Before Palmerston North City Council

Under	the Resource Management Act 1991
In the matter of	a proposed plan change to rezone land at 611 Rangitikei Line to establish the Whiskey Creek Residential Area

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STATEMENT OF EVIDENCE OF PHILIP LAWRENCE WALLACE

IN SUPPORT OF FLYGERS INVESTMENT GROUP LIMITED

FLOOD ISSUES

18 MAY 2022

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INTRODUCTION

1. My full name is Philip Lawrence Wallace

Qualifications and Experience

2. I am a director of River Edge Consulting Ltd. I have held this role since 2008.

3. Between 2014 and early 2020 I also was employed as a Principal Engineer by DHI Water and Environment Ltd ("DHI").

4. I hold a Bachelor of Engineering (Hons) in Civil Engineering from the University of Auckland and a Master of Science (Hons) in Resource Management from the University of Canterbury.

5. I have 35 years of experience in the fields of river engineering, river modelling and floodplain management. My experience has included several years working for regional councils, in addition to time in a range of consultancies, both in New Zealand and the United Kingdom. I have also worked as a policy analyst in local government.

6. Amongst the projects I have carried as a consultant are several in the Manawatu and Palmerston North areas for Horizons Regional Council ("Horizons") and Palmerston North City Council (PNCC), including:

   (a) Preparing a model of the entire Lower Manawatu Scheme and running various flood scenarios to help assess the benefits of the Scheme

   (b) Modelling the Lower Mangaone Stream and mapping the flood hazard

   (c) Modelling the flood hazard in two areas of Palmerston North under consideration for urban growth areas at the time

   In the mid-2000s, I also undertook a modelling study for a previous development proposal for the site that is the subject of this proposed Plan Change. As part of that work, and a further upstream project relating to the Mangaone Stream, I visited the site as well as the Flygers Line (or Mangaone) Spillway and the much of the downstream reaches of the Mangaone Stream and Whiskey Creek.

7. I am a member of the following professional organisations:

(a) New Zealand Hydrological Society

(b) International Association for Hydro-Environment Engineering and Research ("IAHR")

(c) New Zealand Water and Wastes Association ("Water New Zealand")

(d) Rivers Group (a technical group of Engineering New Zealand and Water New Zealand). (I am a current committee member and Treasurer)

Involvement in Proposed Plan Change

8. DHI was commissioned in 2018 to carry out flood modelling for the development proposal and assess the flood impacts of the proposal. Although I was not directly involved in the assessment at that time, as an employee of DHI I provided advice and background information to assist with the investigations.

9. My direct involvement with the current proposal recommenced in April 2022. Since that time, I have

(a) familiarised myself with the flood modelling and documentation

(b) participated in a pre-hearing expert conference regarding flooding and stormwater matters (with Horizons, PNCC, Stantec and GHD)and a pre-hearing meeting with submitters (4 May 2022), and

(c) refined and updated the flood model with new data.

Code of Conduct

10. I have read the Code of Conduct for expert witnesses in the Environment Court Practice Note 2014 and I have complied with it when preparing this evidence. Other than when I state that I am relying on the advice of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of Evidence

11. In this statement I:

(a) Outline the flood modelling investigations and conclusions

(b) respond to relevant matters raised by submitters

(c) respond to relevant matters raised by Messrs Asgar and Preston (on behalf of PNCC) within Appendices A and D of the s42A report.

EXECUTIVE SUMMARY

12. The proposed Whiskey Creek Residential area is on a site that is in part subject to flooding from upstream spills of the Mangaone Stream and Whiskey Creek.

13. A detailed computer model has been developed in order to assess the flood hazard for the site as it exists now and then to guide design of site layout and earthworks required to avoid flood risk to the proposed residential development.

14. A design option, incorporating earthworks, bunds and storage ponds, was prepared in 2019 that ensured that the residential area was effectively flood-free whilst predicting that off-site impacts were less than minor.

15. Recent updates of the model and rerunning of the design flood scenario indicate that refinement of the design option will be required to address some minor off-site impacts. I am confident that this will be possible. Approved design and construction of earthworks will be needed before any residential construction can proceed.

16. A number of technical matters regarding modelling that have been raised in the PNCC peer review process have been addressed, but on-going liaison with both Horizons and PNCC will be required during the detailed design and consenting stages.

FLOOD HAZARD ASSESSMENT

Background

17. The site characteristics and the background to the flood risk to the site are provided in the evidence of Mr Paul Mitchell. In summary, the site is subject to flood overflows from the Mangaone Stream and Whiskey Creek.

Hydraulic Modelling

18. Computational hydraulic models have been developed to assess and map flood hazards in the lower Manawatu area. For all models referred to in my evidence, the software used is MIKE FLOOD, developed by DHI and used extensively within New Zealand and world-wide for flood hazard studies.

