

**Before the Hearings Panel
At Waimakariri District Council**

Under Schedule 1 of the Resource Management Act 1991

In the matter of the Proposed Waimakariri District Plan

Between **Various**

Submitters

And **Waimakariri District Council**

Respondent

**Statement of evidence of Mr Damian Debski on behalf of Waimakariri District
Council (Coastal Flood Hazards)**

Date: 9 June 2023

INTRODUCTION:

- 1 My full name is Damian Debski. I am employed as a Principal Hydraulic Engineer at Jacobs New Zealand Limited.
- 2 I have prepared this statement of evidence on behalf of the Waimakariri District Council (**District Council**) in respect of technical related matters arising from the submissions and further submissions on the Proposed Waimakariri District Plan (**PDP**).
- 3 Specifically, this statement of evidence relates to coastal flood hazard matters in Chapter NH - Matepā māhorahora - Natural Hazards.
- 4 I am authorised to provide this evidence on behalf of the District Council.

QUALIFICATIONS AND EXPERIENCE

- 5 I hold the qualifications of Bachelor's degree in Engineering from the University of Cambridge, UK (1992) and Master of Science degree in Irrigation Engineering from the University of Southampton, UK (1994).
- 6 I have worked for twenty-eight years in the fields of hydraulic engineering and flood and stormwater management, comprising two years working in coastal engineering research and twenty-six years working in water resources engineering consulting, including extensive experience in flood risk modelling and mapping.
- 7 I am a chartered member of the Chartered Institution of Water and Environmental Management and a registered Chartered Engineer with the UK Engineering Council.

Code of conduct

- 8 I have read the Code of Conduct for Expert Witnesses set out in the Environment Court's Practice Note 2014. I have complied with the Code

of Conduct in preparing my evidence and will continue to comply with it while giving oral evidence before the Environment Court. My qualifications as an expert are set out above. Except where I state I rely on the evidence of another person, I confirm that the issues addressed in this statement of evidence are within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from my expressed opinions.

SUMMARY

- 9 My name is Damian Debski.
- 10 I have been asked by the Council to provide coastal flood hazard evidence in relation to the appeal on Chapter NH - Matepā māhorahora - Natural Hazards.
- 11 My statement of evidence addresses submissions received on the PDP relating to provisions for controlling development in relation to coastal flood hazards.

INVOLVEMENT WITH THE PROPOSED PLAN

- 12 I have been involved in the PDP since 2023.

SCOPE OF EVIDENCE

- 13 My statement of evidence addresses the matters raised by the following submissions in relation to Provisions of the Chapter NH - Matepā māhorahora - Natural Hazards:
- Submission number 316.84, sub-section Activity Rules, provision NH-R15, submitted by Canterbury Regional Council
 - Submission number 316.85, sub-section Activity Rules, provision NH-R16, submitted by Canterbury Regional Council

- Submission number 316.86, sub-section Activity Rules, provision NH-R17, submitted by Canterbury Regional Council
- Submission number 195.63, sub-section Activity Rules, provision NH-R17, submitted by Transpower New Zealand Ltd
- Submission number 316.88, sub-section Activity Rules, provision NH-S1, submitted by Canterbury Regional Council
- Submission number 316.89, sub-section Activity Rules, provision NH-S2, submitted by Canterbury Regional Council
- Submission number 186.15, sub-section Activity Rules, provision NH-S2, submitted by Pines and Kairaki Beaches Association

