BEFORE THE HEARING PANEL

IN THE MATTER	of the Resource Management Act 1991
A N D	
IN THE MATTER	of the Proposed Plan Change 29 to the Nelson Resource Management Plan

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STATEMENT OF EVIDENCE OF DAMIAN NATHAN VELLUPPILLAI

TONKIN & TAYLOR LTD

21 June 2024

INTRODUCTION

QUALIFICATIONS AND EXPERIENCE

1 My full name is Damian Nathan Velluppillai.

2 I am a Water Resources Engineer with Tonkin & Taylor Ltd (T+T). I hold the qualification of BE (Hons) Civil and am a Chartered Professional Engineer (CPEng). I am a member of Engineering New Zealand, the New Zealand Hydrological Society, and the New Zealand Coastal Society. I am a committee member on Engineering New Zealand's Rivers Group.

3 I have 22 years of experience in flooding and stormwater assessment in New Zealand. The majority of this experience is in relation to the identification, management and mitigation of flood risk, often supported by the use of numerical flood models. I have presented evidence as an expert witness for stormwater and flooding in numerous resource consent hearings in Nelson and Tasman.

4 I have been involved in the assessment, mapping and communication of flood hazard and risk within Nelson City since 2006. I have led T+T's technical team tasked with delivering river and stormwater modelling and flood mapping for Nelson City Council (Council). I have provided peer review services, briefings to city councillors and practitioners, and assisted Council with public consultation regarding coastal and river flooding.

5 I have been to selected sites that feature in the submissions and I am familiar with Nelson City's river catchments and coastal environment.

CODE OF CONDUCT

6 I confirm that I have read the Code of Conduct for expert witnesses contained in the 2023 Environment Court Practice Note and that I agree to comply with it. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions I express. In particular, unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

SCOPE AND STRUCTURE OF EVIDENCE

7 The scope of my evidence covers:

a A high level overview of how the recent coastal and river flood mapping used in PC29 has been developed. I also refer to Council's continual improvement of flood models as new data becomes available that impacts our understanding and mapping of flood hazard;

b Responses to submissions relating to flooding, including:

i Flood mapping in the lower Brook Stream floodplain;

ii Water sensitive design (WSD);

iii Flood mapping at 100 Tasman Street;

iv Flood mapping at 206 Kawai Street;

v Flood mapping at Manuka Street Hospital;

vi Flood mapping at 2 Little Todd Valley Stream.

8 The following matters are not included in the scope of my evidence:

a Flooding matters that are dealt with in the evidence of Mr. Toby Kay, including the approach taken to manage flood risk for new development in the PC29 extent, detail on the timing of Council's flood modelling programme and responses to individual submissions dealt with by Mr. Kay;

b Commentary on council's ability to provide stormwater infrastructure to service growth. This is provided in the evidence of Mr. Alec Louverdis.

EXISTING FLOOD MODELLING AND MAPPING

9 Nelson City is subject to flood hazard from a number of sources, including:

a Coastal – due to elevated sea levels and wave effects, particularly during storm events. The main associated hazards are coastal erosion and inundation;

b River – during high flow events, particularly when the major urban rivers and streams do not have capacity to convey peak storm runoff between channel banks. The main urban stream catchments are (from north to south:

i Wakapuaka floodplain (including Hillwood Stream)

ii Oldham Creek;

iii Maitai/Brook/York;

iv Jenkins/Arapiki/Poorman Valley;

v Orchard/Orphanage;

vi Saxton Creek (not modelled, as the recent/current channel upgrades have been designed for full containment of the 2130 RCP8.5M 1% annual exceedance probability (AEP) flow).

c Stormwater – Stormwater is water runoff that comes from rainfall running off land surfaces and being conveyed outside of main river channels. This includes runoff from roofs, car parks, streets and local slopes. Where pipe network capacity is available, stormwater can be conveyed within the underground pipe system. Where capacity is not available, stormwater is conveyed on the ground surface and can lead to flooding. Modelling of stormwater flooding almost always includes representation of the stormwater pipe network, whereas river flood modelling may not (not included in Nelson City's river flood models). Some problematic stormwater areas are identified in the Nelson Resource Management Plan (NRMP), using information that was current at the time the plan was developed in the 1990s. Council is currently working with consultants to map overland flowpaths for the Nelson urban area. However, it will likely be several years before this work is complete. Stormwater flooding can be linked to landslips that block overland flowpaths during high rainfall events, other blockages of drainage infrastructure (e.g. stormwater pipe network intakes), low points in the terrain from where there is insufficient drainage, and urban barriers to flow, e.g. fences, vegetation, walls etc;

d Other – including groundwater, tsunami and dambreak flood hazard (none of these included in PC29).

