

**BEFORE AN INDEPENDENT HEARING COMMISSIONERS APPOINTED BY THE
NELSON CITY COUNCIL**

IN THE MATTER OF

The Resource Management Act 1991
(**RMA or the Act**)

AND

IN THE MATTER OF

Hearing of Submissions and Further
Submissions on Plan Change 29 to
the NRMP

AND

IN THE MATTER OF

Submissions and Further Submissions on
Proposed Plan Change 29 by
BAYVIEW NELSON LIMITED
GP INVESTMENTS LIMITED
NELSON NORTH LIMITED
SUFFOLK HEIGHTS LIMITED
588 LIMITED

**SUPPLEMENTARY STATEMENT OF GEOTECHNICAL EVIDENCE OF CAMERON
LINES**

Dated: 9 September 2024

CONTENTS

INTRODUCTION	2
SCOPE OF MY EVIDENCE	2
KEY ISSUE 1: FAULT DEFORMATION AND FAULT AWARENESS OVERLAYS – RECURRENCE INTERVALS (RIS)	3
KEY ISSUE 3: SLOPE INSTABILITY SUSCEPTIBILITY OVERLAYS AND DEBRIS RUN-OUT OVERLAY – COMBINING AREA 2 AND 3 OVERLAYS AND CONSIDERATION OF RULES TO BE APPLIED	7
KEY ISSUE 4: SLOPE INSTABILITY SUSCEPTIBILITY OVERLAYS AND DEBRIS RUN-OUT OVERLAY – LAND WITHIN 100M DOWN SLOPE OF FAULTS	13
KEY ISSUE 5: SLOPE INSTABILITY SUSCEPTIBILITY OVERLAYS AND DEBRIS RUN-OUT OVERLAY – STABILISED/MODIFIED LAND AND THE OVERLAYS	13
SUMMARY	16

MAY IT PLEASE THE COMMISSIONERS**INTRODUCTION**

1. My full name is Cameron John Lines. I am a Principal and Director of Baseline Geotechnical Limited. I have the qualifications and experience set out in my primary statement of evidence on this matter, dated 5 July 2024.
2. I attended expert conferencing on 31 July 2024. Details of the items agreed and those still outstanding are given in the Joint Witness Statement (JWS) of 31 July 2024.
3. I have read the Rebuttal Statements and Summary Statements of Mr Dan Chamberose and Ms Janice Carter. I watched a recording of their presentations during the Hearing on 27 August 2024, along with their responses to queries raised by the Commissioners.
4. I provide this further statement of evidence to address matters raised in the Rebuttal Evidence of Dan Chamberose and in Addendum 1A to the Section 42A Report – Geotechnical prepared by Janice Carter.
5. As noted in my primary statement of evidence, I have read the Code of Conduct for expert witness contained in the Environment Court's Practice Note 2023. I have complied with the Code in preparing this evidence. This evidence is within my area of expertise and represents my best knowledge about this matter except where I note that I am relying on the evidence of another witness. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

SCOPE OF MY EVIDENCE

6. In my evidence I will review the information provided by Mr Chamberose on the Key Issues discussed in his Rebuttal Evidence being:
 - (a) Key Issue 1: Fault Deformation and Fault Awareness Overlays – Recurrence Intervals (RIS).
 - (b) Key Issue 3: Slope Instability Susceptibility Overlays and Debris Run-out Overlay – Combining area 2 and 3 overlays and consideration of rules to be applied.

- (c) Key Issue 4: Slope Instability Susceptibility Overlays and Debris Run-Out Overlay – Land within 100m down slope of faults.
- (d) Key Issue 5: Slope Instability Susceptibility Overlays and Debris Run-Out Overlay – Stabilised/modified land and the overlays.

7. I also make comment on the specifics of proposed modifications to the rules prepared by Ms Carter.

KEY ISSUE 1: FAULT DEFORMATION AND FAULT AWARENESS OVERLAYS – RECURRENCE INTERVALS (RIS)

8. It is my view that the discussion around Fault Deformation requires a summary of the important terms that might assist the panel in relation to this matter. These terms are:

- (a) Building Importance Category (BIC).
 - (i) This is set out in NZS1170.0¹ at Table 3.1 to 3.3 (refer Attachment A). Defined as Importance Level in this document, the categorisation is derived based on the consequence of failure.
 - (ii) MFE 2003² take this a step further and divide Building Importance Category into 2a (Residential timber-framed construction) and 2b (Normal structures and structures not in other categories and includes among other structures, very large houses or those outside the scope of NZS3604). Refer Attachment A.
- (b) Serviceability Limit State (SLS) – This is well defined in the MBIE Guidelines³ for residential dwellings “*Structural system members and parts of structures shall not experience deformations that result in damage that would prevent the structure from being used as originally intended without repair*”. Essentially this means that a structure subject to SLS loads may require

¹ Australian/New Zealand Standard. Structural Design Actions. Part 0: General Principles. AS/NZS1170:0 2002.

² Ministry for the Environment, 2003. Planning for development of land on or close to active faults. A guideline to assist resource management planners in New Zealand. Institute of Geological & Nuclear Sciences client report 2002/124 Project Number: 440W3301.

³ MBIE & NZGS 2021. Earthquake geotechnical engineering practice Module 1: Overview of the guidelines. November 2021.

repair of cosmetic and minor amenity damage, but it may continue to be used while those repairs are undertaken.