- 14 **Submission No. 316.84 (Canterbury Regional Council): Provision NH-R15 Natural hazard sensitive activities within the urban environment.** The submission seeks to remove condition 1 of proposed Rule NH-R15 in its entirety on the basis that the condition could enable inadequate standards of flood mitigation if floor levels have been based on lower magnitude flood events, e.g., a 50-year ARI (Annual Recurrence Interval) – equivalent to a 2% Annual Exceedance Probability (AEP) – or on information that is now outdated.
- 15 Proposed condition 1 of NH-R15 specifies Permitted (PER) activity status for natural hazard activities within the urban environment in the Coastal Flood Assessment Overlay if the building is erected to the level specified in an existing subdivision consent notice or on an approved subdivision consent plan that was approved after 1 January 2021 and is less than five years old.
- 16 It is my understanding that any floor levels specified by District Council for subdivisions in the coastal area subject to resource consent since January 2021 have been informed by current flood hazard modelling data for the district which are accessible through the Waimakariri District Natural Hazards Interactive Viewer (the Interactive Viewer) and were available to Council prior to 1 January 2021. The data indicate the estimated depth and extent of flooding from localised rainfall, breakout

from the Ashley Rakahuri River and from coastal inundation, including the effects of climate change.

- 17 The Interactive Viewer states that 'For the purpose of clarity the model results shown on this webmap all relate to the 0.5% AEP event combined with a 100 year RCP8.5 climate change scenario.' However, I note that the coastal flooding layer is separately referred to as '100 Year Coastal Flood Depth' and the data shown for coastal flooding appear to be the model outputs for the 1% AEP (i.e., '100 year') produced under the Jacobs Coastal Inundation Modelling (Phase 2) project in March 2020.
- 18 For coastal flooding dominated by the effects of storm tides, the difference in flood levels between the 1% AEP and 0.5% AEP events can be relatively small. Within the Coastal Flood Assessment Overlay of the PDP, the Jacobs Coastal Inundation Modelling results indicate differences of less than 150 mm over much of the flooded area which is within the usual range of freeboard allowed for when specifying floor levels (300 mm to 500 mm is typical). For this reason, floor levels based on the 1% AEP flood level are likely to also be above the 0.5% AEP flood level.
- 19 I therefore consider that floor levels specified by District Council for subdivisions subject to resource consent since January 2021, which have been based on current flood modelling of extreme events including a freeboard allowance, provide an adequate standard of flood mitigation. For consistency between the flood hazard data for the three sources of flooding presented in the Interactive Viewer, I consider that the coastal flooding layer in the Interactive Viewer should be updated to show the 0.5% AEP model results.
- 20 **Submission No. 316.85 (Canterbury Regional Council): Provision NH-R16 Natural hazard sensitive activities outside the urban environment.** The submission seeks to delete the Permitted (PER) activity status in NH-R16 for new natural hazard sensitive activities in the

Coastal Flood Assessment Overlay on the basis that the proposed provisions do not give effect to Chapter 11 (Natural Hazards) of the Canterbury Regional Policy Statement (CRPS), particularly in relation to high hazard areas in the coastal environment. The submission considers that specifying PER and Restricted Discretionary (RDIS) activity status for development in areas subject to coastal hazards is not consistent with the policy direction for a high hazard area under the CRPS and does not give effect to Objective 11.2.1 and Policy 11.3.1 of the CRPS. Further that the CRPS requires that risk from flooding and inundation in high hazard areas is avoided and that outside of existing urban areas CRPS Policy 11.3.1 does not provide for the mitigation of effects as it does for existing urban areas.

21 PER activity status in NH-R16 is subject to compliance with either of two conditions:

- **condition 1** permits a building to a level specified in an existing subdivision consent notice or an approved subdivision consent plan.
- **condition 2** limits the PER activity status for buildings to locations where the depth of 'coastal flooding' is less than 0.3 m.

22 Regarding condition 1, as set out in paragraphs 16 to 19 of my evidence relating to condition 1 of NH-R15, I consider that floor levels specified by District Council for subdivisions subject to resource consent since January 2021 which have been based on current flood modelling of extreme events, including a freeboard allowance, provide an adequate standard of flood mitigation.