19. In 2007, Horizons commissioned DHI to build a hydraulic model of the Taonui Basin, encompassing a floodplain between the south (true left) bank) of the Oroua River and the north (true right) bank of the Manawatu River, downstream of Fielding and Bunnythorpe (Figure 1).

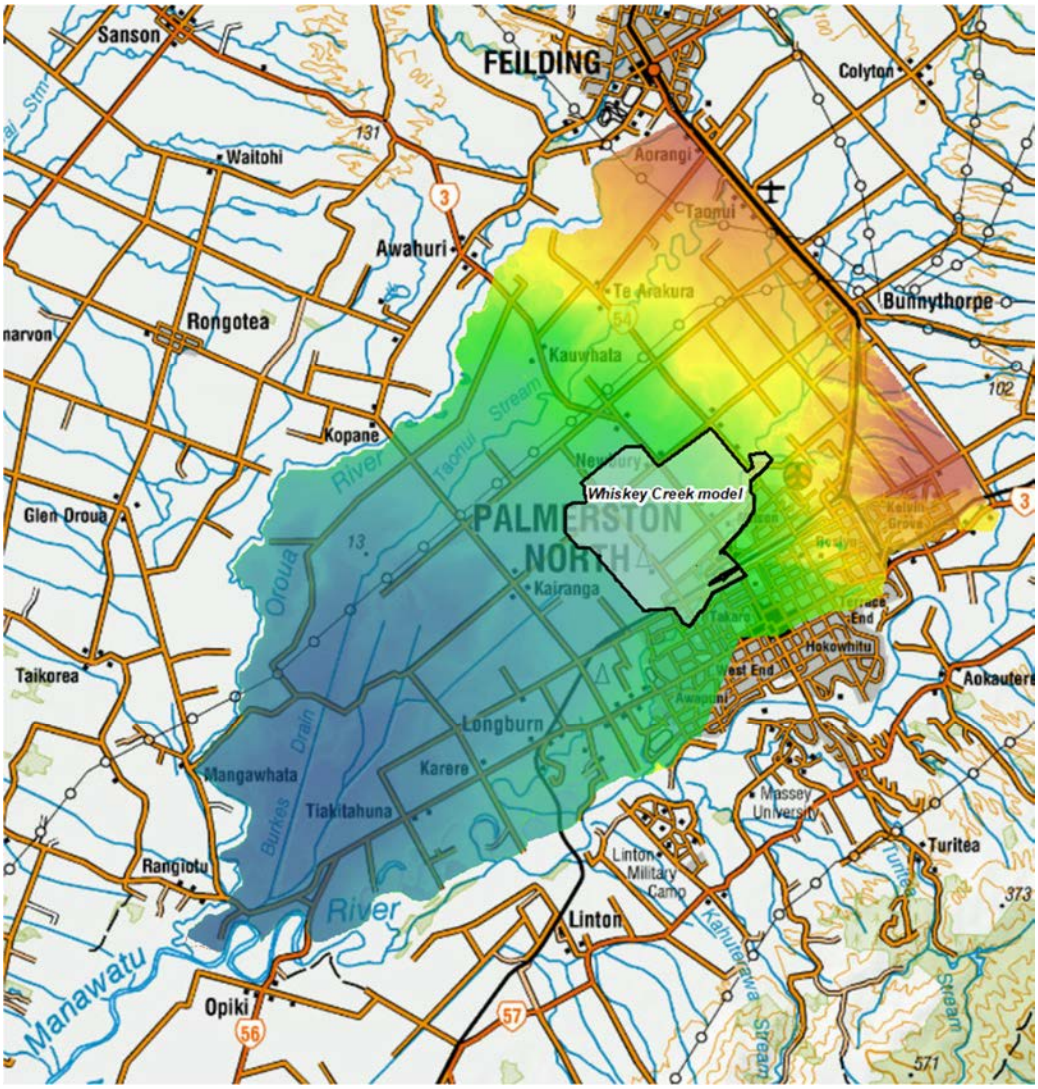

Figure 1: Taonui Basin and Whiskey Creek model areas

20. Following the 2015 flood event, Horizons engaged DHI to update the model to make use of the then current software version, to validate the model

against the 2015 flood and to rerun design scenarios (1% AEP[1] and 0.5% AEP flood events).

21. In 2018, Horizons agreed that the Taonui Basin model could be used as a starting point for modelling the flood hazard of the proposed Whiskey Creek Residential area ("the site").

22. DHI prepared a smaller but more detailed model (the "Whiskey Creek model") of the area between Milsons Line and 1 km downstream of Gillespies Line. The area of that model is also shown in Figure 1. Time series of discharges and water levels were extracted from the Taonui Basin model results for the 0.5% AEP flood scenario, at the locations of the upstream and downstream boundaries, respectively, of the detailed model. A Flygers Line spillway peak flow of 114 m^3/s in the 0.5% AEP event, as estimated by Horizons, has been incorporated.