10 Flood overlays in the currently operative Nelson Resource Management Plan (NRMP) were based on much less flood information and data than we have available today. The NRMP overlays relating to flooding (Inundation Overlay, Floodpath Overlay, Flood Overlay, Floodway Overlay) were typically based on the experienced extents during historic flood events.

11 More recently, Council has developed a larger database of information relating to flood hazards, including:

a Observations made during historic flood events (news articles, photos, written observations), including feedback from community

b Flood complaints register;

c Surveyed flood levels immediately after flood events;

d Mapped flood damages;

e Mapped flood extents;

f Aerial photography;

g Rainfall, flow and level gauge data.

12 Council has used the available information to develop coastal, river and stormwater models. The coastal and river flood models have been updated over time to make best use of available modelling technologies, relevant datasets and climate projections. It is anticipated that these models will continue to be updated and refined as new datasets (e.g. LiDAR ground information, hydrological gauge information, flood observations, climate projection information) become available and as Council funding allows. The first generation of city-wide stormwater models are currently under development and not available for PC29.

13 Where sufficient data is available, these models are calibrated using historic storm events. They are then run with design rainfall and/or sea level conditions to produce flood hazard maps..

14 Ongoing modelling updates also allows the benefits of any new stormwater infrastructure to be reflected in the updated flood mapping as it is installed.

15 At each major model update, and prior to the release of this information to the public, Council has the modelling work peer-reviewed to provide additional confidence that the models make best use of available technologies and information.

16 The current flood models are summarised as follows:

Flood hazard type	Date	Summary
Coastal inundation	2022	Council has developed coastal inundation mapping for the city. The first version of these peer-reviewed maps were developed in 2019, based on available sea level, storm tide and wave climate information. Mapping across the city is based on a "bathtub" modelling approach that conservatively assumes that all land up to the design sea level is able to be inundated. In reality, this may not be possible due to overland flow constraints. Mapping delineates between 'connected' and 'non-connected' areas – i.e. connected areas that are exposed to the open coast via overland flow, and non-connected areas that are inland and low-lying, that could only experience coastal flooding via backflow through the stormwater (pipe) network. In addition to the bathtub modelling, a hydrodynamic model has been run for the Nelson CBD area. Council updated the bathtub modelling in June 2022 to incorporate newer sea level information and the 2021 LiDAR dataset across the city. In 2023/2024, Council is currently updating the coastal inundation assessment again to take into account updated sea level rise information, vertical land movement information (via the SeaRiseNZ project) and latest MfE guidance (Feb 2024). This information indicates about 0.4 m higher relative sea level rise by 2130 in the SSP5-8.5H+ scenario. This latest information will not be ready for PC29. The SSP5-8.5H+ inundation extent (as per bathtub modelling) is being used to set the extent of Plan Change 29.
River inundation	Various	River flood models have been developed, covering the major urban streams (except Saxton Creek, which is assumed to stay within channel banks in events up to the 2130 RCP8.5M 1% AEP, due to recent upgrade works). These models are MikeFlood coupled 1d/2d models that represent the main river channels and any outbreak flowpaths. Main culverts/bridges on the main streams are included. The models do not include the stormwater pipe network. The models all use NIWA HIRDS v4 rainfall data and have been run for events up to the 2130 RC8.5M 1% AEP event. Flood mapping is based on an envelope of critical storm durations across the floodplain. Based on joint probability work for Council by NIWA 2019, the design 1% AEP river flow events are combined with a mean higher high water (MHHW) tide level (an average over time of the higher of the two daily high tide levels). The models use LiDAR survey data (and in some cases, ground-surveys of river cross sections and structures). Depending on the age of the model, each model uses either 2015 or 2021