- (c) Ultimate Limit State (ULS) – This is also defined in the MBIE Guidelines as: *“Building damage should be limited and controlled when subjected to the ULS earthquake shaking so that the risk of building collapse is very low and so that evacuation of the building occupants may be safely carried out. The building design should be robust (ie able to resist greater loads and displacements than those defined for ULS without collapse) because of the possibility of earthquake loading in excess of the ULS design level. The ULS is centred on life safety and accepts the possibility of significant damage to the building, even resulting in its demolition.”*

9. At paragraph 2.2 of his Rebuttal Evidence Mr Chamberose clarifies his position on the recurrence interval of faults that have been included in the Fault Avoidance and Awareness overlays and that these are “active faults” in accordance with the definition of GNS, being a recurrence interval (RI) of less than 125,000 years.

10. While the information prepared by Beca and adopted by NCC may be useful in some planning contexts when considering structures at higher BIC’s (hospitals, schools and daycare centres for example), applying rules to residential development at these sorts of recurrence intervals is significantly inconsistent with other seismic hazards being considered and demonstrates the extreme levels of conservatism being adopted for fault rupture. For comparison.

10.1 ULS design for liquefaction is based on a 1:500 year recurrence interval seismic event (for residential development – BIC2).

10.2 ULS design for ground shaking is based on a 1:500 year recurrence interval seismic event (for residential development – BIC 2).

11. Through paragraphs 2.4 to 2.7 Mr Chamberose quotes and references parts of the MFE Guidelines. However, Mr Chamberose is selective in the parts of the document that he references or quotes and does not address the parts of the document that do not support his position. For example:

- (a) MFE 2003 Section 4.1 first paragraph (emphasis added).

“We recommend that councils use this risk-based approach, based on risk management standard AS/NZS 4360:1999, when they develop provisions for their district plans.”

“This risk-based approach combines the key elements of fault recurrence interval (section 7), fault complexity (section 8), and Building Importance Category (section 9).”

(b) MFE 2003 Section 10.13 second paragraph.

“Section 11 describes how the fault recurrence interval, fault complexity, and Building Importance Category can be used to establish resource consent categories.”

(c) MFE 2003 Section 10.13 third paragraph.

“Rules need to be based upon risk.”

12. At Paragraph 2.6 of his rebuttal evidence Mr Chamberose says that the current Nelson City Council (NCC) NRMP rules are presented as an example in the MFE Guidelines, presumably as a justification for his position. I have read the guidelines and note that the Guideline simply references the NCC approach. It identifies the approach as conservative, but otherwise makes no value judgement on whether the approach is good or bad. Just because NCC's approach is included as an example in the Guideline does not mean it is a valid justification for the approach in the first place.

13. Mr Chamberose infers (at Paragraph 2.8 of his rebuttal evidence) that there may be some issue with the technical basis for the MFE Guideline based on its age (2003) and that it may be updated at some undefined point in the future. The fact that it is still widely used by GNS (the authors of the Guideline) in their own assessments for other territorial authorities (for example GNS 2021⁴ for Wellington City Council) suggest that they hold no similar reservations.

14. It is my view that as geotechnical specialists we should not attempt to second guess what might be in a future guidance document or even when it might be issued. It is certainly not a reasonable justification for a decision that is being made now. It is my opinion that a revised guideline at some point in the future would be a matter for a future plan change.

⁴ Morgenstern R, Van Dissen R.J. 2021. Active Fault Mapping and Fault Avoidance Zones for Wellington City. GNS Science Consultancy Report 2020/57, May 2021.

15. I note that GNS in their 2021 reporting to support a similar process for the 2024 Wellington City Council Plan Change adopt proposed activity status in accordance with Section 11 of the MFE 2003 Guidelines for fault traces in the Wellington Region. These are set out in Appendix 3 of that document.

16. It is notable that the GNS 2021 document also provides several national examples of fault ruptures, none of which resulted in complete collapse of the dwellings nor loss of life.

17. The examples provide in GNS 2021 indicate that fault rupture to ground surface can meet the ULS (Ultimate Limit State) requirements (which is life safety) in the Building Act.

18. Mr Chamberose does not appear to be clear about whether his view on fault avoidance is related to life safety (the ULS design case) or protecting residential dwellings from damage (the SLS design case).

19. If, as set out in the GNS 2021 report, there is a low life safety risk from fault rupture based on actual examples of fault rupture beneath occupied structures, then the issue is actually; what is an acceptable extent of damage to the structure? This is quite clearly an SLS design case.

20. I have viewed the recording of Mr Chamberose's evidence presented at the hearing on Tuesday 27 August 2024, where he discussed fault rupture in relation to damage to structures, foundation options and opportunities to re-level. These issues all relate to the SLS design case. I note that the SLS design case for general earthquake shaking set out in NZS1170:0 is a recurrence interval of 1:25 (refer Table 3.2, Attachment A).

21. It is worth noting that a seismic event with a recurrence interval of >1:3,500, that is shallow enough to result in fault rupture is also likely to result in severe general ground shaking away from the immediate fault rupture zone. This would almost certainly exceed the SLS design seismic loads and possibly the ULS design seismic loads for residential structures. I would anticipate that in that instance, many homes outside of the currently defined fault avoidance zones could be substantially damaged by general ground shaking requiring repair or even demolition and rebuild.