23. With these "boundary conditions", the existing situation was modelled with a 0.5% AEP flood event. Various options for the landforms and features of the completed development were tested, with the aim of reducing off-site flood impacts to acceptable limits. "Option 6" was settled upon as a suitable layout for the development. The process and options tested are described in the DHI memorandum that forms Appendix 2 of the Plan Change application.

24. I have recently made refinements to the Whiskey Creek model, including:

    (a) Updating the model topography with 2018 LiDAR data and combining it with site survey data collected by Resonant in 2018 and 2019

    (b) Incorporating recent Whiskey Creek stopbank upgrades adjacent to Benmore Avenue and further downstream near Flygers Line

    (c) Slightly reducing the model extent in some areas to exclude areas not showing as flooded in previous model simulations

    (d) Relocating the downstream boundary further south and refining the boundary condition to better represent the Taonui Basin model results

[1] Annual Exceedance Probability. A 1% AEP also referred to as a "1 in 100-year" event, as a 100-year ARI (Average Recurrence Interval) event or more simply as a "100-year" event. A 0.5% AEP is also referred to as a "200-year" event.

along that boundary (after rerunning the Taonui Basin model with an updated coordinate system)

(e) Making slight changes to the model resolution, varying it over the model extent (but maintaining or improving the resolution over large areas)

(f) Making use of more efficient software and hardware now available.

25. Flood depths for the existing situation in a 0.5 % AEP flood event are as shown in Figure 2 (and in Figure 3 at a larger scale). These show a small amount of spilling over the Benmore Avenue stopbanks, with the spill continuing down along Benmore Avenue. However, the level of the stopbank at the spill location (99 Benmore Avenue) is uncertain and it may be that the model underestimates the actual stopbank level, in which case there would be less or no spill over the stopbank.