Flood hazard type	Date	Summary
		LiDAR data. Models are updated with latest LiDAR data at each major update in the modelling programme. The most recently updated model is the Jenkins/Arapiki/Poorman Valley Streams model. This was updated in 2023 to include 2021 LiDAR information. All other flood mapping is as was released to the public in 2017. Flow gauge data suitable for use in the calibration of models to recorded events is only available for the Orphanage Stream, Maitai River, Brook Stream, York Stream. Model parameters for other catchment models are inferred from these calibrated models. A large amount of flood observations and level survey was captured for the August 2022 event. Council is currently having this data used to refine the calibration of flood models as resources allow. This updated modelling is in progress and is therefore not available for PC29.
Stormwater inundation	Not yet complete	Council is currently developing detailed stormwater modelling and mapping for the Nelson urban areas. This includes the stormwater pipe network as well as overland flowpaths. It is anticipated that this modelling will cover the extent of the urban area, and be used to map stormwater flood hazard for planning and engineering purposes. This mapping will help to identify flooding issues caused by stormwater catchments between the main river catchments as captured by the river flood models. This modelling and mapping is in progress at the time of the hearing, and will be peer reviewed before being publicly released.

17 For river flood modelling, the models are run over a range of storm durations (typically three durations, e.g. 6-hour, 12-hour, 24-hour) to determine the rainfall condition that causes the worst flooding by depth and extent at each point in the floodplain.

18 Council has adopted a hazard classification to delineate flood hazard to either low or high flood hazard. Refer to the Section 32 report for details of the hazard classification.

19 As is standard practice throughout New Zealand, a minimum depth threshold is applied to mapping of river flooding. A 5 cm threshold has been adopted by Council for their PC29 “flood hazard” and “high flood hazard” overlays. This

means that only areas where flood depths exceed 5 cm are considered when mapping flood hazard.

20 The proposed PC29 includes six layers relating to flood hazard, bringing together layers from the previous NRMP, though with some modifications. Refer to the Section 32 report for more details on the six flood layers.

LOWER BROOK/WAIMARAMA STREAM FLOOD MAPPING (VARIOUS SUBMISSIONS)

21 A number of submitters have questioned the accuracy of the flood mapping in the lower Brook/Waimarama Stream, and asked Council to undertake further investigations into flood hazard in that area. The most comprehensive submission on this is S20.011 by submitter Mr. Tim Bayley.

22 In my evidence I will focus on addressing Mr. Tim Bayley's submission, as doing so will also address all related submissions.

23 Before addressing the submission as a whole, I respond to a specific question raised in the submission by Mr. Tim Bayley, relating to the assumed downstream (tailwater) condition. Specifically, whether the Brook Stream flood mapping is based on a high or low flood flow/level in the Maitai River. I confirm that the flood mapping is based on a high flow condition in both the Maitai River and Brook/Waimarama Stream. That is, the modelled rainfall event producing design flows in the Brook/Waimarama catchment is simultaneously applied to the Maitai, Brook/Waimarama and York/Wairepo catchments (spatially varying in accordance with HIRDS v4 rainfall contours). This produces runoff hydrographs in each major watercourse with approximately coincident peak flows.

24 In any real rainfall event, the relative magnitudes and timing of peak flows in the Brook/Waimarama Stream and Maitai River will likely be different to what has been modelled. Worst case 1% AEP flooding in the lower Brook/Waimarama Stream floodplain may be caused by:

a Extreme flows in the Maitai River and more moderate flows in the Brook/Waimarama Stream; or

b Extreme flows in Brook/Waimarama Stream and more moderate flows in the Maitai River; or

c An intermediate case.

A joint probability assessment would be needed to confirm the curve of combinations that all have a 1% AEP. While there is a reasonable data period for

Maitai River flows, the flow gauge on the Brook/Waimarama Stream is still too young to provide sufficient data for use in a joint probability assessment. In the meantime, a precautionary approach has been taken, assuming 1% AEP rainfall occurring simultaneously across these sub-catchments. The same approach has been taken for all major urban stream models.

25 In his submission, Mr. Bayley asserts that modelling under-represents lower Brook/Waimarama Stream flood hazard. A key basis for this assertion is his estimate of the channel flow capacity in the lower Brook Stream, specifically through the Domett Street bridge at the confluence with the Maitai River. His capacity assessment is based on an assumed flow velocity of about 1 m/s. I agree with Mr. Bayley's assertion that flow velocities in this part of the channel are dependent on available cross-sectional flow area, which in turn is largely governed by the Domett Street bridge opening dimensions and the Maitai River water level. Modelling indicates that at the peak of the design 1% AEP flow event, and accounting for high tailwater conditions (water level) in the Maitai River, flow velocity is likely to be much higher than 1 m/s, in the order of 3-4 m/s. I have cross-checked this modelled flow velocity using a second 2d model (developed using TUFLOW software) based on similar flows in the Brook/Waimarama Stream and Maitai River. Unlike a 1d flood model, a 2d flood model explicitly allows for the 2d interaction of flows at the confluence, including eddy effects, superelevation at bends, and bend losses. The 2d model confirms that peak flow velocities are likely in the order of 3-4 m/s, and therefore that the flow capacity at the Domett Street bridge is likely greater than Mr. Bayley assumes.