22. It is my opinion that the approach presented by Mr Chamberose is out of step with the Guidelines and with what is being proposed elsewhere in New Zealand. Wellington

City Council has adopted the GNS 2021 report findings and recommendations, which are based on MFE 2003 in their proposed 2024 district plan rules⁵. These provide permitted activity status for building residential developments (BIC 2a) across faults with RI's >1:3,500.

23. The supplementary evidence of Dr Hargraves identifies several additional examples of this approach being adopted by other territorial authorities in New Zealand.

24. I reiterate that I fundamentally disagree with the "precautionary" approach adopted by NCC and supported by Mr Chamberose. It is my opinion that there is no reasonable geotechnical justification for ignoring recurrence interval, fault complexity and Building Importance Category when considering fault rupture risk, yet this is the approach taken in PC29.

25. The MFE 2003 Guidelines at Section 11 provide a succinct set of tables (reproduced in Attachment B) that set out the proposed activity statuses for combinations of recurrence interval, fault complexity and Building Importance Category. These are adopted for fault rupture by many other territorial authorities and in my opinion provide the most robust and consistent approach to managing fault rupture in a planning context.

KEY ISSUE 3: SLOPE INSTABILITY SUSCEPTIBILITY OVERLAYS AND DEBRIS RUN-OUT OVERLAY – COMBINING AREA 2 AND 3 OVERLAYS AND CONSIDERATION OF RULES TO BE APPLIED

26. Mr Chamberose makes a number of statements about the slope instability susceptibility overlays in his rebuttal evidence associated with this key theme. Many of these seek to minimise the extent of the inaccuracies in the overlays, defend some of the issues with the assessment and cast doubt on the conclusions Dr Hargraves and I have drawn.

27. I disagree with Mr Chamberose's statement about scale of the overlays at Paragraph 4.1. It is important to recognise that the overlays were not completed at a regional scale, they were presented at a 1:5,000 scale. There is a significant difference between the two. I struggle to believe that any capable geo-professional would limit themselves to 1:5,000 scale and intentionally not take advantage of the ability to zoom in

⁵ <https://eplan.wellington.govt.nz/proposed/rules/0/209/0/0/0/60> Natural Hazards NH-R10 to NH-R14 and Subdivision SUB-R18 to SUB-R20.

or look more closely at specific geomorphic features when undertaking an assessment such as this.

28. Mr Chamberose also sets out that the overlays do not consider risk (Paragraph 4.1). While this is also what is stated in the Beca reporting. To the contrary, the overlays in their current form actually do represent and communicate some element of risk, which is part of the inherent issue with them.

29. Risk at its most simple definition is a function of likelihood multiplied by consequence. The inclusion of an elevated susceptibility Tier 2 area compared a potentially susceptible (Tier 3) area in the 2021 assessment must include some form of risk consideration. Given that the consequence of failure is unknown for many areas, the elevated susceptibility tier can only be based on an increased likelihood.

30. Mr Chamberose has been careful not to introduce risk terms in Paragraph 4.6 and instead uses the phrase “varying nature of slope susceptibility”. “Varying nature” in my opinion is a euphemism for “lesser or greater potential for...”, which can only be based on likelihood and therefore includes risk concepts. The outcomes of the SI-TAG inputs to the process has resulted in some type of slope instability overlay that is not quite susceptibility, not quite hazard and not quite risk. It is therefore not a great surprise that the overlays have been misunderstood and misused in their current form.

31. The inclusion of elements of risk assessment in Beca’s 2021 report is a fundamental flaw in the susceptibility assessment. It is this flaw that is one of the drivers behind the recommendation in the JWS to combine tier 2 and 3 into a single overlay.

32. I disagree with Mr Chamberose’s characterisation of the inaccuracies in the overlay mapping as being a “difference in interpretation” (at 4.3) and inferring that the basis for my examples has been influenced by site specific knowledge (at 4.3 & 4.4).

33. In some of the examples I have used in my primary statement of evidence, there are large cracks in the ground evident in aerial photography that I would expect would be identified as a significant slope instability issue by a capable geo-professional. While I understand that Mr Chamberose did not undertake the geomorphic mapping himself, this is not a matter of “differences in interpretation”. The key geomorphic features have either been recognised or not. It suggests either inexperienced personnel undertaking the assessment, insufficient review by experienced staff, or both.

34. While I have provided several examples of more detailed assessments carried out at submitter sites by T+T, my own assessment at these sites as provided in my evidence is based on the original aerial photographic assessment work that I undertook at Bayview prior to visiting the site (due to Covid restrictions in Auckland) and at Suffolk Heights prior visiting the site as part of my engagement to provide evidence for PC29. This is regional scale, remote sensing assessment of the type I would expect to have been incorporated in the assessment completed by Beca.

35. While I agree with the combination of slope instability overlay areas 2 & 3 into one overlay area, my reasons are very different than those of Mr Chamberose. The combination will assist in managing some of (but not all of) the inaccuracies in the base geomorphic mapping, it will also remove the flawed basis for separating areas 2 & 3 and address the issues around incorporating risk-based concepts in the susceptibility assessment.

36. It must be noted that combining these two overlay areas into one does not address all of the technical concerns that I have with respect to the accuracy of the overlays and the methodology used for classification. (I ignore the Tahunanui Slump area here, which could be set aside as a hazard or risk area).

