BEFORE THE HEARING PANEL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of Proposed Plan Change 29 to the Nelson Resource Management Plan

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STATEMENT OF REPLY OF DAN CHAMBEROSE

Dated 27 November 2024

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1. INTRODUCTION

1.1 My full name is Daniel Thomas Chamberose, and I am an Associate Engineering Geologist at Beca Limited.

1.2 My qualifications and experience were set out in my Primary Statement of Evidence dated 24 June 2024.

1.3 The purpose of this document is to respond to specific matters raised by supplementary evidence and as part of the hearings for Plan Change 29 (PC29). Specifically, the evidence of:

(a) Mr. Cameron Lines; and

(b) Dr Sally Hargraves.

1.4 Expert conferencing and Geotechnical Natural Hazards Joint Witness Statement (JWS) have been completed on 6th and 25th November 2024.

2. FAULT DEFORMATION AND FAULT AWARENESS OVERLAYS – UPDATES TO OVERLAY

2.1 Dr Hargraves has provided further information relating to the location of the fault at 155 Nile Street. A number of boreholes were completed at the site, and I have reviewed this information, and agree that it does constrain the location of the fault in this area. It is therefore appropriate to amend the Fault Awareness Overlay as shown in Figure 1 below. The location of the fault outside of this property address remains uncertain, therefore the Fault Awareness Overlay has been linked to match up with the original extent of the overlay beyond the property.



Figure 1. Updated section of Fault Awareness Overlay in the Nile Street Area.

3. FAULT DEFORMATION AND FAULT AWARENESS OVERLAYS – WELL DEFINED VS. UNCERTAIN FAULTS

3.1 Commissioner Parsonson has requested further information on the definition of well-defined faults in the Nelson region following the Natural Hazards Hearing on 17th September. Below is some further commentary on this matter.

3.2 The MfE, 2003[1] guidance refers to fault complexity being the width and distribution of the deformed land around the fault trace. Table 8.1 in the MfE guidance provides definitions of the fault complexity types (reproduced in Figure 2 below).

A **Well defined**	**A well defined** fault trace of limited geographic width Typically metres to tens of metres wide
B **Distributed**	Deformation is **distributed** over a relatively broad geographic width Typically tens to hundreds of metres wide Usually comprises multiple fault traces and/or folds
C **Uncertain**	The location of fault trace(s) is **uncertain** as it either has not been mapped in detail or it cannot be identified. This is typically a result of gaps in the trace(s), or erosion or coverage of the trace(s)

Figure 2. Table 8.1 from the MfE, 2003 guidance defining fault complexity.

3.3 The faults of Nelson are typically well defined, as the fault traces are of limited geographic width (in the order of metres to tens of metres). This is described in the Beca (2021) report[2] and also outlined in Johnston & Nicol (2013)[3], which says that the faults in the Waimea-Flaxmore Fault System have a relatively narrow zone of intense deformation which is in line with the Table 8.1 definition, unless they are covered by thick alluvial deposits.

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[1] Kerr, J., Nathan, S., Van Dissen, R., Webb, P., Brunsdon, D and King, A. 2003. Planning for Development of Land on or close to Active Faults. Report for the Ministry for the Environment by the Institute of Geological & Nuclear Sciences. Institute of Geological & Nuclear Sciences Client report 2002/124 440W103301, July 2003.

[2] Beca, 2021. Revised Nelson Fault Deformation Overlay, Report prepared for Nelson City Council by Beca Limited, Christchurch, New Zealand. Revision 3, dated 10 December 2021.

[3] Johnston, M. R and Nicol, A. 2013. Assessment of the location and paleoearthquake history of the Waimea-Flaxmore Fault System in the Nelson-Richmond area with recommendations to mitigate the hazard arising from fault rupture of the ground surface. GNS Science Consultancy Report 2013/186.

3.4 The Fault Deformation Overlay in Nelson covers fault traces that are well-defined. The widths of the deformation overlay vary depending on the accuracy of the dataset used, anticipated deformation width, confidence in fault trace location and the 20m set-back recommended in MfE (2003) guidance. This typically results in Fault Deformation Overlay widths between 20-80m, with the exceptions being existing sections of the fault hazard overlay that were unchanged as part of the Beca, 2021 update and localised updates to small sections of faults. The existing sections of the Fault Hazard Overlay that remain unchanged (but are now incorporated into the PC29 Fault Deformation Overlay) are wider in places than the Beca (2021) update as no new information was available in these locations.