26 Mr. Bayley refers to a flood assessment report prepared by T+T in 2023 for Kāinga Ora, for their resource consent application to develop a property at 107 Nile Street. He notes that the modelled flooding presented in that report is significantly different (more extensive out-of-channel flooding in the lower Brook/Waimarama floodplain) than what has been used for the PC29 flood overlay.

27 I consider it inappropriate to compare the flood mapping used to set minimum development levels for a specific property, with the flood mapping prepared by Council to identify potential flooding issues at a catchment scale. A site-specific flooding assessment may include more detailed survey and local features not

able to be represented in a larger model and may also adopt a more risk-averse approach to setting development levels (e.g. allowances for culvert blockage).

28 However, I concur with Mr. Bayley and other submitters that the lower Brook/Waimarama Stream is an area where ongoing refinement to the model is necessary as information becomes available. Council is currently using updated flow gauge rating information, together with observations and survey information captured from the August 2022 event to refine the calibration of the model to observed flooding. This work will also include refinement of the representation of the Nile/Tasman Street culvert. This work is currently underway and will then need to be peer reviewed. It is not available for PC29.

WATER SENSITIVE DESIGN ('SPONGE CITIES' – VARIOUS SUBMISSIONS)

29 Numerous submissions requested that Council establishes "sponge city" principles in its city planning and engineering framework. A number of these submissions refer to the report titled "Sponge Cities" by Kali Mercier, dated August 2023. This report defines the aim of the sponge city approach as being *"to protect, enhance and sustainably manage water resources in urban environments by slowing the passage of stormwater…..This can include building or restoring urban wetlands, 'daylighting' streams and creating space for urban waterways to flood safely…".* The approach is often discussed in the context of climate adaptation for existing built environments.

30 The report notes "the techniques themselves are not new" but rather that "a gradual evolution in thought in stormwater management has taken place in many countries", including New Zealand, where the concepts have been more commonly referred to as Water Sensitive Urban Design or simply Water Sensitive Design (for example, in the Nelson Tasman Land Development Manual 2020).

31 I strongly agree with submitters that an approach to stormwater management that seeks to minimise the interruption of the hydrological cycle by minimising impervious coverage and creating room for "blue-green infrastructure" (e.g. wetlands, ponds, parks) that mimic natural water processes better than a highly impervious/modified urban environment is highly preferable to an approach that relies heavily on engineered channels and flowpaths. Importantly, this approach is also more likely to respect the mauri of water and enhance te mana o te wai outcomes.

32 I note that the intensification within the central city proposed by PC29 aligns with a key recommendation of the 2023 Sponge Cities report to "encourage 'upwards' development in preference to 'outwards' sprawl and 'infilling' back yards, to leave more green space available to absorb water". However, as the report notes, intensification needs to be coupled with "clear guidance on how to address conflict between housing needs, and the need to provide green spaces".

33 I also note that as outlined in the Section 42A report (para 107), PC29 "includes requirements for a minimum permeable landscape area" and "other provisions…aimed at enabling and encouraging sustainable design outcomes". I support these approaches.

34 Water sensitive design principles are already required for new development in the Nelson Tasman Land Development Manual 2020 (refer Section 5.3.2). Council is currently developing stormwater strategies for the city (including a stormwater quality strategy) that seek to address existing and future stormwater hazards. I agree with submitters and the 2023 Sponge Cities report that water sensitive design principles will become increasingly important for Nelson, both in reducing the impacts of intense rainfall and giving effect to te mana o te wai principles.