37. For a single susceptibility overlay area, the basis for including or omitting a particular property needs to be as technically robust as possible, due to the additional level of regulation and unintended consequences of inclusion.

38. The issues with the methodology that would need to be addressed include:

- (a) The methodology parameter that includes land on "...ridgelines, < 30 m wide and allowing for a 10 m set back from break in slope."
- (b) "Land with slope between 20° and 35° and containing geomorphic evidence of instability..."

39. It is my view that if an appropriate set back is provided from the break in slopes of a ridgeline, then it should not be necessary to also place a minimum size on the width or the ridge crest itself. As geotechnical specialists we should be addressing the instability susceptibility based on technical information, not defining it based on whether it is practical for a dwelling to be built within the remaining space.

40. It is not at all clear how the 20-35° slope angle parameter has been implemented in the existing Beca assessment and over what distance “geomorphic observations of instability” remain relevant. For guidance there is a significant difference between an area with “geomorphic observations of instability” that has a slope angle of 34° and an adjacent area with a slope angle of 22° along the same overall ridgeline that has no geomorphic observations of instability, yet both may be captured by this parameter. It is my view that this parameter needs considerable refinement before instability susceptibility based on it can be accepted with any confidence.

41. Given the issues of accuracy and methodology that would still remain for a single overlay, the proposed naming of the overlay as “Slope Instability Susceptibility Area 2 (Nelson Hills)” presents a potentially alarming title to those without specialist geotechnical knowledge, particularly as it references Area 1, the Tahunanui Slump, a well-known area of landslide activity in the region.

42. It must be recognised that the combined overlay would be applied to areas of existing historical slope instability as well as areas that have shown no historical evidence of instability equally, effectively tarring both with the same brush. Considering this, the purpose of the overlay is therefore to apply a series of controls on how sloping land can be used and developed without consent (permitted activities) while also ensuring slope instability hazards are identified at consenting stage and then mitigated during site development.

43. It is my view that “Slope Management Overlay” is a more appropriate title for the overlay, given its purpose. This would also present a clear pathway to incorporate engineered landforms as one input to the overlay with the Beca slope instability susceptibility maps (potentially remaining outside the plan change) as another input to the overall Slope Management Overlay. Engineered landforms are discussed further below.

44. I have continuing reservations about the methodology and accuracy of the technical work that supports the slope instability susceptibility overlay planning maps. However, if the commissioners were minded to accept a single combined overlay then I have considered the earthworks rules proposed by Mr Chamberose for the combined slope instability overlay zone.

45. My understanding of the intent of these earthworks rules is to avoid inadvertently destabilising properties during localised site development.

46. While I am in general agreement with the maximum cut and fill heights suggested by Mr Chamberose, I do not follow the logic behind the restriction on earthworks volumes.

47. For example. The proposed cut earthworks volumes of 3 m³ would neither allow for typical foundation excavations, nor trial pit excavations (for geotechnical investigation) as either type of earthworks would exceed the volume threshold and immediately require consent.

48. Further, the provision of an earthworks volume as a way of managing geotechnical slope instability risk appears to have the opposite effect of that intended, where the steeper the slope (and inherently the greater the slope instability risk), the greater the allowable length of cut or fill while remaining within the earthworks rules. Examples are presented below.

Table 1: Examples of cut heights and associated volumes

Slope Angle (°)	Max Cut height (m)	Volume (m ³) of cut per metre length of cut (assumed vertical)	Maximum length of cut for 3 m ³ of volume (m).
40	1.2	0.72	4.2
35	1.2	1.02	2.9
30	1.2	1.24	2.4
25	1.2	1.54	1.9
20	1.2	1.98	1.5
15	1.2	2.67	1.1

Table 2: Examples of fill heights and associated volumes

Slope Angle (°)	Max Fill height (m)	Volume (m ³) of Fill per metre length of Fill (assume vertical retaining)	Maximum length of fill for 10 m ³ of volume (m)
40	0.6	0.21	48
35	0.6	0.31	32
30	0.6	0.37	27
25	0.6	0.46	22
20	0.6	0.59	17
15	0.6	0.80	13

49. It is my understanding that the key issue around earthworks rules in a geotechnical context is managing the risk of development at a site where uncontrolled, high cuts or fills are made that substantially undermine or load a significant proportion or width of the slope. It is far rarer that mass balance issues need to be considered.

50. Considering the issues relating to the volumes suggested, and the intent of the rules from a geotechnical perspective, then it would be more appropriate, in my opinion, to address a maximum length of cut or fill. Dr Hargraves and I have discussed this issue and consider that these restrictions could be revised as follows:

50.1 Cut Height.

- (a) Maximum cut height = 1.2 and,
- (b) Sum of cut height multiplied by cut length must not exceed 6⁶.

50.2 Cut Volume.

- (a) Maximum cut volume⁷ 30 m³.

50.3 Fill.

- (a) Maximum fill height 0.6 m, or
- (b) Maximum fill volume 10 m³, or
- (c) No fill to be placed on slopes steeper than 18 degrees (1V:3H).

51. I note that these restrictions would be appropriate for existing developed sites within a slope instability susceptibility overlay area. However, they would be overly restrictive within sites that have been stabilized during sub-division by bulk earthworks. This is another reason why engineered landforms need to be treated differently in the susceptibility overlays (addressed further below).