3.5 The Fault Awareness Overlays have been applied to sections of fault trace that are poorly defined or where there is significant uncertainty around the specific fault location. These sections typically occur where a fault is deeply buried beneath overlying soil, thick alluvium, or landslides; where no surface expression of the fault is observable; or where the small-scale geological maps are the only available evidence of the fault's location. In my opinion, I believe this aligns with the definition of an uncertain fault trace in Table 8.1 of the MfE guidance. These awareness areas are typically wider than the deformation overlays due to this uncertainty in location, and typically range from 150-250m in width.

3.6 Considering Nelson faults are typically well-defined, the width of the Fault Deformation overlay applied to these faults may appear wide. It is not unusual for well-defined faults to have wider overlays placed around them for similar reasons raised in paragraph 3.4. As a comparison of the Nelson Fault Deformation Overlay widths, I have reviewed some sections of the fault avoidance overlays created for the Marlborough and Wellington region that are shown in the New Zealand Active Faults Database[4] for various faults. These fault avoidance overlays essentially

[4] *GNS New Zealand Active Faults Database. https://data.gns.cri.nz/af/index.html. Accessed on 09/10/2024.*

align with the intent of the Nelson Fault Deformation Overlays but have a different name. These are summarised in Table 1 below.

Table 1. Summary of fault awareness areas in Marlborough and Wellington

Fault	Complexity	Recurrence interval (yrs)	Fault avoidance overlay width (m)	Type of surface expression and method used to determine fault trace
Wairau Fault	Well-defined	0-2,000	100	Surface trace - LiDAR
Wellington Fault	Well-defined	0-2,000	60-140	Surface trace – air photo and LiDAR
Wairarapa Fault	Well-defined	0-2,000	80-105	Eroded scarp/surface trace - LiDAR
Shepherds Gully Fault	Well-defined	3,500-5,000	75-150	Eroded scarp -LiDAR
Moonshine Fault	Uncertain constrained	5,000-10,000	280-320	Eroded scarp – Air photo and LiDAR

3.7 The Fault Deformation Overlay widths specified for the faults around Nelson are in alignment with other well-defined faults in nearby regions that have been identified using similar methods to define the fault trace.

3.8 Considering the information provided above, in general the following definitions apply to the Nelson region, based on the MfE, 2003 guidance:

(a) The sections of fault in the Fault Deformation Overlay are generally well defined.

(b) The sections of fault within the Fault Awareness Overlay are generally uncertain.

3.9 The planning implications for sites located within the Fault Deformation Overlay or the Fault Awareness Overlay are further discussed by Ms Carter in the s42A report, the S42A addendum and in the Council's reply – geotechnical hazards.

4. SLOPE INSTABILITY SUSCEPTABILITY OVERLAYS AND DEBRIS RUN-OUT OVERLAY – SLOPE ANGLE ADJUSTMENT

4.1 Through the PC29 hearing/evidence process, Mr. Lines submitted expert evidence that presented example areas where it was believed that the slope instability susceptibility overlay (referred to as slope overlay from here on) boundaries should be in a different location to those presented in the PC29 slope overlays (even when considering a combined Area 2 and 3 overlay). These differences identified were initially thought to be the result of using site specific knowledge to re-map the overlay boundaries. Beca explored this further because some of the examples presented in Mr. Lines evidence showed slope angles were shallower than presented in the datasets used for the slope overlay mapping. A review of the slope angle dataset was then undertaken by Beca.

Slope angle dataset creation and dataset processing

4.2 The slope angle dataset was derived by Beca by processing the 2008-2015 combined 1m resolution digital elevation model (DEM) created by Land Information New Zealand (LINZ) from light detection and ranging (LiDAR) information.

4.3 The as-received slope angle dataset showed variations in angles across the land surface that created complexity by outputting areas of highly variable slope angles, making it challenging to categorise into distinct slope ranges when trying to link up areas of the overlay. This was raised to Nelson City Council (NCC), and it was discussed that a pixelated overlay map was not desirable as it would be difficult to apply planning provisions to. Therefore, options were explored to 'smooth' the pixelation of the slope angles and allow creation of continuous, non-pixelated overlays. As part of this option assessment, the 1m DEM was resampled to 5m and this was used to derive a new slope angle dataset to better link similar slope angle areas together. This reduced but did not eliminate pixelation and allowed more continuous slope overlays to be produced.

Description of the issue

4.4 To further reduce the pixelation, a "factor" was applied to the slope angle dataset in an attempt to allow simpler slope overlays to be produced (i.e. allow areas of the overlay to be linked together, rather than isolated pixelated areas). This factor was intended to be applied to slope angles steeper than 35° given the methodology tree included all such slopes into the slope overlay. The factor applied over-estimated the slope angles, which reduced pixelation and allowed simpler overlay creation.