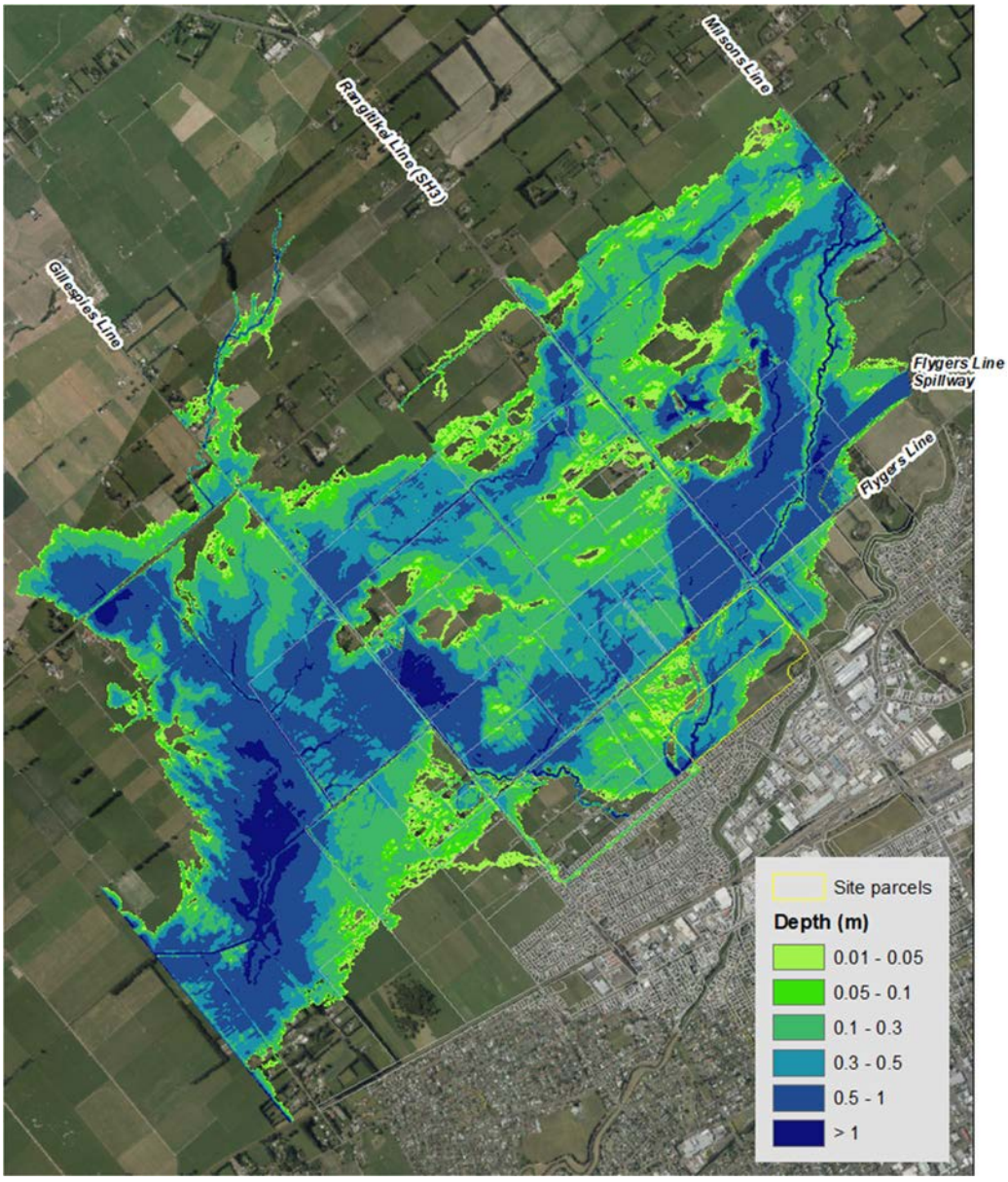

Figure 2: Predicted flood depths, 0.5% AEP flood, existing situation

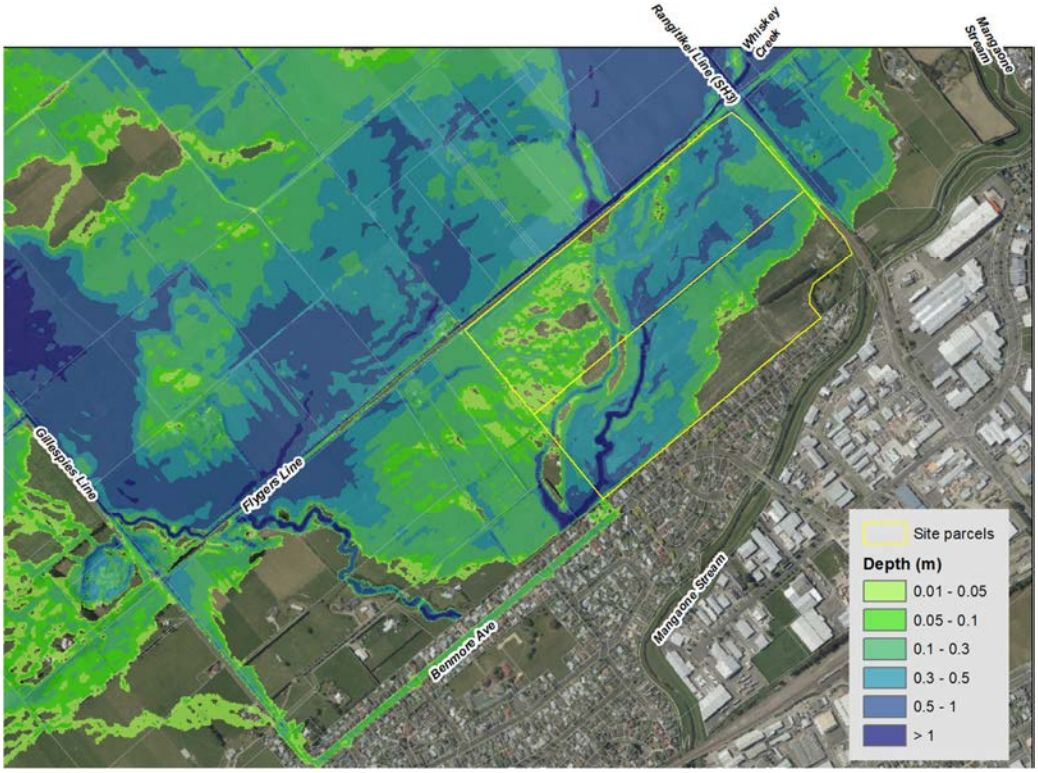

Figure 3: Predicted flood depths, 0.5% AEP flood, existing situation (larger scale)

26. The model was rerun with the Option 6 layout. Resulting flood depths are as shown in Figure 4. The effect of Option 6 on peak flood depths, i.e. the difference between the depths shown in Figure 4 and Figure 3, is shown in Figure 5. Along Benmore Avenue, the flood depths reduce by 60 – 80 mm. However, flood depths are predicted to increase by up to 100 mm over a portion of the property at 247 Flygers Line.

