence to be within a "Red Zone". Subsequently, insured residential property owners with properties in the Red Zone were given the choice to sell the affected properties to the Crown. The Crown took assignment of the EQC land claims for the properties sold to the Crown (the **Crown RRZ Claims**). The functions of CERA, including in relation to insurance recovery, were transferred to LINZ in 2015.

9 EQC has been progressively settling the Crown RRZ Claims. The properties subject to Crown RRZ Claims were grouped into three categories, depending on the types of land damage observed:

9.1 **Flat Lands (Excluding Known Severe Lateral Spreading Areas)**: properties located outside the Port Hills area of Christchurch that suffered one, or a combination, of visible land damage and increased vulnerability to future hazards as a result of subsidence caused by the earthquake sequence.

9.2 **Flat Lands (Known Severe Lateral Spreading Areas)**: properties located outside the Port Hills area of Christchurch that suffered a combination of visible land damage and increased vulnerability to future hazards as a result of subsidence caused by the earthquake sequence *and* that have been positively identified as having vulnerability to severe lateral spreading at 500 year return period levels of earthquake shaking.

9.3 **Port Hills**: properties located in the Port Hills area of Christchurch that suffered certain forms of visible land damage such as rock fall, cliff collapse and retaining wall damage.

10 In December 2017, EQC provided LINZ with documentation supporting its assessment of the Crown RRZ Claims for Flat Lands (Excluding Known Severe Lateral Spreading Areas) and Port Hills. For Flat Lands (Excluding Known Severe Lateral Spreading Areas) properties, EQC's decisions are summarised in its report *Explanatory notes for EQC residential land settlement for Residential Red Zone: Flat Land (Excluding Known Severe Lateral Spreading Areas)* (December 2017) (**2017 Explanatory Notes**).

11 The present report relates to the third and final category of Crown RRZ Claims: Flat Lands (Known Severe Lateral Spreading Areas). This concerns properties outside the Port Hills area of Christchurch, which have suffered the same types of damage as properties in the Flat Lands (Excluding Known Severe Lateral Spreading Areas), but which have also been identified as having vulnerability to severe lateral spreading at 500 year return period levels of earthquake shaking.

The relationship between this report and the 2017 Explanatory Notes

12 As described in more detail in Section (B) of this report, there is a significant overlap in the types of natural disaster damage observed between the Flat Lands categories, both within and outside known severe lateral spreading areas.

13 Accordingly, this report should be read together with the 2017 Explanatory Notes. The 2017 Explanatory Notes provide background to and description of EQC's approach to land damage assessments in the Red Zone outside the Port Hills area and, in particular, contains a summary of:

13.1 the legal principles that EQC applies to settle claims for natural disaster damage to residential land under the EQC Act;

13.2 the additional fundamental principles that the Board of EQC has adopted to guide settlement of the Crown RRZ Claims; and

13.3 general assumptions made by EQC in relation to the settlement of the Crown RRZ Claims.

14 The present report explains how the assessment of natural disaster damage for Flat Lands properties described in the 2017 Explanatory Notes was adapted for properties in known severe lateral spreading areas, and the reasons for this.

EQC's claims settlement process for Flat Lands (Known Severe Lateral Spreading Areas)

15 One of the fundamental principles adopted by the EQC Board for settlement of the Crown RRZ Claims is that EQC will settle Red Zone claims using the same policies and methodologies developed for Green Zone properties, where those policies and methodologies are applicable.

16 EQC recognises the same damage types in the Red Zone as were recognised in the Green Zone, where information is available indicating that damage occurred. This includes, as described in more detail in Section (B) and (E) of this report:

16.1 visible forms of land damage;

16.2 Increased Flooding Vulnerability (**IFV**) land damage associated with subsidence to the residential land caused by the Canterbury earthquake sequence; and

16.3 Increased Liquefaction Vulnerability (**ILV**) land damage associated with subsidence to the residential land caused by the Canterbury earthquake sequence.

17 EQC sought and obtained engineering advice from its expert engineering advisors, Tonkin + Taylor (**T+T**), concerning whether any other forms of land damage have occurred in the Residential Red Zone that are not present in the Residential Green Zone. EQC's engineering advice was that:

17.1 areas of the Red Zone land had suffered extensive stretching and ground cracking as a result of severe lateral spreading. The stretching and cracking in these areas was such that the repair approaches used to repair cracking in the Green Zone and other areas of the Red Zone would not be suitable to restore the integrity of the land;

17.2 outside of areas identified as having severe lateral spreading, stretching and cracking of the land can be repaired using the repair approaches adopted in the Green Zone and the only forms of land damage that exist were also present in the Green Zone.

18 Severe lateral spreading, and the damage caused by it, is described in more detail in Section (B) of this report. In summary, severe lateral spreading is defined as a vulnerability to greater than 0.5 m of lateral stretch in a 1 in 500 year level of earthquake shaking. The vulnerability of land to severe lateral spreading pre-existed the Canterbury earthquake sequence – as reflected in the observed damage attributable to this vulnerability - and was not increased by physical changes to the land as a result of the sequence. Put another way, the residential land was vulnerable to severe lateral spreading before the Canterbury earthquake sequence occurred and has not become any worse as a result of land damage caused by the Canterbury earthquake sequence.

19 There are currently no engineering, analytical or probabilistic tools that are sufficiently developed to provide consistent and reliable methods of assessing lateral spreading risk. Therefore, it is not possible to identify all the areas of the Residential Red Zone where the lateral spreading is expected to be severe at 500 year return period levels of earthquake shaking. However, certain properties have been identified as having severe lateral spreading vulnerability due to the presence of extensive stretching and ground cracking resulting from severe lateral spreading in the Canterbury earthquake sequence which occurred at levels of shaking of less than a 500 year return period level of shaking.

20 EQC is satisfied that the identified presence of severe lateral spreading vulnerability and resulting different natural disaster damage suffered by those properties means that the policies and methodologies developed for Green Zone properties cannot be used for Flat Lands (Known Severe Lateral Spreading Areas) without modification. That is because:

20.1 the extensive stretching and ground cracking damage that was caused by the Canterbury earthquake sequence is different in scale to that observed in the Green Zone and other areas of the Red Zone, with different practical implications. As described in more detail in Section (B) of this paper:

(a) the repair techniques developed for cracking damage in the Green Zone are insufficient to repair land that has suffered this form of damage, and as such the cost of Green Zone repairs cannot be used as a proxy for the diminution of value (**DoV**) attributable to this form of damage; and

(b) the extensive stretching and ground cracking damage increases the vulnerability of the land to liquefaction damage in future earthquakes. This form of damage has been defined by T+T as Increased Liquefaction Vulnerability due to compromised crust (**ILV_{CC}**).

20.2 EQC's policies and methodologies for assessing the appropriate settlement for natural disaster damage to land assume that the residential land is capable of future residential use. However, T+T's advice is that due to the pre-existing potential for lateral spreading, which has not become any worse as a result of the land damage caused by the Canterbury earthquake sequence, the residential land cannot be practically built on, on an individual property basis.

21 To assist with the development of adapted policies and methodologies to settle Crown RRZ Claims for Flat Lands (Known Severe Lateral Spreading Areas), EQC engaged T+T to provide specific advice on the identification of properties with severe lateral spreading vulnerability, the natural disaster damage suffered by those properties, and the practical implications of the damage given the pre-existing vulnerability of the properties to severe lateral spreading.

22 EQC has also engaged expert valuation advisors to assist in relation to the valuation impacts of damage to residential land caused by the Canterbury earthquake sequence for land subject to a pre-existing vulnerability to severe lateral spreading.

EQC's engagement on Flat Lands (Known Severe Lateral Spreading Areas)

23 EQC has engaged with LINZ on the settlement of Crown RRZ Claims for Flat Lands (Known Severe Lateral Spreading Areas). As set out in the 2017 Explanatory Notes, this engagement was on the basis that:

23.1 it is ultimately for EQC to determine a settlement amount of the Crown RRZ Claims, and for LINZ to determine whether to accept or challenge any aspect of this settlement;

23.2 as for Green Zone properties, despite clause 7(3) of Schedule 3 of the EQC Act, EQC has gathered information and undertaken work that it considers will enable it to form a view on the appropriate amount to settle Crown RRZ Claims in accordance with its interpretation of its obligations under the Act;

23.3 as for any other claimant and/or assignee of a claim, it is open to LINZ to seek to review EQC's settlement decision by bringing forward new information or a new interpretation of existing information, and prove additional damage or loss in accordance with clause 7(3);

23.4 engagement between EQC and LINZ is likely to identify and facilitate early resolution of any issues regarding the applicable principles and valuation methodologies, leading to a more efficient settlement process for Crown RRZ Claims and avoiding, where possible, duplication of work.