23 Regarding condition 2, flood water of depth less than 0.3 m is not generally considered a high hazard. For example, in the Safety Design Criteria of the Australian Rainfall and Runoff Guidelines, flooding to a depth of less than 0.3 m corresponds to the lowest defined flood hazard class (H1: 'generally safe for people, vehicles, and buildings') for slow moving water (velocity less than 1 m/s). To mitigate the risk from this depth of flooding, condition 2 requires a minimum floor level for

the building, as specified in a Coastal Flood Assessment Certificate for the site.

24 CRPS Objective 11.2.1 seeks:

- 'that risks from natural hazards are avoided in the first instance and otherwise mitigated. Avoiding these impacts involves ensuring that development does not occur in high hazard risk areas.'
- 'In lower risk areas and where development may be otherwise appropriate in high hazard risk areas (where avoidance is not possible), mitigation measures may provide an alternate means of achieving the overall objective. Appropriate mitigation works in these areas should result in the avoidance of significant adverse effects of natural hazards, whilst themselves having minimal adverse effects on the surrounding environment'.

25 CRPS Policy 11.3.1 is:

- 'to avoid new subdivision, use and development (except as provided for in Policy 11.3.4) of land in high hazard areas'

26 In relation to flooding, the CRPS defines 'high hazard areas' as:

1. 'flood hazard areas subject to inundation events where the water depth (metres) x velocity (metres per second) is greater than or equal to 1, or where depths are greater than 1 metre, in a 0.2% Annual exceedance probability (AEP) flood event; and'
4. 'land subject to sea water inundation (excluding tsunami) over the next 100 years. This includes (but is not limited to) the land located within the sea water inundation zone boundary shown on Maps in Appendix 5 of this Regional Policy Statement.'

'When determining high hazard areas, projections on the effects of climate change will be taken into account.'

27 Rule NH-R16 applies to sites within the Coastal Flood Assessment Overlay. In the PDP this overlay is defined by the extent of the '1% AEP

(1 in 100-year) Storm Surge Event concurrent with a 5% AEP (1 in 20-year) River Flow Event with sea level rise of 1m based on an RCP8.5 climate change scenario' as referred to in NH-S2 Coastal Flood Assessment Certificate. The 0.3 m depth limit in condition 2 therefore relates to the 1% AEP coastal flood. For slow moving flood water (less than 1 m/s) this depth of flooding would not be considered to constitute a high hazard under either the CRPS definition or, for example, the Australian Rainfall and Runoff Guidelines hazard classification system.

28 The PER activity status in Rule NH-R16 allows filling, as part of the construction of a building, in the Coastal Flood Assessment Overlay outside the urban environment where water depths are less than 0.3 m without an assessment of the effects of filling on flood hazards. Clauses 3 and 4 of PDP Policy NH-P4 (Activities outside of high hazard areas for flooding) require that:

3 'the risk from flooding to surrounding properties is not significantly increased and the net flood storage capacity is not reduced; and

4 the ability for the conveyancing of flood waters is not impeded.'

29 Since the water depth in which filling is permitted without consent is relatively shallow (less than 0.3 m) and the filling is limited to the building itself within a rural environment, any displaced flood storage volume is likely to be small relative to the overall floodplain volume. For these reasons I consider that there is unlikely to be a significant increase in flood risk to any surrounding properties in such cases, although the net flood storage capacity of the floodplain may be reduced. I therefore consider that the rule is consistent with CRPS Objective 11.2.1 in that the mitigation works should have minimal adverse effects on the surrounding environment.