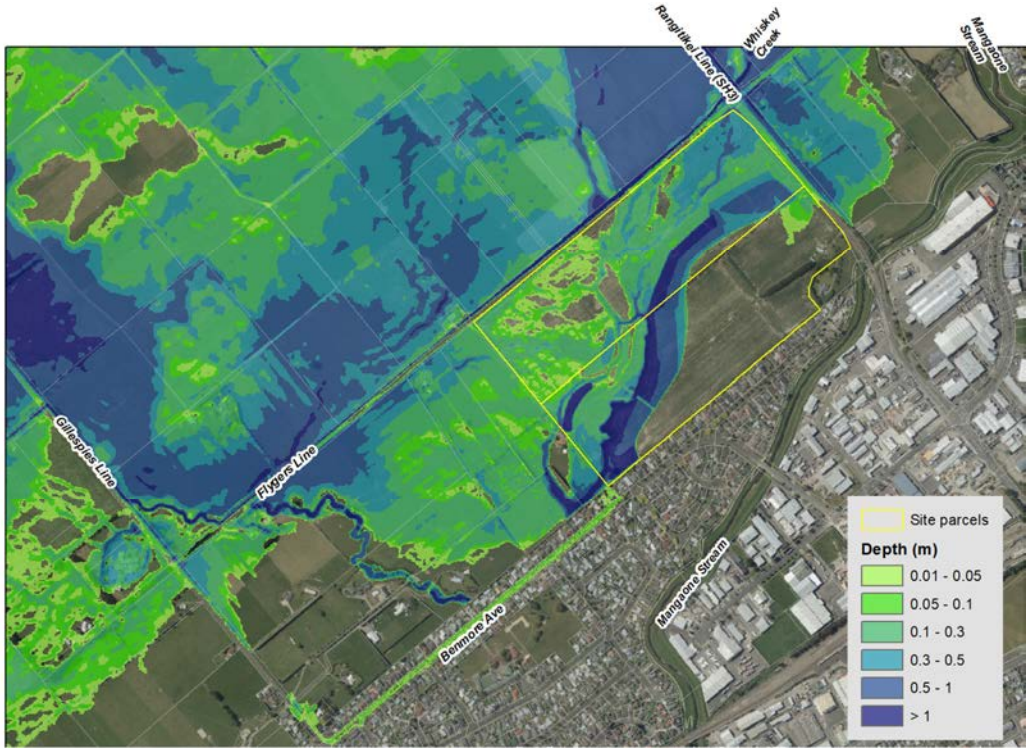

Figure 4: Predicted flood depths, 0.5% AEP flood, proposed situation (Option 6)

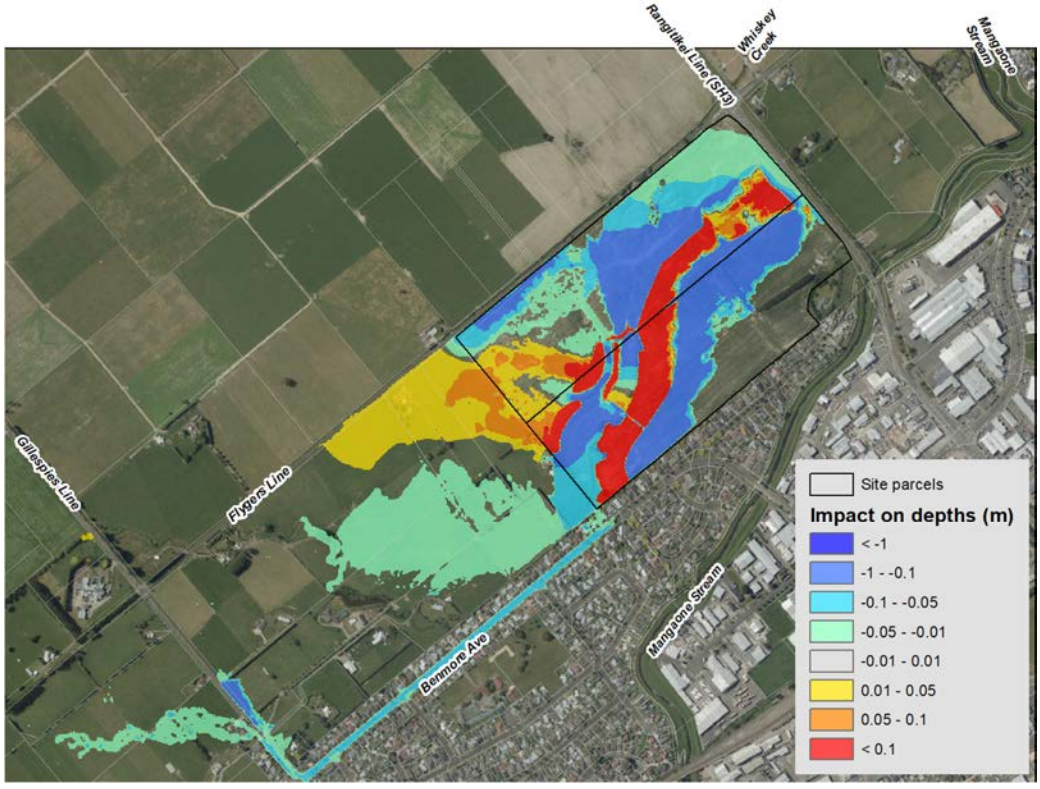

Figure 5: Effect of Option 6 on peak flood depths, 0.5% AEP flood

27. Further design refinements may be needed to reduce the off-site impacts. Testing of design variations is continuing and showing some promise. It is my opinion that appropriate earthworks and site layout can be designed to ensure that any off-site impacts in the design 0.2% AEP flood event are acceptable.