24 The specific engagement with LINZ in relation to Flat Lands (Known Severe Lateral Spreading Areas) included:

24.1 a joint statement by T+T and LINZ's geotechnical advisors, Aurecon, concerning land damage to properties subject to a Crown RRZ Claim, including Flat Lands (Known Severe Lateral Spreading Areas);[1]

24.2 correspondence on the potential for area-wide remedial works to address the pre-existing severe lateral spreading vulnerability; and

24.3 correspondence on the implications of the geotechnical advice for the appropriate assumptions, policies and methodologies to settle Crown RRZ Claims for Flat Lands (Known Severe Lateral Spreading Areas).

25 EQC has taken into account the joint statement from the geotechnical advisors, and the views and information provided by LINZ in the above-mentioned correspondence in reaching its settlement decision.

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[1] T+T and Aurecon *Summary of Geotechnical Discussions (June to October 2017)* (October 2017). The report is replicated in Appendix A8 of the 2017 Explanatory Notes.

(B) GEOTECHNICAL ADVICE FOR FLAT LANDS (KNOWN SEVERE LATERAL SPREADING AREAS)

Geotechnical reports

26 This section of the report summarises the engineering advice provided to EQC concerning Flat Lands (Known Severe Lateral Spreading Areas).

27 T+T have provided a report to EQC on properties with known severe lateral spreading vulnerability and compromised crust damage: T+T, *Increased Liquefaction Vulnerability due to Compromised Crust from the Canterbury Earthquake Sequence: Assessment Methodology and Practical Implications* (December 2017) (the **Compromised Crust Report**), included as **Appendix A2** to this report.

28 The Compromised Crust Report builds on earlier T+T work and analysis and should be read in conjunction with:

28.1 the T+T ILV Assessment Methodology documented in the T+T report, *Canterbury Earthquake Sequence: Increased Liquefaction Vulnerability Assessment Methodology* (T+T, October 2015);

28.2 the peer review of the ILV Assessment Methodology report by an international independent panel, *Peer Review of the Increased Liquefaction Vulnerability Assessment Methodology* (Independent Expert Panel, October 2015);

28.3 the T+T report on the practical implications of ILV land damage, *Practical Implications of Increased Liquefaction Vulnerability Report* (T+T, November 2016) (the **Practical Implications Report**); and

28.4 the T+T report, *Practical Implications of Increased Liquefaction Damage: Residential Red Zone* (T+T, September 2017), included as Appendix A7 to the 2017 Explanatory Notes.

29 T+T and Aurecon have also prepared a joint statement on geotechnical characteristics of the Red Zone, *Summary of Geotechnical Discussions (June to October 2017)* (T+T and Aurecon, October 2017), included as Appendix A8 to the 2017 Explanatory Notes.

Lateral spreading vulnerability

30 In areas with soils that are susceptible to liquefaction, significant damage to land and structures on the land can be caused by liquefaction-related lateral spreading. Lateral spreading is the horizontal movement of the ground downslope or towards a free-face, such as a road cutting, old river terrace or river bank, as a result of liquefaction of shallow underlying soils.

31 Where the spreading is not uniform, the ground surface will stretch and can crack leading to significant networks of deep cracks, ejecta (sands that are ejected to the surface through the cracks), and damage to services and structures on the land. Significant lateral spreading-related damage was observed in the Canterbury earthquake sequence, primarily in close proximity to rivers and streams. A detailed description of lateral spreading-related damage observations is set out in Appendix F to the ILV Assessment Methodology.

- ***Effects of the Canterbury earthquake sequence on lateral spreading vulnerability***

32 The potential for lateral spreading existed prior to the Canterbury earthquake sequence. T+T,[2] the independent peer review panel,[3] and Aurecon[4] agree that the pre-existing potential for lateral spreading has not practically changed for a given level of earthquake shaking as a result of the Canterbury earthquake sequence. If anything, the potential for lateral spreading has slightly decreased due to ground surface subsidence caused by the Canterbury earthquake sequence, but this effect is unquantifiable.

33 As a result of the Canterbury earthquake sequence, the regional seismicity of Canterbury has increased due to changes in stresses in the earth's crust in the regions where there has been movement on the faults. This means that the level of ground shaking at a particular return period (e.g., a 1 in 100 year earthquake) is greater than it was prior to the Canterbury earthquake sequence. Accordingly, a property may be more vulnerable to lateral spreading-related damage in a 1 in 100 year earthquake than prior to the Canterbury earthquake sequence because, due to the change in regional seismicity, the level of shaking described as a 1 in 100 year earthquake after the sequence is greater and therefore more likely to trigger more severe and extensive liquefaction.

34 However, as explained in the ILV Assessment Methodology[5] and peer review report,[6] the change in seismicity is not the result of any physical change to the residential land but rather is the result of remote regional changes. Accordingly, both T+T and Aurecon conclude that the pre-existing potential for lateral spreading has not become any worse as a result of the land damage caused by the Canterbury earthquake sequence.[7]

- ***Implications of lateral spreading vulnerability***

35 Properties with lateral spreading vulnerability are vulnerable to land and building damage in a future earthquake event as a result of lateral spreading. The extent of the vulnerability to future damage will depend on the severity of the lateral spreading vulnerability.[8]

36 In addition, *MBIE Guidance* (2015) (the **Guidance)** requires potential for lateral spreading to be taken into account in designing ground improvements and foundation solutions. The Guidance document categorises lateral spreading vulnerability as:

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[2] T+T *Canterbury Earthquake Sequence: Increased Liquefaction Vulnerability Assessment Methodology* (October 2015) at 60-61.

[3] Independent Expert Panel *Peer Review of the Increased Liquefaction Vulnerability Assessment Methodology* (October 2015) at 17.

[4] T +T and Aurecon *Summary of Geotechnical Discussions (June to October 2017)* (October 2017) at 7.

[5] T+T *Canterbury Earthquake Sequence: Increased Liquefaction Vulnerability Assessment Methodology* (October 2015) at 48.

[6] Independent Expert Panel *Peer Review of the Increased Liquefaction Vulnerability Assessment Methodology* (October 2015) at 16.

[7] T +T and Aurecon *Summary of Geotechnical Discussions (June to October 2017)* (October 2017) at 10.

[8] How this potential for damage intersects with potential liquefaction-related damage associated with ILV land damage is discussed below.

36.1 **minor-to-moderate lateral spreading vulnerability** – between 0 to 0.2 m of lateral stretch is predicted in a 1 in 500 year level of earthquake shaking;

36.2 **major lateral spreading vulnerability** - between 0.2 and 0.5 m of lateral stretch is predicted in a 1 in 500 year level of earthquake shaking;

36.3 **severe lateral spreading vulnerability** – over 0.5 m of lateral stretch is predicted in a 1 in 500 year level of earthquake shaking.

37 The Guidance provides ground improvement and foundation solutions suitable for minor-to-moderate and major lateral spreading areas. In severe lateral spreading areas, there are currently no foundation solutions or ground improvement solutions available on an individual property basis. While one solution (not part of the Guidance) has been identified by T+T and Aurecon, this solution would not be technically feasible for many properties and, in any event, the costs of the work are expected to far exceed the land value. T+T and Aurecon have therefore advised that, in the absence of area-wide works, there is currently no practical way of building on land with severe lateral spreading vulnerability.[9]

- ***Identification of severe lateral spreading vulnerability***

38 T+T have advised, and Aurecon have confirmed, that there are currently no engineering, analytical or probabilistic tools that are sufficiently developed to provide consistent and reliable methods of assessing lateral spreading risk. It is therefore not possible to reliably divide the Red Zone into areas where lateral spreading is expected to be severe, as opposed to major or minor-to-moderate, at 1 in 500 year levels of earthquake shaking.[10]

39 However, while it is not possible to reliably identify all areas of the Red Zone where lateral spreading vulnerability is severe, the performance of the land in the Canterbury earthquake sequence enables the identification of certain properties as falling within this category. That is because all the events in the Canterbury earthquake sequence had lower levels of shaking than what is currently considered (following the Canterbury earthquake sequence) to be a 1 in 500 year level of earthquake shaking. If these events caused more than 0.5 m of lateral stretch, this indicates that the pre-existing vulnerability of the property to lateral spreading is severe.[11]

40 As described further below, T+T have identified properties within the Red Zone where the stretching and ground cracking is so extensive that the standard repair methodologies for cracking land damage developed by EQC are not appropriate. T+T and Aurecon agree that all properties with extensive stretching and ground cracking have had more than 0.5 m of lateral stretch, and therefore can be predicted to have severe liquefaction vulnerability in a future event with a 1 in 500 year level of shaking.