⁶ This relates the length of cut to the height of cut. Lower cuts could be longer while higher cuts must be shorter.

⁷ This accounts for rare cases where existing sites that could be developed on unrecognized large-scale landslides, where a large volume of cut may unload the toe of the landslide resulting in mass movement both above and below the site.

KEY ISSUE 4: SLOPE INSTABILITY SUSCEPTIBILITY OVERLAYS AND DEBRIS RUN-OUT OVERLAY – LAND WITHIN 100M DOWN SLOPE OF FAULTS

52. Mr Chamberose has reviewed the slope instability susceptibility parameter “100 m downslope of a fault” to assess what effect it actually has within the existing Beca slope instability susceptibility overlays. He reports at paragraph 5.1 of his rebuttal evidence that this parameter has no effect on the combined overlays. However, he then goes on to suggest that this is a reason for no change being required.

53. It is my view that if this parameter adds nothing to the assessment, then it is unnecessary and should therefore be omitted from the susceptibility assessment. The purpose of requesting Mr Chamberose review the influence of this parameter during expert witness caucusing was to avoid having to argue the technical justification for the 100 m offset (in only the downslope direction) at a future date.

54. If it is retained as a slope instability susceptibility parameter in the methodology then the width of the offset will need a technical justification. I am yet to be provided with that justification, nor have I agreed to it. In my opinion, continuing to include this as a susceptibility parameter will result in additional unnecessary technical debate where time could be better spent on parts of the assessment that do actually influence the outcome.

55. I note that the continued inclusion of this parameter becomes particularly pertinent if engineered landforms are removed from the susceptibility overlays or annotated as stabilized (see below). This parameter may then re-capture a substantial part of many of these properties, despite the risks having been addressed during site wide earthworks.

KEY ISSUE 5: SLOPE INSTABILITY SUSCEPTIBILITY OVERLAYS AND DEBRIS RUN-OUT OVERLAY – STABILISED/MODIFIED LAND AND THE OVERLAYS

56. With respect to incorporating stabilized or modified land into the susceptibility assessment Mr Chamberose agrees that it is possible to do so, however he then goes on to list a number of considerations (at Paragraph 6.3). He then further sets out additional reasons why engineered landforms should not be excluded from the current methodology (at Paragraph 6.8). It appears that these considerations and reasons form the basis for Ms Carter then recommending against allowing for engineered landforms in the susceptibility overlays at Paragraph 29 of her S42A addendum report.

57. Mr Chamberose suggests that allowing for engineered landforms will induce differences in the datasets between submitters land and other parts of the overlay. I reiterate that:

- (a) There are already differences as outlined in my primary statement of evidence as some engineered slopes are arbitrarily accounted for and shown as non-susceptible if the work was undertaken prior to the Lidar data set used by Beca in their assessment (2008-2015).
- (b) This issue is not specific to the submitters landholdings but rather an issue that needs to be addressed across the entirety of the Nelson City Council area. There needs to be consistency in how large scale earthworks sites are incorporated in the planning overlays across the city.

58. If engineered landforms are addressed correctly, it can form just another parameter in the susceptibility assessment as opposed to a “difference”.

59. The consideration provided at 6.3b in Mr Chamberoses rebuttal has no validity in my opinion. Not updating or reviewing a piece of technical work for fear of identifying errors that need to be corrected is not a valid reason not to undertake this work. The overlays should be as accurate as possible. If this means the boundaries change, but the accuracy improves then this exactly the outcome that we as technical professionals should be striving for.

60. We have already canvassed the issues of re-drafting or updating planning maps at some future stage if PC29 goes through. Modifications to the overlays would then require a future plan change. On this basis, the time to review, revise and correct is clearly before the overlays are included as a planning map, not at some point after.

61. All of the issues raised at Paragraph 6.8 of Mt Chamberose’s rebuttal evidence are the same for any engineered structure, whether it is a building, whether it is a bridge, a retaining wall or a constructed earth slope. In many respects the nature of an earthworks approach is the most robust engineering approach, in that it often removes the underlying geological conditions that influence slope instability susceptibility. The earthworks also do not have a design life per se, as the changes are permanent. It is my view that suggesting that a large site remains susceptible to instability after being earthworked to avoid this very hazard is not a valid technical argument.

62. I note that there are multiple examples in Beca's current reporting where sites earthworked prior to the 2008-2015 Lidar dataset are shown as having no susceptibility, but to my knowledge none of what Mr Chamberose sets out as being necessary under 6.8 b and c have been carried out for these sites.

63. I cannot follow the logic (at paragraph 6.8d) where Mr Chamberose considers it appropriate to ignore information that NCC already hold simply because it could be a time consuming exercise and instead indicate sites as susceptible to instability when NCC already know (or should know) that those sites have been stabilized. All this does is shift the burden from NCC to property owners to demonstrate (again, at not insignificant cost) that they have addressed instability risk.

64. Further, I consider that the inclusion of the stabilisation of multiple hectare sites is completely practical in a regional scale assessment. Beca already include specific landslide inventory information that is many times smaller than the regional scale earthworks sites we are considering.