SUBMISSIONS

28. Several submissions refer to flooding issues and concerns. I will address these by the general themes that I have identified from the submissions.

29. Building in a defined flood zone or flood-prone area: I agree with the general principle that it is better to avoid building in flood-prone areas, rather than attempting to mitigate the risk to buildings and assets within those areas. Here however, the entire residential area (Figure 3 of the Plan Change application) can be raised to be out of the identified 0.5% AEP flood hazard area. I agree with the Horizons submission that earthworks are integral to avoiding the flood hazard in this case.

30. Climate change: The effects of climate change certainly need to be taken into account. For design purposes and in delineating flood hazard areas, Horizons has adopted a 0.5% AEP flood event as a surrogate for a 1% AEP plus climate change scenario. That standard has been adopted in the modelling for this Plan Change application.

31. Impact of proposed KiwiRail freight hub at Bunnythorpe: Several submitters raised concerns that additional runoff from the proposed freight hub would exacerbate the flood hazard at the Whiskey Creek site. The freight hub development is required to be hydraulically-neutral, with conditions prescribing this in the decision on the Notice of Requirement for that proposal[2]. The expectation is that stormwater detention ponds will be designed to ensure hydraulic neutrality. Therefore, no adverse flood effects on the Whiskey Creek site are expected.

32. Flood risk to Benmore Avenue and Meadowbrook Drive:

[2] https://www.pncc.govt.nz/files/assets/public/documents/participate-palmy/have-your-say/kiwirail-freight-hub/commissioners-decision/commissioners-report-on-kiwirails-notice-of-requirement-for-freight-hub-28-february-2022-pages-1-343.pdf

(a) Modelling results from Option 6 show that this layout option would result in lower flood levels adjacent to the stopbank running at the rear of Benmore Avenue and Meadowbrook Drive properties, for the 0.5 % AEP flood. Although Figure 5 shows an increase in depth behind 103 to 111 Benmore Avenue, this is due to the option having an excavated pond in that reach; actual flood levels are lower.

(b) Figure 5 also shows a predicted reduction in depths along Benmore Avenue.

(c) In the existing case, floodwaters are only predicted against properties south of 5 Meadowbrook Drive; in the proposed case, the floodwaters would only extend as far north as 111 Benmore Avenue.

(d) Nonetheless, the proposed pond of Option 6 immediately behind the stopbank, between 103 and 111 Benmore Avenue could threaten the geotechnical integrity of the stopbank at that location and compromise the flood protection that the stopbank offers. I would also expect that Horizons would require a maintenance setback. For these reasons, I recommend that any excavation to form a pond be set back at least 10 m from the stopbank toe. A geotechnical analysis would need to form part of the design process.

(e) Analysis of model results shows that Option 6 does not increase the load on the 900 mm culverted section of the Whiskey Creek Drain (the 900 mm culvert running under Benmore Avenue). Inflows to the pipe from the Benmore Avenue area under the design 0.5% AEP scenario are therefore predicted to be unaffected by the proposed development.

(f) Some of the flood observations in the Meadowbrook Drive area that are provided in the submissions may relate to local runoff and PNCC stormwater network capacity issues.

33. Impacts on 247 Flygers Line:

(a) The owners of the neighbouring property on the south, at 247 Flygers Line, raise a concern that flow across their property may be increased. Further refinement of Option 6 will be required to ensure that any increases to flood depths over that property are acceptable and present no additional risk to the dwelling results.

(b) The submission also expresses a concern that the pond adjacent and upstream of the boundary would hold stagnant water. The pond is envisaged to only be activated during flood events. A throttled outflow to empty once floodwaters have receded will also need to be constructed, so as to allow the storage to be available for subsequent floods.

34. Upstream and SH3 impacts: As shown in Figure 5, no impacts on flood levels over SH3 (Rangitikei Line) or upstream are predicted.

35. Flygers Line drain erosion: Submission S15 includes a report of erosion in the drain on the north/western side of Flygers Line. This drain takes flow from Whiskey Creek after it flows through a culvert under Rangitikei Line. While evidence of the power of the stream in flood conditions, it does not directly relate to the flood risk over the Plan Change site, nor does the proposal impact on levels in that drain in the design event.

36. Peer review: Submissions S15 and S25 called for a peer review of the hydraulic and stormwater modelling. PNCC commissioned a peer review of the flood modelling, findings of which are presented in the s42A report and the evidence of Mr Tim Preston. A robust peer review process adds value to modelling investigations and I would support ongoing peer review during subsequent consenting and design stages.