- 30 On this basis I consider that condition 2 of Rule NH-R16 is not inconsistent with CRPS Policy 11.3.1 and Policy 11.3.2 and CRPS Objective 11.2.1 given that:
- PER activity status is only specified in areas of low coastal flood hazard
 - An appropriate mitigation measure of a minimum floor level is required.
 - The mitigation measure should have minimal adverse effects.
- 31 In terms of defining the extent of a coastal flood hazard area for land use planning purposes, I consider that the likelihood of flooding adopted in the CRPS to define land subject to inundation (0.5% AEP) is appropriate. Statistically, there is a 22% (around '1 in 5') chance of at least one such event occurring during a 50-year period or a 39% (around '2 in 5') chance of at least one such event occurring during a 100-year period. This magnitude of event is therefore reasonably likely to occur within the life of planned activities. This probability of flooding has been adopted elsewhere for defining areas of flood hazard – for example, in the UK Environment Agency's Flood Map for Planning (Rivers and Sea) the 0.5% AEP defines the zone of 'High Probability' of flooding from the sea. I therefore consider that the PDP mapped Coastal Flood Assessment Overlay should be revised to reflect the 0.5% AEP inundation extent to give effect to the CRPS.
- 32 The hazard presented by flooding depends on various factors. The depth of the water and the speed of flow of the water (the velocity) are generally recognised to be the primary factors determining flood hazard. Guidelines have been developed for classifying flood hazard based on scientific research and are widely used by practitioners. The Australian Rainfall and Runoff Guidelines and the UK Framework and Guidance for Assessing and Managing Flood Risk for New Development both consider the flood water depth and velocity to classify flood hazard. The CRPS defines high flood hazard areas in a similar way

through reference to both flood depth and velocity (clause 1 of the definition, paragraph 26 of my evidence).

- 33 In areas of lower velocity, the depth of flooding is more important than the velocity in determining the overall severity of the hazard. In the Australian Rainfall and Runoff Guidelines, the flood hazard category is defined only by the depth of water for velocities less than between 0.5 m/s and 1 m/s (depending on the hazard category). In the CRPS, water depth alone defines areas of high hazard when velocities are less than 1 m/s. Recent hydrodynamic modelling of coastal inundation for the Waimakariri District ('Phase 2 Coastal Inundation Modelling, Final Study Report', Jacobs, 12 March 2020) shows that maximum velocities in the coastal flood hazard area are relatively low (less than 0.5 m/s) over almost all the inundation area such that for practical purposes it is appropriate to categorise flood hazard by the water depths.
- 34 Clause 4 of the CRPS definition of 'high hazard areas' also includes 'land subject to sea water inundation', regardless of the actual hazard (depth or velocity) posed by the inundation. I consider that defining all land which is susceptible to any inundation from the sea as a high hazard area regardless of the depth (or velocity) of inundation is not consistent with the risk-based intent of the CRPS, or with clause 1 of the CRPS definition of high flood hazard for other sources of flooding such as intense rainfall or high river flow, or with other accepted methods for classifying flood hazard.
- 35 In coastal areas, flooding often arises from the combined effects of extreme sea level, intense rainfall, high river flow and high groundwater level – i.e., from both 'sea water' and 'other water' – and the hazard to people does not usually depend on the particular source or sources of the flood water. In my opinion, a consistent approach to the definition of flood hazard to people, independent of the source of flooding, is more appropriate.

- 36 The PDP Natural Hazards definitions reflect such an approach:
- 'The main coastal hazard affecting the District is sea water inundation, which occurs through the Waimakariri River and Ashley River/Rakahuri channels. The sea water inundation extends beyond the mapped Coastal Environment inland. Because of this, and the fact that the sea water inundation extent in the District is affected by concurrent freshwater flows present in the rivers, coastal hazards are located within the Natural Hazards Chapter, rather than as a separate coastal hazard contained in the Coastal Environment Chapter. Areas potentially subject to sea water inundation are identified by the Coastal Flood Assessment Overlay.'
- 37 However, in terms of defining the areas of highest flood hazards, the PDP differentiates between areas of coastal flooding (High Coastal Flood Hazard Area) and other flooding (High Flood Hazard Area).
- High Coastal Flood Hazard Area is defined as:
 - 'a. land likely to be subject to coastal erosion, including the cumulative effects of sea level rise, over the next 100 years; and
 - b. land subject to water depth of 1 metre or greater in a 1% AEP (1 in 100-year) storm surge event (excluding tsunami), concurrent with 5% AEP (1 in 20-year) river flow event with a median sea level rise projection over the next 100 years based on an RCP8.5 high emissions scenario.'
 - High Flood Hazard Area is defined as:
 - 'a. land where there is inundation by floodwater, and where the water depth (metres) x velocity (metres per second) is greater than or equal to 1, or where depths are greater than 1 metre, in a 0.2% Annual Exceedance Probability flood event.'
- 38 As explained in paragraphs 31 to 35 of my evidence, I consider that a single consistent definition of flood hazard, which takes account of the likelihood of flooding and varying contributions to hazard of the depth