65. Mr Chamberose (at Paragraph 6.6) suggests that if engineered landforms are to be allowed for then they should still be assessed within the framework of the susceptibility methodology, because they are likely to "...still exhibit some characteristics that indicate susceptibility". However, he does not clearly identify what specific characteristics he is concerned about. It is my opinion that large scale earthwork sites typically remove or stabilize existing instability, therefore the only areas that might retain a remnant instability risk would be:

- (a) Unstabilized balance lots.
- (b) Steep front faces of engineered fills (not designed to act as building platforms).
- (c) Steep cut batters used to develop building platforms.

66. All of these areas would typically be set out as Restricted Building Areas (RBA) during subdivision development and in site suitability reports, and there is no suggestion that these areas should be excluded from the slope instability susceptibility overlay.

67. I agree with Mr Chamberose that engineered landforms should not be excluded from the overlay methodology entirely. However, they do need to be accounted for. There

are any number of methods that could be used to incorporate engineered landforms into the methodology, for example.

- (a) If the methodology was retained as it is now, then earthworks would essentially remove the “geomorphic evidence of instability” from the sites, therefore leaving the main trigger for inclusion a slope angle exceeding 35°.
- (b) Alternatively, the methodology could be modified to account for engineered landforms (my preference). It could even be given its own overlay status, to illustrate areas that have been modified from their original susceptibility.

68. Overall, it remains my opinion that there is no sound technical basis on which to continue to misidentify large, stabilized sub-division sites as susceptible to instability when they are not. It is my opinion that the justifications provided are either not technically sound, have not been undertaken for existing earthworks sites have been arbitrarily accounted for in the existing overlays, or can be managed through an appropriate annotation process within the overlays themselves.

69. It is my opinion that in future plan changes, initial assessment of where large scale earthworks have been completed could be quite easily achieved by automated comparison between Lidar datasets as a starting point and comparative aerial photographic assessments to confirm areas that need addressing. Final annotation of instability susceptibility status could then be derived based on the site suitability reporting.

SUMMARY

70. I disagree with the approach taken by Beca to Fault Avoidance and Fault Awareness overlays:

- (a) The development of the overlays does not follow the MFE Guidelines and is therefore inconsistent with the approach taken by other territorial authorities elsewhere in the country.
- (b) They are unnecessarily conservative.
- (c) They are inconsistent with recurrence intervals for other seismic hazards in the NCC boundaries (liquefaction and general ground shaking).
- (d) They confuse ULS and SLS design cases when considering the purpose of the overlays.

71. While there has been some progress made on slope instability susceptibility overlays and the rules during and post expert witness conferencing, the existing basis for the slope instability susceptibility overlays (Beca 2021) is inherently flawed. Even were a combined tier 2 & 3 overlay to be considered, the basic geomorphic mapping requires significant review and revision and the susceptibility methodology itself requires additional refinement to make it fit for purpose.

72. In my opinion, engineered landforms must be accounted for in both the susceptibility overlays and in the susceptibility methodology. Continuing to define sites as susceptible to instability when they have been consented (requiring natural hazards to be mitigated) and then developed using a bulk earthworks approach to mitigate that very hazard makes little sense. It simply introduces an unnecessary additional level of regulation along with a range of other unintended consequences (as set out in the evidence of Mr Lile).

Dated 9 September 2024



Cameron Lines

Principal and Director, Baseline Geotechnical Limited

Attachment A – Excerpts from standards and guidelines

Excerpts from NZS 1170:0 Structural Design Actions Part 0: General Principles.

TABLE 3.1
CONSEQUENCES OF FAILURE FOR IMPORTANCE LEVELS

Consequences of failure	Description	Importance level	Comment
Low	Low consequence for loss of human life, <i>or</i> small or moderate economic, social or environmental consequences	1	Minor structures (failure not likely to endanger human life)
Ordinary	Medium consequence for loss of human life, <i>or</i> considerable economic, social or environmental consequences	2	Normal structures and structures not falling into other levels
High	High consequence for loss of human life, <i>or</i> very great economic, social or environmental consequences	3	Major structures (affecting crowds)
		4	Post-disaster structures (post disaster functions or dangerous activities)
Exceptional	Circumstances where reliability must be set on a case by case basis	5	Exceptional structures

TABLE 3.3
ANNUAL PROBABILITY OF EXCEEDANCE

Design working life	Importance level	Annual probability of exceedance for ultimate limit states			Annual probability of exceedance for serviceability limit states	
		Wind	Snow	Earthquake	SLS1	SLS2 Importance level 4 only
Construction equipment, e.g., props, scaffolding, braces and similar	2	1/100	1/50	1/100	1/25	
Less than 6 months	1	1/25	1/25	1/25	—	
	2	1/100	1/50	1/100	1/25	
	3	1/250	1/100	1/250	1/25	
	4	1/1000	1/250	1/1000	1/25	
5 years	1	1/25	1/25	1/25	—	—
	2	1/250	1/50	1/250	1/25	—
	3	1/500	1/100	1/500	1/25	—
	4	1/1000	1/250	1/1000	1/25	1/250
25 years	1	1/50	1/25	1/50	—	—
	2	1/250	1/50	1/250	1/25	—
	3	1/500	1/100	1/500	1/25	—
	4	1/1000	1/250	1/1000	1/25	1/250
50 years	1	1/100	1/50	1/100	—	—
	2	1/500	1/150	1/500	1/25	—
	3	1/1000	1/250	1/1000	1/25	—
	4	1/2500	1/500	1/2500	1/25	1/500
100 years or more	1	1/250	1/150	1/250	—	—
	2	1/1000	1/250	1/1000	1/25	—
	3	1/2500	1/500	1/2500	1/25	—
	4	*	*	*	1/25	*

* For importance level 4 structures with a design working life of 100 years or more, the design events are determined by a hazard analysis but need to have probabilities less than or equal to those for importance level 3.