4.5 Unfortunately, rather than just applying the factor to > 35° slope angles, the factor was applied to the whole slope angle dataset, likely due to a misunderstanding of the initial request. This modified whole slope angle dataset was then used to create the overlays. This was unintentional, as the person using the dataset for mapping was unaware that the shallower slope angles (i.e. less than 35°) were now over-stated. The overlays created using this over-stated slope angle dataset are the slope overlays reflected in PC29. A summary of the effect this factor had on the slope angle is presented in Table 2.

Table 2. Summary of slope angle changes due to factor applied

Overestimated slope angle with factor applied (used in overlay creation)	Actual slope angle with no factor applied	Maximum difference in slope angle
0-10°	0-7°	3°
10-15°	7-11°	4°
15-20°	11-15°	5°
20-25°	15-19°	6°
25-30°	19-23°	7°
30-35°	23-27°	8°
35-40°	27-31°	9°
40-45°	31-36°	9°
45-80°	36-77°	9°

4.6 The slope angle dataset was used in some of the steps of the methodology tree to define the boundaries of the slope overlays, as follows:

(a) Tier 2 Methodology

(i) Land with slopes >10 degrees and underlain by Marsden Coal Measures

(ii) Land with slopes >15 degrees and underlain by Bishopdale Conglomerate

(b) Tier 3 Methodology

(i) Slopes >35 degrees including setback distances from ridgelines

(ii) Slopes between 20-35 degrees with evidence of previous slope instability.

Impact on the slope overlays

4.7 Upon discovering the slope angle issue, Beca has completed remapping of the slope overlays to address the issue (refer to link https://nelsoncity.maps.arcgis.com/apps/instant/basic/index.html?appid=751e06987e4946a0b6f7304144a8e11a for a digital map which identifies the revised extents of the slope overlay and changes from the previous notified overlay). The remapping used the same methodology and datasets as the Beca (2023)[5] mapping (i.e. 2008-2015 LiDAR) with the only dataset changed being the use of unfactored slope angles.

4.8 The remapping has had the below effects on the slope overlays:

(a) No new properties have been included in the slope overlays, when compared to the original Beca (2023) overlays.

(b) There is typically less coverage by the slope overlays, with some properties being removed from the slope overlays entirely.

(c) Some ridgeline areas have been removed from the overlay. This is because the slope angle adjustment now shows that the slope angles are shallower either side of the ridge, now identifying the ridge as wider, therefore meaning it is excluded as per the methodology tree criteria.

(d) Less coverage by runout overlay, with some properties being removed from the runout overlays entirely.

(e) Areas of some properties already in the debris runout overlay have increased where the slope instability overlay recedes, and

[5] *Beca, 2023. NCC Slope Instability Overlay – Post-August 2022 Severe Weather Event Review, Report prepared for Nelson City Council by Beca Limited, Christchurch, New Zealand. Revision 2, dated 3 May 2023.*

some properties that were once in the slope instability overlay are now wholly or partially within the debris runout overlay. This is because the debris runout overlay maps areas potentially susceptible to debris run out only where they extend beyond the slope instability overlay. There are some areas potentially susceptible to debris runout that were previously underlying the slope overlays. Following the remapping, the slope overlay recedes and these areas potentially susceptible to runout are now shown.

(i) Note: There are areas within the slope overlays that may potentially be susceptible to run-out. This is usual practice because debris run-out is a consequence of slope instability, therefore, the material that is likely to evacuate from the slope will also come to rest on the same slope without extending beyond the extent of the slope overlay.

(f) Areas that were included in the slope instability overlays because of both slope angle criteria and because they were within 100m downslope of a mapped active fault (as per GNS active faults database) are still within the slope overlay. They are now still included in the slope overlays because of the fault criteria in the methodology tree, rather than the slope angle criteria.

4.9 The planning implications of these changes are addressed in Ms Carter's reply.

Conclusion

4.10 The slope angle issue identified is related to the base dataset and the impact of the use of this dataset when creating the slope overlays. The issue was not related to the methodology, which remains unchanged. Identifying this issue at this stage of PC29 is regrettable, however, Ido not believe it fundamentally changes the status of the information and evidence presented in PC29 to date.

5. SLOPE INSTABILITY SUSCEPTIBILITY OVERLAYS AND DEBRIS RUN-OUT OVERLAY – ACCURACY OF THE OVERLAYS

5.1 The Joint Witness Statement (JWS) dated 6th November 2024 outlines concerns from Mr Lines and Dr Hargraves on the accuracy of the geomorphic mapping (landslide inventory) and the interpolation/extrapolation between areas of mapped instability, as this underpins how the slope overlays are created. This point largely relates to the methodology tree criteria of "slope angle between 20 and 35 degrees AND geomorphic evidence of instability".