of water and velocity of water, regardless of source or sources, is to be preferred.

39 District Council propose to amend the PDP definition of High Coastal Flood Hazard to align the fresh water and sea water flooding clauses and use a single probability of flooding. Under the amendment the separate PDP definitions of 'High Coastal Flood Hazard' and 'High Flood Hazard' would be deleted and replaced by a single definition of 'High Hazard Area' as follows:

- 'High Hazard Area means:
 - a. land likely to be subject to coastal erosion; and
 - b. land where there is inundation by floodwater and where the water depth (metres) x velocity (metres per second) is greater than or equal to 1, or where depths are greater than 1 metre, in a 0.2% Annual Exceedance Probability flood event.

When determining a. and b. above, the cumulative effects of climate change over the next 100 years (based on latest national guidance) and all sources of flooding (including fluvial, pluvial, and coastal) must be accounted for.'

40 The proposed amended definition is consistent with the current PDP definition of High Coastal Flood Hazard – water depths greater than 1 m – since in these areas the velocity tends to be generally low (paragraph 33 of my evidence) and hazard is determined primarily by water depth.

41 Equally, the amended definition is consistent with the current PDP definition of High Flood Hazard areas – water depth (metres) x velocity (metres per second) is greater than 1 or water depth is greater than 1 m – where the velocity of flood water becomes important as well as depth.

- 42 In my opinion, the amended PDP definition will give effect to CRPS Policy 11.3.1 in terms of the definition of High Hazard Area in that:
- i. the likelihood of flooding at which hazard is evaluated (0.2% AEP) is the same.
 - ii. the hazard threshold (water depth exceeding 1 m or water depth x velocity exceeding a value of 1) is the same.
 - iii. the hazard posed by 'sea water inundation' (specified in the CRPS definition of High Hazard Area) is also included in the amended PDP definition through requiring that all sources of flooding – including 'coastal' – are considered.
 - iv. the effects of climate change are included in both cases.
- 43 The PDP definition applies the same probability and hazard thresholds to coastal flooding as to flooding from other sources whereas the CRPS definition does not address the actual risk posed by coastal flooding. Given the significance of the contribution of the coastal source of flooding to the extent of flood hazards in the district, I consider it appropriate and practical to adopt the same risk-based approach to land use planning for coastal and combined source flooding as for other sources of flooding.
- 44 The proposed amendment to the PDP definition is not prescriptive in terms of how the sources of flooding are combined or in the specific allowances to be made for the effects of climate change. This enables the PDP to make use of updated information such as flood modelling, new knowledge relating to, for example, the joint probabilities of fluvial and coastal events, and revised guidance on the projections of the effects of climate change on mean sea level rise and rainfall intensity.
- 45 To support the amended definition of High Hazard Area, the flood hazard data supporting the PDP and presented in the Interactive

Viewer would need to be updated. To give effect to CRPS Policy 11.3.2, the Coastal Flood Assessment Overlay should be defined by the 0.5% AEP flood extent as discussed in paragraph 31 of my evidence. Within the overlay the flood hazard should be classified by the 0.2% AEP water depths.