Design events for importance level 5 structures should be determined on a case by case basis.

A2

*On 28/05/2019 02:38 PM Baseline Geotechnical Limited purchased a single use licence to store this document on a single computer. Baseline Geotechnical Limited may print and retain one copy only.

TABLE 3.2
IMPORTANCE LEVELS FOR BUILDING TYPES—NEW ZEALAND STRUCTURES

Importance level	Comment	Examples
1	Structures presenting a low degree of hazard to life and other property	Structures with a total floor area of $<30 \text{ m}^2$ Farm buildings, isolated structures, towers in rural situations Fences, masts, walls, in-ground swimming pools
2	Normal structures and structures not in other importance levels	Buildings not included in Importance Levels 1, 3 or 4 Single family dwellings Car parking buildings
3	Structures that as a whole may contain people in crowds or contents of high value to the community or pose risks to people in crowds	Buildings and facilities as follows: (a) Where more than 300 people can congregate in one area (b) Day care facilities with a capacity greater than 150 (c) Primary school or secondary school facilities with a capacity greater than 250 (d) Colleges or adult education facilities with a capacity greater than 500 (e) Health care facilities with a capacity of 50 or more resident patients but not having surgery or emergency treatment facilities (f) Airport terminals, principal railway stations with a capacity greater than 250 (g) Correctional institutions (h) Multi-occupancy residential, commercial (including shops), industrial, office and retailing buildings designed to accommodate more than 5000 people and with a gross area greater than $10\,000 \text{ m}^2$ (i) Public assembly buildings, theatres and cinemas of greater than 1000 m^2 Emergency medical and other emergency facilities not designated as post-disaster Power-generating facilities, water treatment and waste water treatment facilities and other public utilities not designated as post-disaster Buildings and facilities not designated as post-disaster containing hazardous materials capable of causing hazardous conditions that do not extend beyond the property boundaries
4	Structures with special post-disaster functions	Buildings and facilities designated as essential facilities Buildings and facilities with special post-disaster function Medical emergency or surgical facilities Emergency service facilities such as fire, police stations and emergency vehicle garages Utilities or emergency supplies or installations required as backup for buildings and facilities of Importance Level 4 Designated emergency shelters, designated emergency centres and ancillary facilities Buildings and facilities containing hazardous materials capable of causing hazardous conditions that extend beyond the property boundaries
5	Special structures (outside the scope of this Standard—acceptable probability of failure to be determined by special study)	Structures that have special functions or whose failure poses catastrophic risk to a large area (e.g. 100 km^2) or a large number of people (e.g., 100 000) Major dams, extreme hazard facilities

COPYRIGHT

Excerpts from MFE 2003.

Table 9.1: Building Importance Categories: a modified version of New Zealand Loading Standard classifications

Building Importance Category (BIC)	Description	Examples
1	Structures presenting a low degree of hazard to life and other property	Structures with a total floor area of less than 30m ² Farm buildings, isolated structures, towers in rural situations Fences, masts, walls, in-ground swimming pools
2a	Residential timber-framed construction	Timber framed single-story dwellings
2b	Normal structures and structures not in other categories	Timber framed houses of plan area of more than 300 m ² Houses outside the scope of NZS 3604 "Timber Framed Buildings" Multi-occupancy residential, commercial (including shops), industrial, office and retailing buildings designed to accommodate less than 5000 people and also those less than 10,000 m ² gross area. Public assembly buildings, theatres and cinemas of less than 1000 m ² Car parking buildings
3	Structures that, as a whole, may contain people in crowds or contents of high value to the community or pose risks to people in crowds	Emergency medical and other emergency facilities not designated as post disaster facilities Buildings where more than 300 people can congregate in one area Buildings and facilities with primary school, secondary school or day care facilities with capacity greater than 250 Buildings and facilities with capacity greater than 500 for colleges or adult education facilities Health care facilities with a capacity of 50 or more residents but not having surgery or emergency treatment facilities Airport terminals, principal railway stations, with a capacity of more than 250 people Any occupancy with an occupancy load greater than 5000 Power generating facilities, water treatment and waste water treatment facilities and other public utilities not included in Importance Category 4 Buildings and facilities not included in Importance Category 4 containing hazardous materials capable of causing hazardous conditions that do not extend beyond the property boundaries
4	Structures with special post disaster functions	Buildings and facilities designated as essential facilities Buildings and facilities with special post-disaster function Medical emergency or surgical facilities Emergency service facilities such as fire, police stations and emergency vehicle garages Utilities required as backup for buildings and facilities of importance level 4 Designated emergency shelters Designated emergency centres and ancillary facilities Buildings and facilities containing hazardous materials capable of causing hazardous conditions that extend beyond the property boundaries.