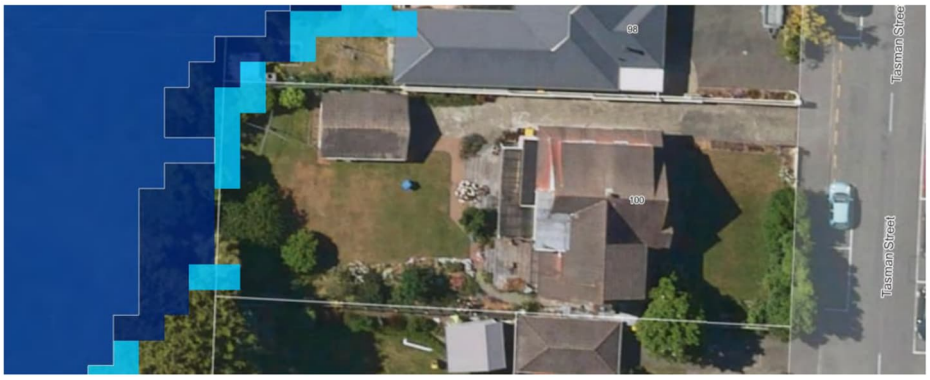
100 TASMAN STREET (S751)

35 GC and LG Pettersson's submissions relates to the mapping of flood hazard on their property at 100 Tasman Street. The mapped flooding very slightly clips the back (western) boundary of their property. The Petterssons note that their property is retained along this boundary by an approximately 1.1 to 1.3 m high retaining wall, with property levels well-elevated above the levels in the Queens Gardens on the other side of their property boundary.

36 Council's Stormwater and Flooding Activity Manager (Toby Kay) and I met on site with Mr. G Pettersson on 7 May 2024. We discussed the submission and made measurements of the existing retaining wall.

37 Having visited the site, it is my opinion that the property is sufficiently elevated to avoid being subject to river flood inundation from the west. As pointed out in the submission, the encroachment of the flood overlay onto the property is due to the resolution of the model results and there is a sound basis for removing the flood hazard overlay from this property. This would best be achieved by

clipping the PC29 Flood Hazard Overlay and PC29 High Flood Hazard Overlay at the property boundary.



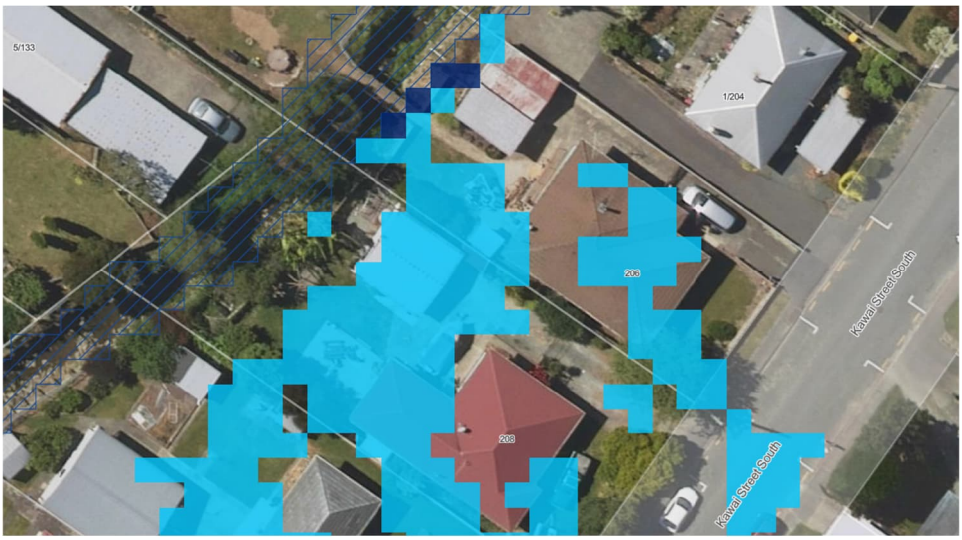
206 KAWAI STREET (S361)

38 Mr. Mike Scott, owner/resident at 206 Kawai Street accepts that his property is subject to flooding but has submitted that the mapped flowpath through his property is not accurate. Specifically, that rather than flowing across the grass berm on the street front and into/under his house, overland flows flow down his driveway during extreme events.

39 Council's Stormwater and Flooding Activity Manager (Toby Kay) and I met on site with Mr. M. Scott on 7 May 2024. Based on observations made on site, and photographs from the 2014 flood event in this area, I believe the recent work carried out by Mr. Scott to raise the grass berm will likely cause flows to preferentially flow down his driveway, such that the mapped flowpath may differ from the actual flowpath.

40 This may be addressed when Council next updates the flood model with newer LiDAR data (current modelling in this area is based on 2015 LiDAR data). Due to advances in modelling technology (hardware and software) since the last model version, it may also be possible to increase the resolution of the modelling across the floodplain, allowing better delineation of these kinds of flowpaths.