41 These areas are "known severe lateral spreading" areas. There may be other properties within the Red Zone that also have severe lateral spreading. However, on

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[9] T +T and Aurecon *Summary of Geotechnical Discussions (June to October 2017)* (October 2017) at 9 and 10.

[10] T +T and Aurecon *Summary of Geotechnical Discussions (June to October 2017)* (October 2017) at 10.

[11] T T +T and Aurecon *Summary of Geotechnical Discussions (June to October 2017)* (October 2017) 10 and 11.

the basis of the existing state of lateral spreading science, these cannot be reliably identified as having severe lateral spreading on the balance of probabilities.

ILV_{CC} land damage

42 In parts of the Red Zone, generally in close proximity to the Avon River, extensive lateral stretching and ground cracking occurred. This cracking compromises the integrity of the non-liquefying crust of the land (essentially, by providing pathways for liquefying sands to reach the surface through the non-liquefying crust).

43 There are two implications of this type of damage:

43.1 the land is visibly cracked, which presents an immediate loss of amenity visually and in relation to its everyday use;

43.2 the cracking increases the vulnerability of the land to liquefaction damage in future earthquake events that have sufficient shaking intensity to trigger liquefaction in the underlying soils.

44 Less severe cracking of the land associated with lateral spreading was observed in both the Green Zone and the Red Zone (this form of damage has been classified as Category 1 land damage). Repair methodologies were developed by EQC for this form of land damage, involving the excavation and back filling of the crack(s) to address both the visual loss of amenity and any increase in liquefaction vulnerability due to the crack.[12] However, in areas of the Red Zone, the stretching and ground cracking is so extensive that the standard repair methodologies developed by EQC are not appropriate, as repair of individual cracks will most likely not reinstate the crust to at least the level of integrity that existed prior to the Canterbury earthquake sequence.[13]

45 In Red Zone areas with extensive cracking, the immediate visual loss of amenity and impacts on everyday uses of the land can be addressed by filling the cracks with soil. However, this will not address the increase in liquefaction vulnerability caused by the loss of integrity in the crust (the crust has been 'compromised').

46 Accordingly, EQC has determined to recognise Increased Liquefaction Vulnerability due to compromised crust (**ILV_{CC}**) as a category of land damage. This form of land damage is defined as:[14]

> a physical change to residential land as a result of extensive stretching and ground cracking in the CES, such that existing individual crack repair methodologies are insufficient to reinstate the crust to pre-CES conditions, adversely affecting the use and amenity that would otherwise be associated with the land by materially increasing the vulnerability of that land to liquefaction damage in future earthquakes.

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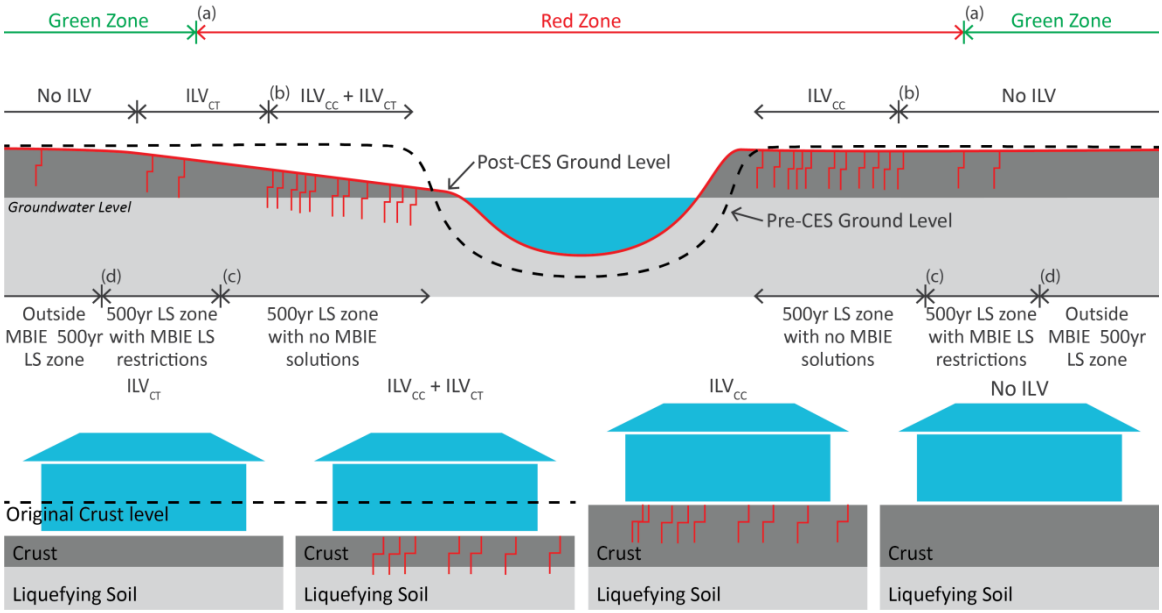
[12] T+T *Increased Liquefaction Vulnerability due to Compromised Crust from the Canterbury Earthquake Sequence: Assessment Methodology and Practical Implications* (December 2017) at 4. The repair methodologies also address any potential increase in liquefaction vulnerability due to the crack: T+T *Canterbury Earthquake Sequence: Increased Liquefaction Vulnerability Assessment Methodology* (October 2015) at 61.

[13] T+T *Increased Liquefaction Vulnerability due to Compromised Crust from the Canterbury Earthquake Sequence: Assessment Methodology and Practical Implications* (December 2017) at 4 and 5.

[14] T+T *Increased Liquefaction Vulnerability due to Compromised Crust from the Canterbury Earthquake Sequence: Assessment Methodology and Practical Implications* (December 2017) at 1.

47 ILV_{CC} land damage has essentially the same implications for land use as ILV land damage. Both are increases in vulnerability to liquefaction-related damage in a future earthquake event due to physical changes to the land. The sole difference is that, for ILV land damage, the changes are due to earthquake-caused subsidence; for ILV_{CC} land damage, the changes are due to earthquake-caused stretching and ground cracking. T+T illustrate the relationship between the two causes of increased vulnerability to liquefaction, and the existence of known severe lateral spreading, in the following diagram.



48 Given the relationship between ILV land damage and ILV_{CC} land damage, essentially the same criteria have been used to assess the presence and practical implications of ILV_{CC} land damage as for ILV land damage. This is described in greater detail in Section (D), below, and the Compromised Crust Report.

Other categories of natural disaster damage to land

49 T+T have confirmed that properties within known severe lateral spreading vulnerability areas may also have suffered the following categories of land damage recognised by EQC in the Green Zone and other parts of the Red Zone:

49.1 visible forms of land damage;

49.2 IFV land damage; and

49.3 ILV land damage.

50 Unlike compromised crust and ILV_{CC} land damage, the presence of these categories of damage does not indicate severe lateral spreading vulnerability. Further, not all properties with severe lateral spreading vulnerability have all these categories of damage. The assessment of whether properties with severe lateral spreading vulnerability have one or more of the other categories of land damage is described in Part (D) of this paper.

Practical implications of natural disaster damage for land with severe lateral spreading vulnerability

51 T+T and Aurecon have provided advice on the practical implications of severe lateral spreading and the relationship between severe lateral spreading and the implications of other damage to land, including ILV_{CC}.

52 The existence of severe lateral spreading vulnerability does not affect the implications of all damage types. For example, in the case of IFV land damage, the presence of vulnerability to lateral spread in a future earthquake event is independent from the vulnerability of the property to flooding.

53 However, there are two ways in which severe lateral spreading vulnerability may impact the implications of natural disaster damage to land:

53.1 first, it may prevent the land from being built upon. In these circumstances, the implications for damage to the land may be different: for example, the damage to the land will not affect the use of the land as a building platform as the land will not be built upon;

53.2 second, in the case of ILV and ILV_{CC} land damage, there is a direct relationship between the practical implications of those forms of damage – future land and building damage related to liquefaction triggered by a future earthquake event – and damage to land and building caused by severe lateral spreading in a future earthquake event.