SECTION 42A REPORT

37. As a general observation, I would not expect the types of clauses listed under "(g) Flood Management in the Whiskey Creek Residential Area" (Appendix A of the s42A report) to be included in a District Plan. Before I comment on the merits of each of the clauses, I suggest that matters of this sort are best dealt with by best practice guidelines or modelling guidelines that local authorities may adopt, or by peer review consensus.

38. Appendix D of the s42A report makes a number of points regarding the flood modelling. These points have for the most part been picked up and followed through by Mr Asgar in his recommendations (i.e. section (g) of Appendix A of the s42A report). I will address the relevant comments of Mr Preston, correlating them to the relevant section (g) sub-clauses where possible.

39. Flygers Line spillway flows (Preston 4.5a, 4.7a, 4.14): Advice from Mr Jon Bell at Horizons is that the 50-year ARI (2% AEP) spillway flow should actually be

approximately 73 m^3/s, but that the 100-year and 200-year (i.e. 1% AEP and 0.5% AEP) spillway flow estimates are 114 m^3/s. The 114 m^3/s is clearly a simplified assumption made by Horizons for design purposes. It has been justified on the basis that in events above a 1% AEP, stopbanks near Roberts Line (i.e. upstream of Milsons Line and the spillway) are expected to fail and spill excess water, so that the upper limit of flow at Milsons Line (just above the spillway) is the 1% AEP flow. This has been described in Appendix D (Stormwater Management Plan) of the Plan Change application.

40. Mangaone Stream data (Preston 4.5b, 4.34, Asgar g(iv), g(v) g(ix)): I have channel survey data extending a little way upstream of Milsons Line, but I am uncertain whether additional survey data upstream exists. In any case, as noted the stream banks are likely to fail in large events and, looking at the general topography of the area, outflows will likely all end up eventually crossing Milson Line and flowing into the Whiskey Creek system. A lack of data is less of a concern in that case. Horizons can be approached to discuss whether refined flow estimates are available, for future modelling at the detailed design stages of the development.

41. Map legends (Preston 4.5c): The maps in Appendix 2 of the Plan Change application are superseded by the maps in my evidence, above.

42. Gap in bund for Option 6 (Preston 4.5d): The gap is in the larger of the two channels, around 200 m in a straight line from the southern corner of the site. No blockage of the smaller channel to the west was included in Option 6.

43. LiDAR (Preston, 4.5e, 4.7b, Asgar g(vi): I suspect that the +/- 0.5 m error quoted in the DHI report should actually refer to the horizontal accuracy. As noted in my evidence, the latest modelling now uses 2018 LiDAR data. This has accuracies of vertical +/- 0.10m @ 95% confidence and horizontal +/- 0.50m @ 95% confidence[3]. My limited checks have shown little difference between the 2005 and 2018 LiDAR data.

44. Inclusion of stormwater network inflows, Benmore Avenue (Preston 4.5f, 4.7c, 4.8, 4.32, Asgar g(iii)): Feeder stormwater pipes to the 900 mm Benmore Avenue culvert were not modelled. Results for the 0.5% AEP design scenario

[3] https://cloud.sdsc.edu/v1/AUTH_opentopography/www/metadata/NZ18_PalmN_metadata.pdf

modelled show a decrease in tail water levels within the pipe, so the omission of local drainage inflow is irrelevant for that flow event.

45. Benmore Avenue stopbanks (Preston 4.5g, 4.7d, 4.9, 4.36, Asgar g(vii): As I have outlined earlier, actual bank levels (or design levels where as-builts were not available) have been incorporated into the most recent modelling. These include the stopbanks upgraded in 2018 and 2019. Option 6 is now shown to lessen the overtopping. Nonetheless, stopbank crest levels behind 99 Benmore Avenue are uncertain and the model may overestimate the spilling. I recommend that additional survey capture the crest level at that location.

46. Downstream boundary condition (Preston 4.5h, 4.7e): I have extracted the downstream boundary condition from the Taonui Basin model. Levels along the boundary vary in time and space. This boundary is well beyond the area of interest and will not affect results in the area of interest; the maximum level at the boundary is around 18 m RL[4], whereas the peak levels at the site boundary are well above this at around 25 m RL.

47. Consistency between the baseline flood for the latest (i.e. "Whiskey Creek") model and the regional (i.e. "Taonui Basin") model (Preston 4.5a, 4.7f, 4.31, Asgar g(ii)): (Note that this question appears to have been lost in translation in the conditions recommended by Mr. Asgar.) Figure 6 illustrates that there is consistency between the two models. Differences between the two will in large part be due to the much greater resolution of the ground topography in the Whiskey Creek model.

[4] Reduced Level. The model has been built based on Wellington Vertical Datum 1953 and all model results and levels quoted are in terms of this datum.