5.2 During expert conferencing and as stated in the JWS, I confirmed I would check whether the scope of the CGW peer review[6] and the Slope Instability Technical Advisory Group (SI-TAG) included review of the geomorphic evidence (slope instability inventory) presented in the original Beca assessment.

5.3 I have reviewed the peer review document that outlines the scope as well as the outcome of the peer review. There is no specific scope item that requested the slope instability inventory be specifically reviewed, and the peer review focussed on the methodology of how the slope overlays were created. I note that the peer review states, "the work that has been carried out is of a high standard, has considered the numerous factors that can contribute to slope instability and that it is fit for purpose in the context of NCC's proposed use in planning".

5.4 I have also reviewed the meeting minutes from the SI-TAG meetings and confirm that the group was given the opportunity to provide input on the extent of the overlays as well as the methodology that was used to create them throughout the process but were not specifically requested to review the geomorphic information (slope instability inventory). The SI-TAG were given the opportunity to review the post August 2022 overlays and datasets via an online webmap. The SI-TAG were in agreement that the extent of the overlays was adequately defined (all Tiers) and that the

[6] *CGW, 2020. Peer Review – NCC Slope Instability Overlay (Beca Limited). Report prepared for Nelson City Council by CGW Consulting Engineers, Nelson, New Zealand. 20480-RPTGEO-001-A, dated 10 November 2020.*

methodology used for the August 2022 storm update to the slope overlays was appropriate.

5.5 As stated in the JWS, I have provided Mr Lines and Dr Hargraves with access to a GIS webmap of areas presented in Mr Lines evidence to allow them to complete a 'spot check' of the geomorphic elements used to create the slope overlays. The webmap included the slope overlays as well as datasets used to create the overlays related to the methodology tree parameter of "slope angle between 20 and 35 degrees AND geomorphic evidence of instability" (including the slope instability inventory and datasets that show evidence of previous instability).

5.6 Mr Lines and Dr Hargraves completed 'spot checks' of these areas in advance of the expert conferencing session, as presented in their letter dated 22nd November 2024 attached to the JWS dated 25th November and have identified a number of areas where they have concerns. Some of these concerns were briefly discussed in expert conferencing on the 25th November 2024 and my response to the concerns identified in the letter are included as an appendix to my reply (refer Appendix A).

5.7 Within the expert's letter and the JWS of 25th November 2024 they present a summary of the concerns raised during their check. Below is my response to these concerns.

Inconsistent application of methodology

5.8 The letter describes that there is no way to verify why a specific site has been incorporated into the various slope instability tiers and that many tier 3 areas do not include geomorphic evidence of instability or exceed 35° in slope angle. There is concern that this shows inconsistency in application of the methodology.

5.9 I agree, it may be challenging for people that have not completed creation of the overlays to verify or replicate the result of why a property has been located in the overlay, however, I disagree that there is no way to verify why a property has been included in the overlay. Beca defined the overlay boundaries by applying the methodology criteria using the various datasets available, therefore identification of why a specific property is located in the overlay is possible because it can be traced back to the step

in the methodology criteria that was triggered and the dataset reviewed as to why it was included. I note that Beca had the same people complete mapping and verification of all revisions of the slope overlays to ensure there was consistency of application and judgement applied to the overlays.

5.10 With respect to the methodology item "slope angle between 20 and 35 degrees AND geomorphic evidence of instability", this is described in the Beca, 2021 report which contains further explanation on what has been considered in this step of the methodology. A summary of the dataset explanation is included below. The report explains that slopes adjacent to those with features in the slope instability inventory and exhibiting consistent geomorphic and geologic conditions have been included in the overlay. From a technical perspective, this is appropriate when identifying areas that may potentially be susceptible to slope instability, because these areas exhibit similar characteristics to where instability has occurred nearby or in the past. Furthermore, considering the intent of these slope overlays is to act as a tool to flag where further site-specific geotechnical assessment is required and to apply planning provisions to manage slope instability risks, I believe this criteria is appropriate and reasonable to align with this intent.

5.11 I consider it is worth noting, that the peer review says that "there is an immense amount of subjectivity involved in assessing slope instability, at this level" [i.e. regional level] and I note again that the peer reviewer states "the work that has been carried out is of a high standard, has considered the numerous factors that can contribute to slope instability and that it is fit for purpose in the context of NCC's proposed use in planning". This is important to note in the context of Mr Lines and Dr Hargraves concerns around accuracy of the maps or inconsistent application of methodology because there is subjectivity and judgement required. As I have stated in my rebuttal statement (Paragraph 4.3), there may be subtle differences in interpretation of the same desktop information and datasets at a regional scale between different

geotechnical professionals completing the same exercise using the same methodology, however, there will always be an element of subjectiveness/judgement to where the boundary of the overlay should be drawn or how the datasets are interpreted. This element of subjectivity and judgement is common when completing these types of regional scale assessments, but in my opinion the methodology has been appropriately applied and the slope overlays have been created using a robust, thoroughly reviewed methodology (initially through peer review and later by the SI-TAG), and they appropriately identify where slope instability may potentially occur within the region.