- ***Residential use***

54 T+T and Aurecon have advised that neither flooding nor liquefaction vulnerability, whether alone or in combination, would prevent land in the Red Zone being used for residential development. Accordingly, for the reasons summarised above, severe lateral spreading vulnerability is the only hazard that results in not being able to practically build in the Residential Red Zone.

55 In areas with severe lateral spreading vulnerability, there are no practical ways of providing lateral spreading mitigation measures on an individual property basis apart from potentially a few exceptions which would typically be the higher value properties (i.e., the cost of ground improvement and the accompanying foundations exceed the property land value for most of the Residential Red Zone properties). Instead, in these areas, area-wide lateral spreading mitigation measures in the form of perimeter treatment are required before MBIE standard foundation solutions could be used.

56 With perimeter treatment:

56.1 rebuilding of residential buildings on land improved by the perimeter treatment works could be undertaken in a practical way in accordance with MBIE Guidance, as with other TC3 land; and

56.2 the implications of ILV land damage or ILV_{CC} land damage would be those set out in T+T's Practical Implications Report and Compromised Crust Report.

57 In the absence of perimeter treatment, the severe lateral spreading hazard causes significant constraints for building on the land. As discussed above, in many cases it would not be economic. However, if undertaken, the deep ground improvement required to address the severe lateral spreading hazard would completely address the liquefaction vulnerability and remediate all ILV and ILV_{CC} damage.

- ***ILV and ILV_{CC} land damage***

58 If perimeter treatment works were carried out, the implications of ILV land damage or ILV_{CC} land damage would be those set out in T+T's Practical Implications Report and Compromised Crust Report.

59 If severe lateral spreading is not addressed, ILV and ILV_{CC} land damage have more limited practical implications for the property than would be the case if the severe lateral spreading was not present. In summary:

59.1 if severe lateral spreading is not triggered, which is likely to be the case for earthquakes for 25 year return period levels of shaking and some less frequent events, the implications of ILV and ILV_{CC} land damage for the risk of future land damage and house damage will be the same as if the property was not vulnerable to severe lateral spreading;

59.2 if severe lateral spreading is triggered, which is likely to be the case at least from a 100 year return period, the land and building damage that would be caused by severe lateral spreading would be very severe and any increase in liquefaction vulnerability due to ILV or ILV_{CC} land damage would be negligible (that is, immaterial).

60 Put another way, where severe lateral spreading is triggered, the damage caused by that mechanism (including new cracking caused by lateral spreading that will provide pathways for ejecta to reach the surface and cause land and building damage), will subsume any increased vulnerability of the land due to liquefaction-related damage based on subsidence or a compromised crust.

(C) IDENTIFYING THE LOSS OF VALUE ATTRIBUTABLE TO NATURAL DISASTER DAMAGE

61 The EQC Act insures residential land on an indemnity basis. EQC's objective is therefore to indemnify the claimant against his or her financial loss *as a result of* the natural disaster damage to the insured property by appropriate payment.[15] EQC is not entitled or liable to compensate claimants for loss that is not caused by natural disaster damage.

62 It follows that EQC is not liable for all economic loss that is attributable to an earthquake or its aftermath. Consistent with this, consequential loss is expressly excluded from the insurance under the Act.[16] Instead, EQC must be satisfied, on the balance of probabilities, that loss has been caused by natural disaster damage.

63 This requires EQC to identify:

63.1 what is, and what is not, natural disaster damage, in the context of properties with known severe lateral spreading vulnerability, and taking into account the engineering advice outlined in Section (B); and

63.2 what loss is caused by the identified natural disaster damage, which informs the assumptions to be made in assessing the DoV resulting from the natural disaster damage.

64 Each of these matters is discussed in more detail below.

Natural disaster damage

65 The definition of "natural disaster damage" provides:[17]

> **Natural disaster damage** means, in relation to property,—
>
> (a) any physical loss or damage to the property occurring as the direct result of a natural disaster; …

66 "Natural disaster" is defined as meaning (among other things) "an earthquake".[18]

67 The definition of natural disaster damage has been considered in a number of cases arising out of the Canterbury earthquake sequence. As interpreted by the courts, natural disaster damage requires the following:

67.1 there must be a physical change, a physical alteration or a physical disturbance to the materials or structure of the insured property;[19]

67.2 the physical change, alteration or disturbance must impair the value or usefulness of the changed element as a component in the property;[20]

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[15] *Earthquake Commission v Insurance Council of New Zealand* [2014] NZHC 3138, [2015] 2 NZLR 381 at [94] (**Land Declaratory Judgment**).

[16] Earthquake Commission Act 1993, Sch 3 cl 2.

[17] Earthquake Commission Act 1993, s 2(1), definition of "natural disaster damage".

[18] Earthquake Commission Act 1993, s 2(1), definition of "natural disaster".

[19] See, generally, *Kraal v Earthquake Commission* [2015] NZCA 13, [2015] 2 NZLR 589 at [78]; *O'Loughlin v Tower Insurance Ltd* [2013] NZHC 670, [2013] 3 NZLR 275 at [44]; *C & S Kelly Properties Ltd v Earthquake Commission* [2015] NZHC 1690 at [175]; *Parkin v Vero Insurance New Zealand Ltd* [2015] NZHC 1675 at [38].

67.3 since the "physical loss or damage" must occur "as the direct result" of the earthquake, that physical change, alteration or disturbance must have been caused by the (insured) earthquake; and

67.4 the physical change, alteration or disturbance must be material, not *de minimis*. Each case must be examined on its own facts to determine whether an alteration to the physical state has occurred to such an extent that it can be considered more than *de minimis*, and the point reached that physical damage can be said to have occurred.[21]

68 In the context of the insurance of residential land, EQC and the Insurance Council of New Zealand sought and obtained declarations that two particular forms of damage, both involving an increase in vulnerability of the land to future natural disaster damage due to physical changes that are the direct result of the Canterbury earthquake sequence, are natural disaster damage for the purposes of the EQC Act.[22] These are:

68.1 IFV land damage - a physical change to residential land as a result of an earthquake that adversely affects the uses and amenities that could otherwise be associated with the land by increasing the vulnerability of that land to flooding events; and

68.2 ILV land damage - a physical change to residential land as a result of an earthquake that adversely affects the uses and amenities that could otherwise be associated with the land by increasing the vulnerability of that land to liquefaction damage in future earthquake events.

69 Essentially for the same reasons as apply to IFV and ILV land damage, EQC is satisfied that ILV_{CC} land damage is natural disaster damage for the purposes of the EQC Act. That is because:

69.1 the extensive cracking and stretching of the residential land is a physical alteration or disturbance to the materials or structure of the insured property (i.e., the residential land);

69.2 the cracking and stretching causes an immediate loss of visual and use amenity, as well as reducing the amenity of the property by increasing the vulnerability of the land to liquefaction-related damage in a future earthquake event;

69.3 the cracking and stretching has been caused by the Canterbury earthquake sequence; and

69.4 the alteration is more than de minimis.

70 In contrast, changes in vulnerability that result from external changes other than to the residential land, or changes in perceptions of pre-existing vulnerability, are **not** natural disaster damage and therefore fall outside the scope of the statutory

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[20] *C & S Kelly Properties Ltd v Earthquake Commission* [2015] NZHC 1690 at [175]; *O'Loughlin v Tower Insurance Ltd* [2013] NZHC 670 at [44].

[21] *C & S Kelly Properties Ltd v Earthquake Commission* [2015] NZHC 1690 at [175].

[22] Land Declaratory Judgment.

insurance. That is because such changes do not result from a physical change to the materials or structure of the insured property.

71 In the context of land that has known severe lateral spreading vulnerability, this means that the following is **not** natural disaster damage:

71.1 *Severe lateral spreading vulnerability*: as described in Section (B), above, the vulnerability of land to lateral spreading pre-existed the Canterbury earthquake sequence and has not been increased as a result of physical change to the land;

71.2 *Increase in seismicity*: as described in Section (B), Canterbury seismicity has increased as a result of the Canterbury earthquake sequence. As a result, the level of shaking predicted for a particular return period, such as a 1 in 100 year earthquake, has increased. However, this results from regional changes to the fault which does not result from physical changes to the insured land. Accordingly, the increase in seismicity is not natural disaster damage;

71.3 *Increase in knowledge and/or awareness of severe lateral spreading vulnerability*: prior to the Canterbury earthquake sequence, knowledge of lateral spreading vulnerability was not widespread. The result is that, prior to the Canterbury earthquake sequence, decisions were made concerning the use of land and construction of residential buildings, and the sale and purchase of existing residential buildings on land with severe lateral spreading vulnerability, that may not have been made had all relevant persons had full knowledge of the pre-existing vulnerability to severe lateral spreading.