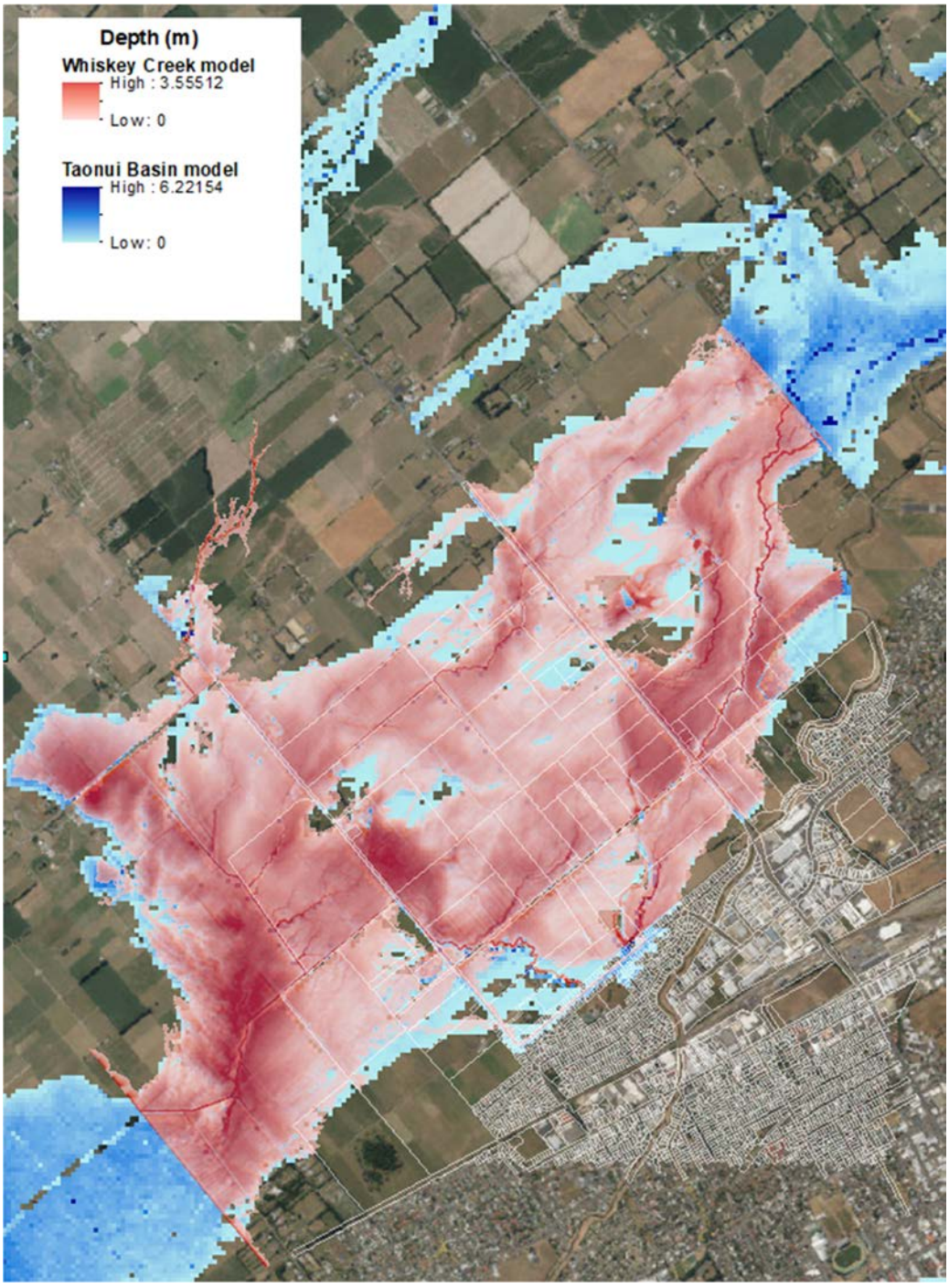

Figure 6: Peak flood depths for Taonui Basin and the Whiskey Creek models

48. A range of storm event ARIs and durations should be modelled (Preston 4.13, 4.37, 4.38, Asgar g(viii), g(ix)): This is not a clear-cut matter. Whether the impact at lesser flows (i.e. lesser ARIs) is of importance can depend on the current level of risk to land and existing assets, for example. While a different duration or flood hydrograph shape may give different results, the analysis

should still consider a duration and input volume that has a probability of occurrence commensurate with the design standards. I disagree with the use of a steady state analysis, particularly given the role that storage will form in any design solution; results would be excessively conservative.

49. Comments regarding Option 6 (Preston 4.15, 4.16, 4.30, Asgar g(i)): I agree that some modification of Option 6 will be required, especially in light of the latest findings. However, the latest results do indicate a reduction in risk to the Benmore Avenue area.

Philip Lawrence Wallace

18 May 2022