Lack of quality assurance/review of the geomorphic mapping

5.12 The letter describes that there are examples identified of instability features being missed or erroneously mapped features (shallow vs. deep and vice versa).

5.13 With respect to the slope instability inventory, this is described in the Beca, 2021 report and as mentioned in the JWS (6th November), the landslide inventory has been created in accordance with the AGS guidance[7] and aligns with a 'basic' level inventory. The mapping of landslide features in the inventory is not considered to be an exhaustive record of all instability in the region but is sufficient to show the distribution of slope instability on hillslopes in the region. The intent of the inventory was to capture a representation of slope failure locations and types in the region to inform creation of the overlay.

5.14 It is worth noting that this is the first time the slope instability inventory has been viewed in detail by people outside of Beca as the inventory was created to inform the extent of the overlay knowing that it was never intended as a complete record of landslides in the region. This inventory was not altered in advance of providing to the Mr Lines and Dr Hargraves and was provided in its raw form.

5.15 This inventory was created for its intended purpose only and once it was created, it was treated as a dataset to inform the extents of the overlay

[7] *Australian Geomechanics Society, 2007a. Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning, Journal and News of the Australian Geomechanics Society, 42 (1): 13- 36.*

and not a ‘live register’ that was kept up to date. If additional landslide features or changes to the landslide classification were identified during creation of the overlays or internal Beca review/verification processes and it did not affect the extent of the overlays, the inventory was often not updated. Therefore, it is not surprising that the experts have noted a number of additional landslide features present on the hillslopes in their 'check' areas identified in the 22nd November 2024 letter.

5.16 In my opinion, this type of inventory, in combination with the other evidence of slope instability (i.e. records provided by NCC and the Post-August 2022 landslide dataset provided by GNS) is sufficient to inform the creation of these slope overlays and the inventory aligns with the AGS guidance. I note that these features identified by the experts are largely within the extents of the current slope overlay.

5.17 Concerns have been raised by experts on the interpretation of shallow vs. deep seated instability identified in the slope instability inventory. Based on the datasets used/available to the assessing person (and verifier), they assessed and made judgement that the feature was either shallow or deep because the way they interpreted the datasets/information. To make a decision on whether an area fell within Area 2 or Area 3 of the slope overlay, they needed confidence or possibly additional information that was not available to them to decide, therefore made an appropriate judgement with the information at hand. At times, to confirm if features are deeper seated and their exact extents would require field verification, intrusive investigations or site-specific knowledge which was often not included or available as part of developing these regional scale susceptibility overlays. This level of detail would be expected to be provided at the site-specific assessment stage that the susceptibility map would trigger. Note that the classification of the slope overlay into Area 2 or 3 reflects the final agreement reached between the Beca person doing the assessment and the Beca verifier, and the slope instability inventory was not always updated to reflect the final agreement of the landslide feature.

5.18 If we consider a combined overlay as recommended in previous evidence documents, it is important to note that the extents of the overlay will not change in light of experts letter dated 22nd November 2024 where they have identified additional features not included in the slope instability inventory, except for some minor areas that I agree should be included (acknowledging that not a full review of all the areas provided or the whole region was completed by the experts and that these changes do not change the extents of the notified overlays). Responses and suggested changes to overlays in light of the 22nd November 2024 letter are documented in Appendix A.

Lack of clarity around which published geological maps have been used

5.19 The experts have identified that it is not clear what geological maps have been used to complete the assessment. I can confirm that the revised geological map of the Nelson-Richmond Urban Area (Johnston et al. 2021) [8], V2 was used in the assessment of deep-seated landslides and to define the extents of the Bishopdale Conglomerate and the Marsden Coal Measures.

5.20 The Nelson-Richmond Urban Area (Johnston et al. 2021), V2 map was used to identify Tier 2 areas where mapped landslide deposits, indicating the presence of deep-seated landslides, were present. The corresponding extents of the Tier 2 areas were subsequently refined using topographic evidence observable within the Digital Elevation Model (DEM) to define the boundaries seen in the current overlays.

5.21 The extent of the Bishopdale Conglomerate and Marsden Coal measures was taken from the Johnston et al. (2021) map, not the QMap.