71.4 *Changes in regulatory and building practice:* EQC understands that, since the Canterbury earthquake sequence, the increased seismicity in the region and increased awareness of the vulnerability to liquefaction have led to changes in building regulations and practices. These changes have resulted in more extensive geotechnical testing and more robust foundation designs being required in areas that are vulnerable to liquefaction-related damage or lateral spreading. Again, these regulatory and practical developments are not changes that arise from the physical damage to the insured land.

72 Essentially for the same reasons, in the context of the insurance of residential buildings (but equally applicable to the insurance of residential land), the Government's decisions concerning the Residential Red Zone has been confirmed **not** to be natural disaster damage by the Courts.[23]

73 EQC is therefore not liable to indemnify claimants against loss suffered as a result of the decision to create the Red Zone.[24]

Loss caused by natural disaster damage

- ***The basis for settlement is diminution of value***

74 EQC has determined that it will settle the Crown RRZ Claims for natural disaster damage to residential land by payment rather than reinstatement. In determining whether the amount of the payment is assessed by reference to repair costs or DOV

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[23] *O'Loughlin v Tower Insurance Ltd* [2013] NZHC 670, [2013] 3 NZLR 275.

[24] EQC has not assessed the implications of the Red Zone decision on value of properties. However, a discussion of the issue can be found in *Quake Outcasts v Minister of Canterbury Earthquake Recovery & Anor* [2017] NZCA 332 at [49]–[50], [55]–[59] and [87].

as the best measure of the claimant's loss, EQC has applied the policies set out in EQC's IFV and ILV Land Damage Consolidated Policy Statement.

75 One of the circumstances identified by EQC as where settlement on the basis of DoV is appropriate is when the property has been sold by the original owner. This principle has been endorsed by the High Court.[25]

76 The Crown as assignee of the Crown RRZ Claims can be in no better position than the original claimant. That is, as all Crown RRZ Claims involve properties that have been sold, EQC has determined that all will be settled on the basis of DoV.

- ***Diminution of value must be caused by natural disaster damage***

77 EQC is required to determine the DoV caused by natural disaster damage, as opposed to other earthquake-related or non-earthquake related causes.[26] The assessment of whether particular loss is caused in fact by natural disaster damage is generally assessed by a "but for" approach: that is, but for the natural disaster damage, would the insured have suffered loss.[27]

78 This principle follows from the basic principle of indemnity that a claimant should not recover more or less than the loss suffered as a result of natural disaster damage to the insured property.[28] The relevant loss is the loss that is caused directly by the natural disaster damage. It should not include loss that results from other causes.[29]

79 Accordingly, in the context of insurance of residential land, if a particular loss would have occurred in the absence of the natural disaster damage to the insured residential land, this is not loss caused by the natural disaster damage to that land. This principle has been confirmed by the High Court in relation to the insurance provided under the EQC Act for residential buildings, and is equally applicable to the insurance of residential land.[30]

- ***Assumptions resulting from causal requirement***

80 In order to assess the DoV caused by natural disaster damage, EQC's valuers have adopted DoV methodologies that:

80.1 assume full knowledge by a willing buyer and willing seller of the natural disaster damage, and the practical implications of that damage on the future use and enjoyment of the property, as those implications would be described to a buyer or seller by a reasonable engineering advisor; and

80.2 focus on the practical implications of natural disaster damage identified by EQC's engineering advisors on the property, and adopt discounts that reflect

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[25] Land Declaratory Judgment at [113].

[26] Consistent with this, natural disaster damage is itself defined as, in relation to property, any physical loss or damage occurring "as the direct result" of a natural disaster: Earthquake Commission Act 1993, s 2.

[27] See, for example, *Orient-Express Hotels Ltd v Assicurazioni Generali SpA* [2010] EWHC 1186 (Comm), [2010] 1 CLC 847. See *also Smaill v Buller District Council* [1998] 1 NZLR 190 (HC) at 291, where loss of value of land with instability was held not to be caused by a council's negligent grant of building consent, because the loss of land value would have occurred anyway once the instability problem became public knowledge.

[28] *Ridgecrest NZ Ltd v IAG NZ Ltd* [2014] NZSC 117, [2015] 1 NZLR 40 at [53]–[54].

[29] *Blue Circle Industries Plc v Ministry of Defence* [1999] Ch 289 (CA) at 316.

[30] *Sadat v Tower Insurance Limited & Ors* [2017] NZHC 1550 at [254]; *He v Earthquake Commission & Ors* [2017] NZHC 2136 at [66]–[67].

the impact of those practical implications on the future use and enjoyment of the property;

80.3 apply those discounts to the undamaged value of the property. For land that is not subject to known severe lateral spreading vulnerability, EQC adopts the market value of the property or land as at the date of the earthquake as the best evidence for the undamaged value of the relevant property.

81 The Expert Valuation Panel has noted that the effect of these assumptions is likely to be generous in some cases:[31]

> The Panel notes that the effect of some of the express valuation assumptions contained in the methodology, in particular that of well-informed market participants, is that the reductions in value produced by the methodology are likely to be higher than that observed for real world market transactions to date. In practice, market participants currently have varying degrees of knowledge (and generally less knowledge than EQC's valuers) as to the extent and impacts of ILV land damage on residential properties. Whilst there is an increasing awareness of these impacts by vendors and purchasers, they are not yet fully understood.

82 In addition, the assumption that the pre-earthquake market value reflects the undamaged value of the property with full knowledge of its vulnerability to natural hazards (but for the natural disaster damage) may be generous in some cases. In particular, it is possible that, if the vulnerability of the land was not known or appreciated prior to the earthquake, the value of the land may be higher than if full knowledge was held.

83 The practical implications of natural disaster damage that are relevant to the valuation exercise are those that affect the highest and best use of the land. In the Green Zone, and in most parts of the Residential Red Zone, the assumption has been made that the highest and best use is residential use. As set out in Section (B), T+T's advice is that the natural disaster damage resulting from the Canterbury earthquake sequence does not prevent residential development.

84 The practical implications for natural disaster damage in this context are considered in light of current regulation and practice, as this will affect the on-going use of the property.[32] In other words, the assessment asks what difference the natural disaster damage makes to the ongoing use and enjoyment of the property, in light of current knowledge, regulation and practice.

Potential for area-wide works

85 Area-wide perimeter treatment is considered the most appropriate mitigation measure for areas of severe lateral spreading hazard in Christchurch. With perimeter treatment, rebuilding of residential properties could be undertaken in a practical way and IFV and ILV land damage, and ILV_{CC} land damage, would have the same practical implications as if the land was not subject to known severe lateral spreading vulnerability.[33]

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[31] *Expert Valuation Panel Statement – ILV (Cleared Site) DoV Methodology* (November 2016).

[32] *Diminution of Value Methodology for Increased Liquefaction Vulnerability (for where the residential building has been or will be rebuilt)* (November 2016) at [52.7].

[33] T+T *Increased Liquefaction Vulnerability due to Compromised Crust from the Canterbury Earthquake Sequence: Assessment Methodology and Practical Implications* (December 2017) at 5.

86 EQC has considered what weight, if any, should be given to the potential for area-wide perimeter treatment works to be carried out in known severe lateral spreading vulnerability areas. Such works could be funded in theory either by private developers, or by the Government.

87 As part of its consideration, EQC enquired of LINZ whether area-wide works to address severe lateral spreading vulnerability were contemplated. On 26 September 2017, LINZ advised that no decisions have yet been made by the Crown about future use of this land, including the feasibility of remediation and/or potential residential use:

> until such time as future use decisions are nearing finalisation, no definitive statement can be made as to the nature and extent of any land remediation that may allow residential and/or other use of Christchurch flat land residential red zone land, including perimeter treatment works. And we cannot make an assumption either way whether any land remediation work would or would not be publicly funded.

88 On 27 October 2017, LINZ reiterated that:[34]

> … there is no certainty around whether or not this will be undertaken, and if it was to be undertaken, when that work would occur. Nor is it clear whether it would be for all affected areas of the RRZ, or just some. So at best, perimeter treatment as part of a separate Crown remediation project is speculative – that is, it is something which may be given further consideration in the future. LINZ does not accept it should be taken into account as part of the settlement.