- 46 **Submission No. 195.63 (Transpower New Zealand Limited): Provision NH-R17 Above ground critical infrastructure.** The submission seeks to amend condition 1.a. of NH-R17, to apply the footprint limit for Permitted (PER) activity status of 10 m² to each structure within an infrastructure activity instead of the entire activity, on the basis that the condition does not anticipate linear infrastructure, particularly infrastructure that is made up of a number of structures, such as a transmission line. The submission also seeks to remove condition 2, which specifies Non-Complying (NC) status for an activity not meeting the conditions, in its entirety on the basis that the most stringent activity status that should apply is Restricted Discretionary (RDIS) because any potential effects in respect of the coastal flood hazard can be adequately assessed via Matters of Discretion.
- 47 In my opinion condition 1.a. should be retained. The proposed amendment by Transpower could apply PER activity status for a single 'infrastructure' activity composed of many individual 'structures' – which includes buildings – each with footprints of less than 10 m² but an aggregate footprint much larger than 10 m² to be constructed within the Coastal Flood Assessment Overlay in any depth of flood water. Such an activity could potentially adversely affect flood risk depending on the size of the aggregate footprint and the nature and location of the 'structure'.
- 48 I consider that condition 2 of NH-R17 (2) should also retained. The condition limits RDIS status to activities which are to be located in areas where the depth of flood water in the Coastal Flood Assessment Overlay is less than 1 m and specifies NC status if this condition is not complied with. I consider this is appropriate in that it recognises the

greater hazard of deeper water reflected in the risk-based approach of the PDP and is consistent with Objective NH-O2(3) of the PDP (critical infrastructure is avoided in high flood hazard areas and high coastal flood hazard areas, unless there is a functional need or operational need for the location or route) which gives effect to Policy 11.3.4 of the Canterbury Regional Policy Statement (CRPS).

49 **Submission No. 316.86 (Canterbury Regional Council): Provision NH-R17 Above ground critical infrastructure.** The submission seeks to delete Permitted (PER) activity status in NH-R17 for new infrastructure in the Coastal Flood Assessment Overlay on the basis that the proposed provisions do not give effect to Chapter 11 Natural Hazards of the Canterbury Regional Policy Statement, particularly in relation to high hazard areas in the coastal environment and the PER and Restricted Discretionary (RDIS) activity status for development in areas subject to coastal hazards. This is not considered consistent with the policy direction for a high hazard area under the Canterbury Regional Policy Statement. The submission considers that the rule does not give effect to Canterbury Regional Policy Statement Policy 11.3.4 which requires that new critical infrastructure will be located outside high hazard areas unless there is no reasonable alternative.

50 In my opinion PER status in NH-R17 could be retained. However, I also consider that condition 1.c of the rule and the advisory note to Natural Hazard Standard NH-S2 could be clarified. Condition 1.c allows construction, without resource consent, of critical infrastructure which is not a building within the Coastal Flood Assessment Overlay and which complies with a Coastal Flood Assessment Certificate issued in accordance with Natural Hazard Standard NH-S2. Under NH-S2, a required minimum floor or land level will not be provided if the activity is located in the High Coastal Flood Hazard Area within the Non-Urban Flood Assessment Area and a resource consent will be required in this situation (paragraph 3 of the Advisory Notes to NH-S2). This is consistent with Canterbury Regional Policy Statement (CRPS) Policy 11.3.4 - 'new critical infrastructure will be located outside high hazard

areas unless there is no reasonable alternative’ – but this control of the permitted pathway could be clarified in the rule and standard.

51 **Submission No. 316.88 (Canterbury Regional Council): Provision NH-S1 Flood Assessment Certificate.** The submission seeks that the criteria for setting appropriate freeboard levels in NH-S1 1.e are specified to provide greater clarity for plan users and that NH-S1 1.e.iii should be amended to refer to a 0.5% AEP to give effect to CRPS Policy 11.3.2.