5.22 As stated in the letter, it is best to use the most up to date and detailed mapping information, which this geological map was at the time the overlays were developed. As this information was incorporated through later stages of overlay creation, it was not documented in the Beca reports.

Flaw in Methodology – Lower slopes of large-scale instability

[8] *Johnston M. R., Ghisetti, F. C. & Wopereis, P. 2021. Revised Geological Map of the Nelson-Richmond Urban Area. V2. (https://nelson-richmond-geolmap.github.io/RGMap/).*

5.23 As described in my evidence in chief, the overlays have been developed in a number of stages. The original slope overlay was produced as a single overlay identifying land susceptible to either slope instability or runout, without any tiers of susceptibility identified. The original susceptibility overlay was largely developed using the 20 degree slope angle/geomorph evidence criteria of the methodology tree. Based on the recommendation from the SI-TAG, this single overlay was split out into the three different tiers of instability. The overall extents of the overlay were not changed as part of this process as the SI-TAG were in agreement with the overall overlay extents and the overlays. Therefore, when Tier 2 areas were created for the landslide criteria of the methodology tree, if the landslide had slope angles of less than 20 degrees in their extent, they were already excluded from the overly because of how the original overlay was created. This appears to be the reason why there are some 'holes' within Tier 2 landslide areas and some lower parts of deeper-seated instability features are not included in the overlay. This criterion of the methodology tree and extents of the Tier 2 areas was agreed and accepted by the SI-TAG and no change was suggested. The remapping to correct the slope angle adjustment did not change the extents of these Tier 2 landslide areas as there was no slope angle criteria related to them in the Tier 2 methodology.

5.24 In the future, it may be appropriate to develop this criterion of the methodology tree to incorporate these lower slope angle areas of deeper-seated instability and incorporate areas (“holes”) that are not currently included within the overlay in areas of deeper-seated instability.

Faulting – inconsistent application of fault database

5.25 The faults included in the 100m downslope of a fault criteria in the methodology tree are the faults presented on the GNS Active Faults database. The AGS guidance identifies that sliding may be possible on steep natural slopes in regions affected by large earthquakes. The 100m downslope of active faults is to reflect this, as well as the consideration that the bedrock near active faults will typically be more fractured and

likely to have water seepages. Therefore, these areas are likely to be potentially susceptible to instability.

5.26 The updates to the fault deformation/awareness areas postdated the original overlay creation and were therefore not included for consideration as part of these overlays. This criterion of the methodology tree was agreed and accepted by the SI-TAG and no change was suggested.

5.27 In the future, it may be appropriate to develop this criterion of the methodology tree to incorporate the areas downslope of all the active faults identified in the fault deformation/awareness areas.

6. SLOPE INSTABILITY SUSCEPTIBILITY OVERLAYS AND DEBRIS RUN-OUT OVERLAY – METHODOLOGY

6.1 Mr Lines and Dr Hargraves have raised concerns over the methodology criteria used for classification of areas in the slope overlays. They have indicated that for a single slope overlay (i.e. the combination of Area 2 and 3), the basis for including or omitting a particular property needs to be as technically robust as possible. They have raised concerns around the methodology criteria relating to width of ridgelines, slope angle between 20 and 35 degrees and geomorphic evidence of instability (as previously discussed) and land within 100m downslope of active faults.

6.2 As suggested in all expert's evidence, we assume the recommendation for combining Area 2 and 3 advanced and agreed through the JWC will be adopted. The Beca, 2020 methodology aligns with AGS guidance and was peer reviewed by CGW. This methodology was then further divided into the tiers following advice from the SI-TAG and the methodology was reviewed and agreed with the SI-TAG (initially and following the inclusion of August 2022 event findings) and through each step was internally reviewed by Beca.

6.3 Therefore, I believe the methodology is robust enough as it stands and is appropriate for the intended purpose of the overlay which is for NCC to identify land potentially susceptible to instability which warrants further

consideration in land development and meets NCC's requirements under the RMA to identify land potentially susceptible to natural hazards.

7. SLOPE INSTABILITY SUSCEPTIBILITY OVERLAYS AND DEBRIS RUN-OUT OVERLAY – RULES

7.1 I have reviewed the earthworks rules proposed in Mr Lines and Dr Hargraves supplementary evidence dated 9 September 2024. This is reproduced in Figure 3 below.

CUT HEIGHT
- a) max cut height =1.2 and,
- b) the sum of cut height multiplied by cut length must not exceed 6.