41 I note that this would not likely remove the property from the modelled floodplain. Therefore, it is my opinion that bringing a model update sooner in Council's modelling programme to address this property-specific issue is not warranted.



MANUKA STREET HOSPITAL (S881)

42 The Manuka Street Hospital (MSH) submission opposes the flood hazard overlay on their site at 36 Manuka Street. According to the submission, the site was redeveloped in 2017, at which time the site was not assessed as being subject to flood hazard.

43 I note that the original Maitai River flood modelling, completed in 2013, did not represent flooding in the Brook/Waimarama Stream valley/floodplain. The Brook/Waimarama Stream (and York/Wairepo Stream) floodplains were added when the model was updated in 2017. Thus, it may not have been available at the time that the MSH redevelopment was consented.

44 Council's current flood mapping shows both low and high flood hazard affecting a majority of the site during a 2130 1% AEP flood event. Flows are expected to break out of the Brook/Waimarama Stream at Bronte Street, and track through residential property north, eventually flowing through the MSH property before re-entering the Brook/Waimarama Stream before Nile Street.

45 While the current mapping is based on a ground surface that pre-dates the redeveloped/current ground surface, I expect that changes of ground levels at the site may reduce flood depths but not eliminate the presence of both low and high flood hazard zones within the site.

46 During the August 2022 flood event, the Brook/Waimarama Stream came within 30 cm of overtopping the channel bank at the Bronte Street footbridge. The peak flow rate during this event was likely less than half the 2130 1% AEP flow,

and thus the August 2022 flood observations support the model's predicted outbreak at this location.

47 All else being equal, I would expect modelled flood depths to reduce at the site due to the increase in ground levels that formed part of the 2017 site redevelopment, when Council next updates the flood model in this area. However, it is likely that the site would remain at risk of flooding. In my opinion, it would inappropriate to lift the flood hazard overlay from the MSH site at 36 Manuka Street.

2 LITTLE TODD VALLEY ROAD (S949)

48 Mr. Drew Hayes, owner/resident at 2 Little Todd Valley Road has requested that Council removes the Flood Overlay (currently proposed for PC29) from private property along the lower part of Little Todd Valley Road. This is requested on the basis that the extent of the overlay is as per the previous NRMP Flood Overlay and likely to be out of date with respect to current ground levels and flowpaths. Mr. Hayes contends that the original NRMP Flood Overlay on Little Todd Valley Road was based on an historic flood event that pre-dates the more recent reconstruction of the road carriageway (seal, kerb and channel, footpath), and that the current road corridor has greater flow capacity than the previous carriageway.

49 Council's Stormwater and Flooding Activity Manager (Toby Kay) and I met on site with Mr. D. Hayes on 7 May 2024, to gain an understanding of local flowpaths, including those observed during the August 2022 event.

50 I note that the current river flood model does not show flooding along Little Todd Valley Road properties, and thus the "Flood Hazard Overlay" and "High Flood Hazard Overlay" layers are currently not present at the site. However, I also note that the river flood mapping in this area is likely to change when the model is next updated with the latest data and information. In particular, there are under-sized culverts in the Little Todd Valley sub-catchment that are not currently represented in the model. These will be added when the model is next updated, and I consider it likely that the Little Todd Valley Road overland flowpath will be present in updated flood modelling.

51 I also note that during August 2022, an overland flowpath not dissimilar to the one shown on the NRMP Flood Overlay layer was observed down Little Todd Valley Road. As shown on the photos below (photos courtesy Nelson Tasman

Emergency Management) and confirmed with Mr. Hayes during our site visit, significant flows were experienced down Little Todd Valley Road during the August 2022 event. A significant amount of gravel was deposited along the road carriageway during the event. Flow direction on Little Todd Valley Road is shown with blue arrows.





52 Mr. Hayes noted that during this event flood flows just started overtopping the footpath into his driveway, and that flood levels on the road at his property may have been elevated due to the deposition of gravels along Little Todd Valley Stream.

53 Based on observations in other parts of Nelson during the August 2022 storm, it is likely that the storm was less than a present-day 1% AEP event in this area. We can expect that based on existing stormwater infrastructure, flows down Little Todd Valley Road to be significantly greater during a 2130 1% AEP rainfall event. This is the event used for river flood hazard mapping. Therefore, I consider it appropriate to retain the NRMP Flood Overlay at this point in time. The overlay should be reviewed when updated river flood modelling is available.



Damian Nathan Velluppillai
21 June 2024

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