89 Consistent with LINZ's position, EQC considers that, based on the information currently available to it, it is not appropriate to assume that perimeter treatment works would be undertaken in any part of the Residential Red Zone for the purposes of the valuation exercise. To be taken into account in the DoV assessment of the natural disaster damage as at the date of the relevant earthquakes, the potential for perimeter treatment must be more than speculative.

90 EQC is satisfied that this is not the case:

90.1 as LINZ have advised, no government funded scheme has been announced to date, and is regarded by LINZ as speculative. While this information was not available at the date of the earthquake, EQC considers that information as to what has in fact occurred is relevant to the assessment of the available contingencies as at the date of the earthquakes;

90.2 the potential for land with known severe lateral spreading vulnerability to be sold to a developer to undertake perimeter treatment works (with the result that the potential value of the land with works undertaken might be reflected in the sale price), or for a group scheme to be undertaken, is limited given the difficulties such a project would face.

91 In relation to the potential for privately funded perimeter treatment works to be undertaken, at least the following difficulties would arise:

91.1 to be viable in a context outside of a government scheme, perimeter treatment schemes would require the sale of all land subject to severe lateral

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[34] LINZ letter to EQC dated 27 October 2017, at [11].

spreading to a single developer or for each property owner to agree to participate (in addition, for some schemes public land would be required). There would therefore be a material hold out risk for any private scheme not backed by a compulsory acquisition option;

91.2 the civil works required to undertake perimeter treatment schemes are very expensive. In the preliminary analysis undertaken by T+T for the purposes of the valuation exercise, drawing on earlier work completed in the Red Zone:[35]

(a) the estimated costs of civil works for the schemes in most areas of the Red Zone exceeded the combined pre-earthquake value of the insured land;

(b) in the five areas where the estimated costs of civil works for the schemes did not exceed the combined pre-earthquake value of the land, the cost of works in most cases approached 60 to 70% of the pre-earthquake land value;

91.3 the estimate of the cost of civil works is uncertain, as it is dependent on design considerations that are difficult to fully implement in a hypothetical context;

91.4 in addition to civil costs, any developer would have to take into account enabling work costs such as reinstatement of buried services, as well as financing and developer risk margins. Any developer is likely to apply a significant risk margin to the project, given the risks associated with the investment. This would further reduce the number of areas in the Residential Red Zone that could be considered for viable area-wide works, if not eliminate all areas altogether;

91.5 even if perimeter treatment works were economically viable, a developer could choose to use existing site boundaries and services (i.e., a Brownfields development) or redevelop completely the affected area (i.e., a Greenfields development). Attributing the total value of the development after perimeter treatment works are undertaken to pre-earthquake properties is therefore challenging, and would require a number of simplifying assumptions to be made, many of which may not reflect the real-world consequences of development.

92 Given the number and scope of those challenges, on the information available, EQC considers that it is unrealistic to assume a credible prospect of perimeter treatment works being undertaken using private funds for land with known severe lateral spreading vulnerability.

93 Accordingly, EQC's valuers have been instructed to disregard participation in an area-wide works scheme as a viable highest and best use of land in the Residential Red Zone. If further information becomes available indicating the viability of such schemes in any particular area of the Red Zone, this assumption can be revisited.

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[35] T+T *Darfield Earthquake 4 September 2010 Geotechnical Land Damage Assessment & Reinstatement Report – Stage 2 Report* (2010) and T+T *Kaiapoi Red Zones – Engineering Feasibility of Potential Land Uses – Stage 1 Report* (2016).

Residential use in known severe lateral spreading areas

94 EQC and LINZ's engineering advisors have confirmed that natural disaster damage to the insured residential land, including IFV and ILV (whether caused by crust thinning or compromised crust) does not have the result that land cannot be rebuilt on. However, as described in more detail in Section (B), T+T's advice concerning known severe lateral spreading areas is that the presence of the pre-existing hazard means that, in the absence of area-wide works:

94.1 there are no practical ways of providing lateral spreading mitigation measures on an individual property basis apart from potentially a few exceptions which would typically be the higher value properties;

94.2 ILV and ILV_{CC} land damage have more limited practical implications for the property than would be the case if the severe lateral spreading was not present.

95 The joint geotechnical advice from EQC and LINZ's engineers is that, in the absence of the identified natural disaster damage, the land would not be able to be built on in the absence of area-wide works. Put another way, even if all natural disaster damage caused by the Canterbury earthquake sequence was repaired, this would still not enable residential development in the absence of area-wide works to address the severe lateral spreading vulnerability.

96 In the absence of area-wide works, it cannot be said that "but for" the natural disaster damage the land would be capable of supporting residential use. The necessary causal connection between the natural disaster damage and the inability to develop the land for residential use is absent. It follows that EQC must not compensate for loss of value attributable to the inability to develop the property for residential use, and that the undamaged value of the property, reflecting full knowledge and current regulatory and engineering practice, should reflect non-residential use.

97 Equally, it is not appropriate for the practical implications of the natural disaster damage to be assessed against an assumption of on-going residential use when, in the absence of area-wide works, this will not occur and could not occur given knowledge of the severe lateral spreading vulnerability (irrespective of subsequent decisions on Red Zoning and withdrawal of services). If such an assumption were made, this would result in an assessment of an artificial loss of value, not reflective of claimants' actual loss due to natural disaster damage to land.

98 For these reasons, in order to assess the DoV attributable to natural disaster damage for land with known severe lateral spreading vulnerability, EQC has instructed EQC's valuers to assess DoV so that:

98.1 the undamaged value of the property reflects full knowledge of the vulnerability of the land to severe lateral spreading, and the implication of this on the future residential use of the property as a building platform;

98.2 the practical implications of natural disaster damage take into account the existence of the vulnerability of the land to severe lateral spreading damage.

99 Further details on the implementation of these instructions are set out in Section (D) of this report.

100 EQC acknowledges that, prior to the Canterbury earthquake sequence, land in the Red Zone including that which is now identified as having known severe lateral

spreading vulnerability, was lawfully used for residential purposes. As a result of having a residential building insured against fire, the building and associated land were also insured against natural disaster damage under the EQC Act.

101 As a result of the Canterbury earthquakes, EQC accepts that land in known severe lateral spreading vulnerability areas is unlikely to be able to rebuilt. However, this is not caused by natural disaster damage to the insured land; instead, the recognition of a pre-existing hazard, increases in regional seismicity, and changes to regulation and practice have had that result. These matters fall outside the scope of the statutory insurance of residential land provided by the EQC Act.

102 While for liquefaction and flooding vulnerability, full knowledge of the pre-earthquake vulnerability is assumed to be reflected in the pre-earthquake market value of the property, this assumption is not possible for severe lateral spreading vulnerability. That is because of the specific implication that it is not practical to use the land for residential development, which was not reflected in the pre-earthquake market value. In contrast, there is no means of determining the extent to which the pre-earthquake value of the property was over-valued due to lack of knowledge of flooding or liquefaction vulnerability, if at all, and in any event any adjustment is very likely to be modest in comparison with the valuation impact of the knowledge that the land is not able to be used as a residential building platform.

(D) CLAIMS SETTLEMENT ASSESSMENT

Damage categories

103 As for Flat Lands (Excluding Known Severe Lateral Spreading Areas), to ensure consistency of assessment, EQC has, on the basis of engineering and policy advice, adopted a number of categories of natural disaster damage to residential land for Flat Lands (Known Severe Lateral Spreading Areas) properties, reflecting the types of damage observed in Canterbury as a result of the Canterbury earthquake sequence. The categories of land damage are, with the exception of ILV_{CC} damage, the same as for Flat Lands (Excluding Known Severe Lateral Spreading Areas) properties.

104 The forms of damage are:

104.1 Flat Lands Visible Damage, including the extensive stretching and ground cracking damage;

104.2 Flat Lands increased vulnerability damage:

(a) Increased Flooding Vulnerability (**IFV**) land damage; and

(b) Increased Liquefaction Vulnerability (**ILV**) land damage caused both by crust thinning and compromised crust (**ILV_{CC}**).