CUT VOLUME
- c) max cut volume 30 m^3

FILL
- d) max fill height 0.6 m, or
- e) max fill volume 10 m^3, or
- f) no fill to be placed on slopes steeper than 18 degrees

Figure 3. Proposed earthworks rules in Dr Hargraves supplementary evidence, dated 9 September 2024

7.2 From a technical perspective, I believe the cut length/height ratio and fill rules proposed are appropriate as they succinctly manage potential earthworks quantities that may potentially affect the stability of areas identified as susceptible by the overlays. The proposed rules limit the amount of uncontrolled earthworks while allowing minor landscaping works to be completed.

7.3 However, I believe the volume trigger proposed for both cut and fill are not required.

7.4 For the cut volume, this will not likely ever be triggered before the proposed length/ height ratio takes effect. I have explored the length/height ratio to see how much volume may be excavated at different slope angles to see when the 30m^3 may be triggered. Examples of this are summarised in Table 3 below. Therefore, I believe the volume trigger is unnecessary and does not add value.

Table 3. Summary of cut height/length compared to total volume of cut.

Slope angle (°)	Cut height (m)	Volume (m^3) of cut per metre length of cut (assumed vertical)	Max length of cut when length to height ratio of 6 is applied (m)	Total volume of cut based on max length of cut (m^3)
40	1.2	0.85	5	4.25
	0.6	0.21	10	2.1
35	1.2	1.02	5	5.1
	0.6	0.31	10	3.1
30	1.2	1.24	5	6.2
	0.6	0.37	10	3.7
25	1.2	1.54	5	7.7
	0.6	0.46	10	4.6
20	1.2	1.98	5	9.9
	0.6	0.59	10	5.9
15	1.2	2.67	5	13.35
	0.6	0.8	10	8

7.5 As recorded in the JWs dated 25th November, the volume trigger for fill is not likely required and the limit proposed to the fill height is sufficient to manage concerns around fill placement and its effects on slope instability.

7.6 Mr Lines made comments in his evidence that earthworks rules should not be so restrictive that they do not allow typical foundation excavations or typical geotechnical test pit investigations to be completed. Based on the length/height ratio rule proposed, I explored some scenarios to see whether this length to height ratio of 6 would allow these typical activities to be achieved. In general it would only allow limited lengths of foundations to be excavated (i.e. 0.2m of excavation to construct a pad foundation for a 150m^2 house would be 30m^3 in volume and could be completed over a 30m length before the ratio would be triggered) or a limited number of small size test pits to be completed (i.e. 8 No. test pits could be completed before triggering the 30m^3 if you assume max 1.2m depth, 5m long and 0.6m wide).

7.7 I agree that the rules should not be too restrictive that they prevent these types of activities from being completed, providing they are managed in

such a way that they do not result in inadvertent destabilisation of land while they are completed.

7.8 Therefore, I believe it is appropriate to include some exceptions to the proposed earthworks rules that cover temporary excavation scenarios when they are appropriately managed. The details of the earthworks rules and suggested changes are further discussed by Ms Carter in the Council's reply – geotechnical hazards.

8. SLOPE INSTABILITY SUSCEPTIBILITY OVERLAYS AND DEBRIS RUN-OUT OVERLAY – STABILISED/MODIFIED LAND AND THE OVERLAYS

8.1 I have reviewed slope instability susceptibility maps and accompanying technical reports produced for the Bay of Plenty Regional Council, Whangarei District Council and Tauranga City Council. These assessments do not explicitly consider or exclude engineered or modified land, as the process they have used to determine susceptibility is influenced by geology, slope angles and areas of previous instability (among others). Typically slope angles govern the susceptibility classification, regardless of whether the land has been engineered or modified.

8.2 The intent of a regional scale susceptibility map is to identify potentially susceptible areas 'where further analysis should be undertaken by a landslide specialist' (GNS, 2024[9]), and as such specifically excluding modified land does not align with this intent. Furthermore, it is challenging to incorporate engineered or modified land (such as retaining structures) into this type of assessment for various reasons, as detailed below. Consideration of engineered elements (such as retaining walls) would involve undertaking hazard and risk analysis (i.e., the next levels of analysis beyond susceptibility analysis), as it would require consideration of design standards, design event and assessed design life, often with specific maintenance requirements. Determining if an engineered element (like a retaining wall) may be susceptible to instability requires

[9] *GNS (2024). Landslide planning guidance: reducing landslide risk through land-use planning. Lower Hutt (NZ): GNS Science. 77 p. https://doi.org/10.21420/R2X8-FJ49*

consideration of the site-specific design which is not practicable or appropriate at a regional scale (as outlined in paragraph 6.8 of my rebuttal statement), and not in line with the purpose of a susceptibility map.