Table 9.2: Relationship between fault recurrence interval and Building Importance Category

Recurrence interval class	Fault recurrence interval	Building importance category (BIC) limitations* (allowable buildings)	
		Previously subdivided or developed sites	"Greenfield" sites
I	≤2000 years	BIC 1	BIC 1
II	>2000 years to ≤3500 years	BIC 1 and 2a	
III	>3500 years to ≤5000 years	BIC 1, 2a and 2b	BIC 1 and 2a
IV	>5000 years to ≤10,000 years	BIC 1, 2a, 2b and 3	BIC 1, 2a, and 2b
V	>10,000 years to ≤20,000 years		BIC 1, 2a, 2b and 3
VI	>20,000 years to ≤125,000 years	BI Category 1, 2a, 2b, 3 and 4	

Note: Faults with average recurrence intervals >125,000 years are not considered active.

Attachment B – MFE 2003 recommended activity status tables.

Table 11.1: Resource consent activity status for greenfield sites

Building importance category	1	2a	2b	3	4
Fault complexity	Activity status				
Fault recurrence interval class I less than or equal to 2000 years					
A – Well defined	Permitted	Non-complying	Non-complying	Non-complying	Prohibited
B – Distributed	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
C – Uncertain [†]	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
Fault recurrence interval class II greater than 2000 but less than or equal to 3500 years					
A – Well defined	Permitted	Non-complying	Non-complying	Non-complying	Prohibited
B – Distributed	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
C – Uncertain [†]	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
Fault recurrence interval class III greater than 3500 to but less than or equal to 5000 years					
A – Well defined	Permitted	Permitted*	Non-complying	Non-complying	Non-complying
B – Distributed	Permitted	Permitted	Discretionary	Discretionary	Non-complying
C – Uncertain [†]	Permitted	Permitted	Discretionary	Discretionary	Non-complying
Fault recurrence interval class IV greater than 5000 but less than or equal to 10,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Non-complying	Non-complying
B – Distributed	Permitted	Permitted	Permitted	Discretionary	Non-complying
C – Uncertain [†]	Permitted	Permitted	Permitted	Discretionary	Non-complying
Fault recurrence interval class V greater than 10,000 but less than or equal to 20,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Permitted*	Non-complying
B – Distributed	Permitted	Permitted	Permitted	Permitted	Non-complying
C – Uncertain [†]	Permitted	Permitted	Permitted	Permitted	Non-complying
Fault recurrence interval class VI greater than 20,000 but less than or equal to 125,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Permitted*	Permitted*
B – Distributed	Permitted	Permitted	Permitted	Permitted	Permitted**
C – Uncertain [†]	Permitted	Permitted	Permitted	Permitted	Permitted**

Note: Faults with a recurrence interval of greater than 125,000 years are not considered active.

* The activity status is permitted, but could be controlled or discretionary because the fault location is well defined.

** Although the activity status is permitted, care should be taken in locating BIC 4 structures on or near known active faults. Controlled or discretionary activity status may be more suitable.

† Where the fault trace is uncertain, specific fault studies may provide more certainty on the location of the fault. Moving the fault into the distributed or well defined category would allow a reclassification of the activity status and fewer assessment criteria.

Italics show that the activity status is more flexible. For example, where *discretionary* is indicated, controlled activity status may be considered more suitable.

Table 11.2: Resource consent activity status for developed and already subdivided sites

Building importance category	1	2a	2b	3	4
Fault complexity	Activity status				
Recurrence interval class I less than or equal to 2000 years					
A – Well defined	Permitted	Non-complying	Non-complying	Non-complying	Non-complying
B – Distributed	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
C – Uncertain [†]	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
Recurrence interval class II greater 2000 but less than or equal to 3500 years					
A – Well defined	Permitted	Permitted*	Non-complying	Non-complying	Non-complying
B – Distributed	Permitted	Permitted	Discretionary	Non-complying	Non-complying
C – Uncertain [†]	Permitted	Permitted	Discretionary	Non-complying	Non-complying
Recurrence interval class III greater than 3500 but less than or equal to 5000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Non-complying	Non-complying
B – Distributed	Permitted	Permitted	Permitted	Discretionary	Non-complying
C – Uncertain [†]	Permitted	Permitted	Permitted	Discretionary	Non-complying
Recurrence interval class IV greater than 5000 but less than or equal to 10,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Permitted*	Non-complying
B – Distributed	Permitted	Permitted	Permitted	Permitted	Non-complying
C – Uncertain [†]	Permitted	Permitted	Permitted	Permitted	Non-complying
Recurrence interval class V greater than 10,000 but less than or equal to 20,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Permitted*	Non-complying
B – Distributed	Permitted	Permitted	Permitted	Permitted	Non-complying
C – Uncertain [†]	Permitted	Permitted	Permitted	Permitted	Non-complying
Fault recurrence interval class VI greater than 20,000 but less than or equal to 125,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Permitted*	Permitted*
B – Distributed	Permitted	Permitted	Permitted	Permitted	Permitted**
C – Uncertain [†]	Permitted	Permitted	Permitted	Permitted	Permitted**

Note: Faults with a recurrence interval of greater than 125,000 years are not considered active.

* The activity status is permitted, but could be controlled or discretionary because the fault location is well defined.

** Although the activity status is permitted, care should be taken in locating BIC 4 structures on or near known active faults. Controlled or discretionary activity status may be more suitable.

† Where the fault trace is Uncertain, specific fault studies may provide more certainty on the location of the fault. Moving the fault into the Distributed or Well Defined category would allow a reclassification of the activity status and fewer assessment criteria.

Italics – show that the activity status is more flexible. For example, where *discretionary* is indicated, controlled activity status may be considered more suitable.