105 A property in the Flat Lands Residential Red Zone (Known Severe Lateral Spreading Areas) will have two or more of the categories of land damage (as all Flat Lands Residential Red Zone properties have been assessed as suffering visible damage and ILV_{CC}). A breakdown of the number of Crown RRZ Claims properties is shown in the table below.[36]

Damage types	**Number of Flat Lands (Known Severe Lateral Spreading Area) properties**
Visible land damage and **ILV_{CC}** only	165
Visible land damage, **ILV_{CC}** and **IFV** land damage only	77
Visible land damage, **ILV_{CC}** and **ILV** land damage only	182
Visible land damage, **ILV_{CC}**, **IFV** and **ILV** land damage	882
Total Flat Land Crown Residential Red Zone	1306

Table 1: Breakdown of Flat Land (Known Severe Lateral Spreading Areas) Crown RRZ Claims properties by damage category

[36] The figures in the table below are properties with claims assigned to the Crown (i.e., Crown RRZ Claims) only. This differs from the number of ILV_{CC} properties reported in the Compromised Crust report which record all properties with ILV_{CC} damage irrespective of whether the property has a valid EQC claim.

106 Categorisation of land damage does not affect overall EQC liability: all natural disaster damage to land caused by an event is subject to the same indemnity principles and is subject to the same maximum amount of insurance and excess.

Settlement process

107 Assessment of EQC's total liability for Crown RRZ Claims for Flat Lands (Known Severe Lateral Spreading Vulnerability Areas) properties adopts the same steps as for Flat Lands (Excluding Known Severe Lateral Spreading Areas). These are set out in Section (E) of the 2017 Explanatory Notes.[37]

108 The results of the steps have been collated into a model prepared and maintained by T+T (the **Crown RRZ Claims Liability Model**). The results and outputs of the Crown RRZ Claims Liability Model for Flat Lands (Known Severe Lateral Spreading Areas) are set out in **Appendix A1**.

Visible Land Damage

109 EQC has identified, based on engineering advice, a number of forms of visible land damage to Flat Lands properties as a result of the Canterbury earthquake sequence. This category of land damage includes both visible damage to land, and visible damage to certain structures (retaining walls, bridges and culverts) that fall within the definition of residential land under the EQC Act.

110 Subject to modifications required to address the severity of ground stretching and cracking damage, described below, the assessment of visible land damage for Flat Lands (Known Severe Lateral Spreading Areas) was conducted in accordance with the same methodologies as for Flat Lands (Excluding Known Severe Lateral Spreading Areas). These methodologies are summarised in Section (E) of the 2017 Explanatory Notes and the accompanying documentation.

111 As noted in Section (B), for these properties extensive and severe cracking and lateral stretching has occurred that is not able to be repaired using conventional techniques developed for the Green Zone. EQC has therefore estimated the cost of addressing the immediate visual loss of amenity and impacts on everyday uses of the land with ground stretching and cracking by filling the cracks with soil.

112 T+T has done so by using, for properties with land damage index values 5 and 6, the average land damage value for index value 4. This is because index value 4 largely corresponds to remedying undulations and ponding land damage, which is expected to require equivalent expenditure to address visible cracks. In contrast, index values 5 and 6 will reflect cracking, and therefore the average costs to remediate will reflect the different land repair technique for individual cracks adopted in the Green Zone.

113 The modifications to the analysis for visible land damage are set out in more detail in the T+T report, *Properties with Known Severe Lateral Spreading Damage: Estimating the compensation for Category 1 to 7 land damage and structures damage for the LINZ flat land Residential Red Zone properties with EQC claims* (February 2018) included as **Appendix A3**.

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[37] EQC *Explanatory notes for EQC residential land settlement for Residential Red Zone: Flat Lands (Excluding Known Severe Lateral Spreading Areas)* (December 2017) at 22–24.

IFV, ILV and ILV_{CC} land damage

- ***Qualification***

114 EQC's policies for assessing whether properties have suffered IFV and ILV land damage as a result of the Canterbury earthquake sequence are set out in the IFV/ILV Consolidated Policy.[38] These policies were applied in the Residential Red Zone.

115 The assessment of whether properties have suffered IFV and ILV land damage in Flat Lands (Known Severe Lateral Spreading Areas) was conducted in accordance with the same methodologies as for Flat Lands (Excluding Known Severe Lateral Spreading Areas). This process is summarised in Section (E) of the 2017 Explanatory Notes and the accompanying documentation.

116 The qualification process for ILV_{CC} land damage involved two steps, similar to that for ILV land damage:

116.1 **Engineering criterion**: T+T determine whether the vulnerability of the land to liquefaction-related damage has materially increased as a result of physical change to the land caused by the Canterbury earthquake sequence;

116.2 **Valuation criterion**: there must be a material valuation loss as a result of the increased vulnerability of the land to liquefaction-related damage. As for ILV land damage, no separate property specific valuation analysis was required for the purposes of qualification.

117 T+T completed ILV_{CC} land damage engineering qualification assessments for Residential Red Zone properties using the methodology documented in the Compromised Crust Report.[39]

- ***DoV assessment***

DoV methodologies adapted

118 EQC's valuers have developed methodologies, in conjunction with legal and engineering advice, to determine what, if any, DoV to residential land or property has resulted from ILV_{CC} land damage and any ILV land damage and IFV land damage.

119 For the reasons set out in Sections (B) and (C) of this report, the methodologies adopted in the Green Zone were not directly applied to Flat Lands (Known Severe Lateral Spreading Vulnerability Areas), given the presence of the pre-existing severe lateral spreading hazard. The adaptation of the existing methodologies for IFV and ILV land damage to apply to these properties is set out in *Diminution of Value Methodologies for Increased Flooding Vulnerability, Increased Liquefaction Vulnerability and Increased Liquefaction Vulnerability (Compromised Crust) for Crown-owned Properties in the Residential Red Zone (with Known Severe Lateral Spreading Vulnerability)* (EQC, January 2018), included as **Appendix A4.**

120 The objective of the DoV methodologies is:

> to assess the **discount** from the price that would have been paid for a **property or land**, as at **the day of the earthquake** but with **full knowledge** about the vulnerability of the land

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[38] EQC *IFV and ILV land damage Consolidated Policy Statement* (September 2016) at [11]-[23].

[39] T+T *Increased Liquefaction Vulnerability due to Compromised Crust from the Canterbury Earthquake Sequence: Assessment Methodology and Practical Implications* (December 2017) at Section 3.

to **severe lateral spreading**, that would be agreed between a **willing buyer and willing seller** because of the **specified physical change** to the land, with full knowledge of the change and its impact on the vulnerability of the land to flooding and liquefaction, the costs of repair options, and advice from competent and **reasonable advisors** recommending any course of action

121 As explained in Section (C) of this report, EQC's valuers were instructed to assess DoV so that:

121.1 the undamaged value of the property reflects full knowledge of the vulnerability of the land to severe lateral spreading, and the implication of this on the future residential use of the property;

121.2 the practical implications of natural disaster damage take into account the existence of the land's vulnerability to severe lateral spreading damage.

122 EQC's valuers are satisfied that the pre-earthquake market value of the property did not reflect full knowledge of the vulnerability of the land to severe lateral spreading. In particular, there did not appear to be any engineering advice precluding the land's suitability for residential development. Accordingly, the DoV methodologies adjust the pre-earthquake value to reflect an undamaged value of the property as at the date of the earthquake that reflects the limitations on the use of the property:

122.1 where the residential building located on the land prior to the Canterbury earthquake sequence has been or will be removed, the assessed land value will reflect that the standard MBIE ground improvement or foundation solutions cannot be economically used to support residential use of the land, absent area-wide works;

122.2 where the residential building located on the land prior to the Canterbury earthquake sequence has not been and will not be removed, the assessed land value will reflect that the current building may be occupied (as lateral spreading vulnerability does not give rise to any other practical or legal impediment to inhabit the dwelling) but that the standard MBIE ground improvement or foundation solutions cannot be economically used to support residential use of the land, absent area-wide works, in the event that work requiring a consent is undertaken, including redevelopment of the land.

123 The percentage adjustments have also been altered for different practical implications of IFV and ILV land damage, reflecting the impact of those forms of damage on the different highest and best uses assumed for properties and land with known severe lateral spreading vulnerability.