52 NH-S1 1.e specifies that the minimum finished floor level shall include ‘up to 500 mm freeboard’. This indicates that the amount of freeboard applied when determining the minimum floor level for the certificate may vary but the basis for deciding the amount is not specified in the standard. As discussed in paragraph 60 of my evidence, I consider it appropriate for the amount of freeboard to vary according to the severity or consequences of the hazard and the degree of uncertainty in flood levels. I agree that further advice on how freeboard is to be determined in the PDP would be helpful and would aid users of the plan to understand the implications for a prospective activity ahead of making a planning application.

53 Policy 11.3.2 of the Canterbury Regional Policy Statement (CRPS) requires that ‘new buildings have an appropriate floor level above the 0.5% AEP design flood level’. As discussed in paragraph 31 of my evidence, I consider the 0.5% AEP appropriate for defining the extent of coastal flooding and therefore I consider it appropriate to amend NH-S1 1.e.iii to refer to the 0.5% AEP flood level in terms of defining minimum finished floor levels in the Coastal Flood Assessment Overlay.

54 **Submission No. 316.89 (Canterbury Regional Council): Provision NH-S2 Coastal Flood Assessment Certificate.** The submission seeks to amend NH-S2 to delete the Permitted (PER) activity status for new natural hazard sensitive activities in the coastal flood assessment overlay on the basis that NH-S2 does not give effect to Chapter 11 Natural Hazards of the Canterbury Regional Policy Statement (CRPS), particularly in relation

to high hazard areas in the coastal environment. This especially relates to the PER and Restricted Discretionary (RDIS) activity status for development in areas subject to coastal hazards, which is not consistent with the policy direction for a high hazard area under the CRPS.

55 Areas subject to coastal hazards are not necessarily high hazard areas and NH-S2 does not in itself specify PER activity status for natural hazard sensitive activities in the Coastal Flood Assessment Overlay. It provides the necessary controls for both the PER and RDIS activities; the status being determined by the relevant rules in the PDP.

56 For example, Rule NH-R16 specifies PER status for natural hazard sensitive activities in the Coastal Flood Assessment Overlay where the hazard is low (water depth less than 0.3 m) and RDIS status for these activities where the hazard is between low and high (water depth between 0.3 m and 1.0 m). Activities where the hazard is high (water depth greater than 1.0 m) are non-complying and NH-S2 will not provide a minimum floor level for an activity in such areas, a resource consent being required.

57 As discussed in paragraph 23 of my evidence, flood hazard in water depths of less than 0.3 m in depth (PER activity status in Rule NH-R16) is generally considered to be low. In such low hazard areas, NH-S2 also specifies a minimum floor level for the building to mitigate the risk from flooding. On this basis and given the required mitigation measures I consider the flood risk under these conditions to be low.

58 For water depths of 0.3 m to 1.0 m (RDIS activity status in Rule NH-R16) flood hazard is generally considered to be higher than for depths below 0.3 m. This range of water depths includes class H2 'unsafe for small vehicles' (but safe for people) and H3 'unsafe for vehicles, children and the elderly' in the Australian Rainfall and Runoff Guidelines for water velocities less than 0.5 m/s. The matters of discretion in these conditions (NH-MD4) provide for a more detailed assessment of the frequency and extent of damage to buildings, availability of safe access during a flood,

the effectiveness and effect of mitigation measures, potential for future relocation of a building, reliance on Council infrastructure as well as the positive effects of development. Due to the range of water depths (0.3 m to 1.0 m) and hazard included in this definition, and the probability of flooding used to define the flood hazard, I consider the flood risk to be low to moderate and that the matters of discretion provide appropriate means for assessing applications under these conditions.