8.3 However, it may be appropriate to identify modified land specifically for certified large-scale earthworks subdivisions, for consideration as part of the slope overlays. These subdivisions would usually be excluded from the susceptibility overlays if an updated dataset was used as it would show the recontoured land which would not typically trigger criteria of the methodology tree. However, these areas could be identified separately because these earthworks typically remove unstable material and recontour land that can permanently change the stability of an area. Also, the completion documentation of the subdivision typically identifies areas that require further geotechnical consideration within the subdivision. Therefore, if these certified large-scale earthworks were to be considered within, as part of or excluded from the slope overlays, a system could possibly be set up to identify these parcels of land. Further developing the ideas raised in the supplementary evidence of Mr Lines (paragraph 67. (b)) and Dr Hargraves (paragraph 43.2), the following process could be considered as presented in the following sub-sections. This has been provided to show what was considered and investigated while trying to develop this process, however, the outcome of this is presented in Ms Carter in the Council's reply – geotechnical hazards.

Identifying certified large-scale earthworks land in PC29 Mapping

8.4 A new overlay or specific areas could be created/identified which show these certified large-scale earthworks subdivisions using a specific colour/hatching or acronym (i.e., Certified Earthworks Landform or 'CELF' as referred to from here on) and these areas could be 'excluded' from the susceptibility overlay at the parcel boundary. The CELF overlay or areas would direct people to the information held on that subdivision and to any planning provisions applied (discussed further below). Site-specific information held on the subdivision (e.g., certification/consent

documentation, suitable build areas, areas not suitable for building) could then be interrogated by interested parties (e.g., property owners, insurers, Council staff), including completed or proposed works within these CELF areas.

8.5 To identify CELF areas for PC29, the below has been completed:

(a) Land identified in submitter's expert evidence or in submissions where large-scale certified earthworks have been identified.

(b) Review of subdivision completion information held on Council files, related to these submissions to identify extent of certified earthworks and subdivision boundaries.

(i) Note: It is not considered an appropriate approach to identify CELF areas through use of desktop datasets only as these datasets do not hold records of how or for what purpose the earthworks were designed or approved by Council and what conditions were applied to them. All identified land would need to be accompanied by suitable evidence stating certification and approval by the Council.

8.6 To qualify for CELF as part of this PC29 process, the CELF area must have:

(a) Been approved by the Council through the consent process. Areas currently under construction will not be included as CELF as they have not yet been approved by Council.

(b) Obtained resource consent (and is not on uncertified balance land) where the subdivision works included a site-specific Site Certification Report and Statement of Suitability of Land for Building Construction in general accordance with Schedule 2A of NZS 4404:2010 Land Development and Subdivision Infrastructure geotechnical report, for the allotment prepared by a suitably qualified and experienced Geo-professional and including:

(i) Conditions/ geotechnical development recommendations as consent notice conditions to mitigate the risk from slope instability that are applicable to the site.

(ii) Identification of building location areas (in accordance with NZS: 3604), specific investigation/engineering design areas (SID or SED) and restricted building areas (RBA).

(c) Refer to Appendix B for examples of properties that qualify as CELF areas as noted above.

8.7 The process to consider other CELF areas in the region for potential future plan changes could include:

(a) A comparison of the Digital Elevation Model (DEM) datasets (i.e. 2008-2015 and 2022 are currently available) which would identify where landforms have changed and where large-scale earthworks have occurred. The extent of landform change would need to be large enough in scale to be visible at the regional scale. An appropriate trigger to identify these areas could be land of at least 2,500m^2 where earthworks have recontoured the land.

(i) Also, Council may want to give interested parties an opportunity to submit areas for consideration as CELF areas where the submitter believes they meet the above CELF criteria. This could be sent as a request and the timing of this could be aligned with the timing of a proposed future plan change.

(b) These CELF areas would need to qualify as described above (paragraph 8.6) to be considered for exclusion from the slope overlays.

8.8 To capture future CELF areas in the region, the below could be implemented by Council to improve management of these areas:

(a) A suitably qualified geotechnical professional could provide the map (with associated digital files or coordinates) as part of the information requirements of the resource consent process showing the boundaries of where CELF have been completed and approved as part of the consent process.

8.9 The CELF area process set out above presents a way that could enable identification of large-scale certified earthworks across the region or

exclusion of these areas from the slope overlays. There are likely options to manage a system such as this and what is presented here could allow easier management and recognition of these areas. This may then allow updates to CELF areas to be easily incorporated into a future plan if it was deemed appropriate to do so.

8.10 The proposed CELF areas could be excluded from the slope overlays or would need to have their own overlay, rules and separate policy supporting it. These are further discussed by Ms Carter in the Council's reply – geotechnical hazards.

Dan Chamberose
27 November 2024

List of Appendices:

- **Appendix A: Responses to expert's letter dated 22nd November 2024**
- **Appendix B: Examples of properties that qualify as CELF areas**