124 EQC's valuers have not previously determined a valuation methodology for DoV attributable to ILV_{CC} land damage. However, T+T have advised that the practical implications of ILV_{CC} land damage are the same as for ILV land damage, as they are simply two different physical changes to land that increase the future vulnerability of the land to liquefaction-related damage. Accordingly, EQC's valuers have adapted the ILV land damage DoV methodologies to apply to both ILV_{CC} land damage and ILV land damage for Flat Lands (Known Severe Lateral Spreading Area) properties. T+T have classified properties into extent of change in liquefaction vulnerability categories at 1 in 25 and 1 in 100 year levels of earthquake shaking having regard to the effect of both ILV and ILV_{CC} land damage. The effect is that properties with both ILV and ILV_{CC} land damage in general receive a more significant extent of change classification, and therefore a higher DoV, than if ILV alone was taken into account.

Identification of whether residential building has been or will be removed

125 Separate methodologies have been developed for where the residential building located on the land prior to the Canterbury earthquake sequence will not be removed as a result of earthquake damage, and where it has or will be removed:

125.1 where the residential building located on the land prior to the Canterbury earthquake sequence will not be removed as a result of earthquake damage (an **In Situ** property), the discount is assessed from the undamaged property value (that is, the value of the land and improvements); and

125.2 where the pre-earthquake residential building has been or will be removed (a **Cleared Site** property), the discount is assessed from the undamaged land value.

126 EQC has relied upon information supplied by LINZ to determine whether the pre-earthquake building required removal as a result of earthquake damage, and therefore whether the DoV discount should be assessed based on the property or land value for each Crown RRZ Claim.

Implementation of DoV methodologies

127 The DoV methodologies assess the appropriate discount by:

127.1 **Phase 1**: assessing the value on 3 September 2010 of the insured property or land (depending on whether the property is an In Situ property or a Cleared Site property), adjusted to reflect full knowledge of the vulnerability of the site to severe lateral spreading (the **undamaged value**);

127.2 **Phase 2**: using the matrices set out in the DoV methodologies to determine an appropriate percentage adjustment that reflects the practical implications of the land damage (the **percentage adjustment**). Where property or land is affected by both IFV and one or more of ILV and ILV_{CC} land damage, the combined effect of the practical implications of the land damage is determined using the Combination Matrix in the **Crossover Methodology** (discussed below);

127.3 **Phase 3**: multiplying the undamaged value by the total percentage adjustment to obtain a dollar value discount. Valuer judgement is applied to this to ensure that it appropriately reflects the DoV attributable to land damage in all the circumstances.

128 For Phase 1, pre-earthquake values have been assessed using conventional mass appraisal valuation techniques based on indexation of the most recent rating valuations, in force as at 3 September 2010, and adjusting the resulting valuations to reflect the insured area of land. Since the majority of dwellings had been demolished before the valuations were carried out, EQC's valuers relied on the historical information available.

129 EQC's valuers applied adjustments to the pre-earthquake values to reflect the highest and best use of the land with full knowledge of the vulnerability of the site to severe lateral spreading. For In Situ properties, the highest and best use of the property will be to continue to use the residential building and associated land for residential purposes. An adjustment was made to reflect the limitations on the future redevelopment of the land and/or building.

130 For Cleared Site properties, Flat Lands (Known Severe Lateral Spreading Areas) properties were categorised as having a highest and best use of either:

130.1 *Lot aggregation*: aggregation with existing residential properties either not subject to known severe lateral spreading vulnerability or and In Situ property with known severe lateral spreading vulnerability; and

130.2 *Alternative land use*: alternative land use, likely non-residential in at least the medium term.

131 Standard discounts were applied to reflect the different uses, with adjustments made to reflect property specific characteristics (e.g., properties for lot aggregation with desirable features received a lower adjustment to the pre-earthquake value than properties without these features).

132 For Phase 2, percentage adjustments were adapted from the IFV and ILV DoV Methodologies to reflect the practical implications of the different forms of land damage on the highest and best use of the land or property identified by EQC's valuers:

132.1 in the case of IFV land damage, all highest and best uses used matrices based on the IFV DoV methodologies. These were applied using the same modelled mass appraisal valuation technique developed for Flat Lands (Excluding Known Severe Lateral Spreading Vulnerability Areas) and described in the 2017 Explanatory Notes.[40] For the most significantly affected alternative land use properties, an adjusted matrix was applied reflecting the valuers' judgement that severe IFV land damage would have a more significant value impact on this land use than standard residential or lot aggregation uses;

132.2 in the case of ILV and ILV_{CC} land damage, all highest and best uses used matrices adapted from the ILV DoV methodologies, modified to reflect the more limited practical implications of these forms of damage for properties with severe lateral spreading vulnerability. These were applied using combined severity and extent of change classifications for ILV and ILV_{CC} land damage for each property assessed by T+T. The methodologies and processes for this assessment were adapted from the methodologies and processes used for ILV land damage in the Green Zone and are described in the Compromised Crust Report.

133 The analysis of DoV for properties in Flat Lands (Known Severe Lateral Spreading Vulnerability Areas) is set out in more detail in EQC's valuers' report, *Diminution of Value Methodologies for Increased Flooding Vulnerability, Increased Liquefaction Vulnerability and Increased Liquefaction Vulnerability (Compromised Crust) for Crown-owned Properties in the Residential Red Zone (with Known Severe Lateral Spreading Vulnerability)* (EQC, January 2018), included as **Appendix A4.**

- ***Properties with IFV and ILV_{CC} land damage***

134 Properties with ILV_{CC} *and* IFV land damage were assessed in accordance with the ILV and IFV DoVm developed by EQC's valuers: DoV Methodology for properties with both IFV and ILV land damage (EQC, November 2016).

135 The DoV methodology for properties with both IFV and ILV land damage applies an adjustment to the combination of discounts assessed in accordance with the ILV and IFV DoV methodologies, in accordance with a Combination Matrix. The adjustment is applied automatically and then reviewed by EQC's valuers.

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[40] EQC *Explanatory notes for EQC residential land settlement for Residential Red Zone: Flat Lands (Excluding Known Severe Lateral Spreading Areas)* (December 2017) at 33.

136 For the purposes of applying the Combination Matrix, the ILV and ILV_{CC} DoV percentage adjustment was assessed as a combined sum, consistent with the shared practical implications. This was then combined with the IFV land damage DoV percentage adjustment using the Combination Matrix.

137 The analysis for properties with IFV and one or more of ILV and ILV_{CC} land damage in the Residential Red Zone is set out in more detail in EQC's valuers' report, *Diminution of Value Methodologies for Increased Flooding Vulnerability, Increased Liquefaction Vulnerability and Increased Liquefaction Vulnerability (Compromised Crust) for Crown-owned Properties in the Residential Red Zone (with Known Severe Lateral Spreading Vulnerability)* (February 2018), included as **Appendix A4.**

Allocation and apportionment

138 Visible land damage, IFV land damage, ILV land damage, and ILV_{CC} land damage were each assessed across the Canterbury earthquake sequence. The reasons for this, in the context of IFV and ILV land damage, are set out in the respective engineering and valuation methodologies.

139 As the EQC Act provides insurance against natural disaster damage to residential land for each event of damage, it is necessary to determine, first, which event or events contributed to the land damage observed across the Canterbury earthquake sequence, and second, the value of the loss attributable to the damage allocated to each event.

140 EQC has allocated damage and apportioned loss to each event in the Residential Red Zone in accordance with the methodologies and policies used in the Residential Green Zone. In the case of ILV_{CC} land damage, these methodologies were adapted to reflect this form of damage.

Maximum amount of insurance

141 The Crown RRZ Liability Model tests the assessed loss for each event against estimated minimum lot size valuations prepared by EQC's valuers. As the assessed loss for any single event does not exceed the estimated minimum lot size valuations for any Flat Lands (Known Severe Lateral Spreading Areas) properties, the minimum lot size cap has not been applied.

APPENDIX A: SUPPORTING DOCUMENTATION

A1	Outputs of the Crown RRZ Claims Liability Model
A2	T+T *Increased Liquefaction Vulnerability due to Compromised Crust from the Canterbury Earthquake Sequence: Assessment Methodology and Practical Implications* (December 2017)
A3	T+T *Properties with Known Severe Lateral Spreading Damage: Estimating the compensation for Category 1 to 7 land damage and structures damage for the LINZ flat land Residential Red Zone properties with EQC claims* (February 2018)
A4	EQC *Diminution of Value Methodologies for Increased Flooding Vulnerability, Increased Liquefaction Vulnerability, and Increased Liquefaction Vulnerability (Compromised Crust) for Crown-owned Properties in the Residential Red Zone (with Known Severe Lateral Spreading Vulnerability)* (February 2018).