- 59 **Submission No. 186.15 (Land Subcommittee - Pines and Kairaki Beaches Association): Provision NH-S2 Coastal Flood Assessment Certificate.** The submission seeks a review of the 500 mm freeboard allowance, considered excessive, in the calculation for the Coastal Flood Assessment Certificate, deletion of the land height requirement for anything but a new subdivision and continued review of the accuracy of the map data supporting the PDP provisions.
- 60 In my opinion, providing an allowance for freeboard in determining the minimum finished floor level, as specified in NH-S1, is appropriate. I note that the freeboard allowance is specified in NH-S1 rather than NH-S2 (which references NH-S1). In NH-S1, the freeboard to be applied is specified as 'up to 500 mm' rather than a universal value of 500 mm. This allows for a variation in the amount of freeboard included by District Council in the minimum floor level requirement according to the severity or consequences of the hazard or the degree of uncertainty in flood levels. Such an approach to freeboard is commonly adopted in planning and building control – for example, Verification Method E1/VM1 for New Zealand Building Code Clause E1 Surface Water specifies a freeboard of 500 mm to secondary flow of surface water of depth greater than 100 mm and susceptible to wave action from vehicles and a freeboard of 150 mm in other cases.
- 61 I note that areas where the water depth is greater than 1 m (such as the '2 m depth' referred to in the submission) are specified as 'high hazard areas' in the PDP and are non-complying status so that NH-S2

will not necessarily apply in such areas and a freeboard allowance will not be relevant.

62 As discussed in paragraph 52 of my evidence, I consider that further advice on how freeboard will be determined could usefully be provided in the PDP to aid users of the plan understand the implications for a prospective activity ahead of making an application.

63 In my opinion the minimum land level requirement of NH-S2 could be retained. This requirement only applies to activities within the non-urban flood area and outside the high coastal flood hazard area – paragraph 1.c of NH-S2 – i.e., where the water depth is less than 1 m. The status for activities in areas with water depths between 0.3 m and 1 m is Restricted Discretionary (RDIS) – i.e., a resource consent is required which will need to consider the effects of the land raising on hazard to other properties including discharge of runoff and displacement of flood storage volume (NH-MD4).

64 I consider that an additional requirement for the continued review of the accuracy of the map data is unnecessary. The map data referred to (Waimakariri District Natural Hazards Interactive Viewer) does not form part of the PDP. The PDP states, as an advisory to NH-S1 and NH-S2, that ‘The [Annual exceedance probability] flood event risk level, minimum floor levels and overland flow path locations are to be determined by reference to:

- ‘The most up to date models, maps and data held by the District Council and the Regional Council; and
- Any information held by, or provided to, the District Council or the Regional Council that relates to flood risk for the specific land. ‘

This confirms the intention and an obligation to make use of new and improved data in applying the standards as and when they become available.

- 65 Regarding the submitter's query regarding the reliability of 'the levels on the coastal interactive map' I would note that the interactive map presents flood water depths rather than water levels. The flood depth information for coastal inundation presented in the viewer has been derived from modelling of the entire coastline of the district by Jacobs and provides an indication of the relative flood hazards along the coastline.
- 66 The variation in depth values over a flat ground surface at the property referred to is likely due to the broad resolution of the ground model used to calculate flood levels and depths relative to smaller scale topographic features at the site.
- 67 For example, properties to the west of Featherstone Avenue in Kairaki are bounded to the west by Kairaki Creek. In the ground model, ground levels in the western parts of these properties are interpolated between the lower ground levels in the creek channel and the higher, flat ground in the properties adjacent to the creek. In some locations this results in lower ground levels extending locally into the western portions of some of these properties in the model, resulting in locally deeper flood depths in the mapped outputs. The water surface elevation calculated by the hydraulic model (which also takes account of the crest level of the stop bank along the creek), is not as sensitive to local variations in the interpolated ground level data and shows little variation in level at these properties for the event shown in the Interactive Viewer.
- 68 In my opinion, a site-specific flood hazard assessment is better informed by the flood water levels from the current modelling in combination with a higher resolution survey of the site.

Date: 09/06/2023

Janine Holt

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