**BEFORE HEARING COMMISSIONERS**
**FOR THE PALMERSTON NORTH CITY COUNCIL**

**I MUA NGĀ KAIKŌMIHANA WHAKAWĀ**
**MO TE KAUNIHERA O PAPAIOEA**

| | |
|---|---|
| **IN THE MATTER** | of the Resource Management Act 1991 |
| **AND** | |
| **IN THE MATTER** | of proposed Plan Change I: Increasing Housing Supply and Choice to the Palmerston North District Plan |

# SECTION 42A TECHNICAL REPORT OF DAVID WATSON ON BEHALF OF PALMERSTON NORTH CITY COUNCIL

## CLIMATE CHANGE

Dated 25 July 2025

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## A. EXECUTIVE SUMMARY

1. The key conclusions of my s 42A technical report are:

   a. Compared to more traditional detached development, multi-unit housing typologies within the city produce fewer greenhouse gas emissions over their lifespan. Therefore, additional provisions to require emissions reductions are not necessary and if they deter increased housing density may be counter-productive.

   b. The inclusion of a 'worst case' scenario (namely SSP5-8.5) is reasonable when assessing higher risk sites within the Stormwater Overlay but is not necessary as the basis for minimum planning provisions.

   c. The objectives of MRZ-S6 – Shading (i.e. the reduction in 'Urban Heat Island Effect' impacts associated with longer hot periods due to climate change) are sound, but could be delivered by a simpler, clearer and more easily enforceable mechanism, e.g. remove MRZ-S6 and amend MRZ-S5 action 3. to provide the same outcome.

## B. INTRODUCTION

2. My name is David Watson.

3. I hold a Batchelors Degree in Science in Biology and have worked in ecology and environmental disciplines since 2006, primarily as an ecologist in the UK. I have worked in the Palmerston North City Council's ("**the Council**") Climate Change team since 2022 as Climate Change Analyst and Senior Climate Change Advisor.

4. I have been involved in Plan Change I ("**PC:I**") since March 2024 and wrote the Climate Change Technical Report, which formed part of the evidence base for the PC:I s 32 evaluation report and preparation of the notified plan change provisions.

## C. CODE OF CONDUCT

5. I confirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2023. I confirm that I

have stated the reasons for my opinions in this report and have considered all the material facts that might alter or detract from those opinions.

6. Statements expressed in this report are within the scope of my expertise.

7. I have all the information necessary to assess the application within the scope of my expertise and am unaware of any gaps in the information or my knowledge.

## D. SCOPE

8. My s 42A report addresses submissions relating to the selection and use of climate change scenarios, notably the inclusion of a high emissions climate scenario (SSP5-RCP8.5), and the proposed shade provisions set out in Standard MRZ-S6.

9. In preparing this report, I have reviewed the National Adaptation Plan ("**NAP**")[1] and the Ministry for the Environment document "Climate change and local government: What the national adaptation plan means for you".[2]

10. I have reviewed the following submissions:

| Submission Reference | Submitter | Relevance |
|---|---|---|
| SO48.2 | Samuel Hill | Emissions reduction |
| SO48.3 | | |
| SO48.2 | Samuel Hill | Urban Heat Island Effect |
| SO48.3 | | |
| SO137.18 | Rangitāne o Manawatū | Emissions reduction |
| SO137.20 | | Vegetative cooling |
| SO137.29 | | |
| SO137.3 | | Emissions reduction |
| SO137.3 | | Vegetative cooling |
| SO166.28 | Palmerston North City Council | MRZ- S6 Shading |
| SO170.6 | Leith Consulting | MRZ- S6 Shading |
| SO184.48 | Chris Teo-Sherrell | MRZ- S6 Shading |
| SO185.38 | Phocus Planning | MRZ- S6 Shading |
| SO185.50 | Phocus Planning | MRZ- S6 Shading |
| SO194.44 | Horizons Regional Council | Climate scenarios |
| SO199.35 | Kāinga Ora | MRZ- S6 Shading |

1 Ministry for the Environment *Aotearoa New Zealand's first national adaptation plan* (ME 1660, 3 August 2022).

2 Ministry for the Environment *Climate change and local government: what the national adaptation plan means for you* (INFO 1080, 3 August 2022).

| Submission Reference | Submitter | Relevance |
|---|---|---|
| SO210.14 | Natural Hazards Commission Toka Tū Ake | Climate scenarios |

11. My evidence addresses the choice of climate scenario used to inform PC:I, which influences the scale of environmental hazards considered in the plan change. However, submissions that relate to changes in stormwater intensity and likelihood of flooding due to climate change are addressed in the evidence of Ms Mary Wood.

## E. RESPONSE TO SUBMISSIONS

12. In considering the relevant submissions and further submissions for PC:I, I have identified three themes related to my expertise, which I address in detail below:

    a. Whether PC:I should require a reduction of greenhouse gas emissions from development;

13. Whether PC:I is underpinned by and uses the most appropriate climate change scenarios; and

    a. How should residential intensification seek to provide resilience to increases in urban heat accumulation.

*Submission Theme A – Impacts on Greenhouse Gas Emissions*

14. The submissions that request that new developments progressed under PC:I be required to reduce, minimise or offset greenhouse gas emissions need to be considered in context. Section 4 of the PC:I Climate Change Assessment details the differences in embedded and operational emissions between detached, semi-detached and multi-unit developments, such as townhouses or apartments.[3]

15. Using the representative values from the research quoted in the technical report, the relative emissions outcomes of detached housing versus multi-unit housing are:

[3] plan-change-i-climate-change-report.pdf.

16. Materials used to construct detached dwellings contain approximately 66.6 tons of carbon dioxide equivalent gases (tCO2e).[4] The dwellings then use approximately 0.7 tCO2e per year resulting in 63.7 tCO2e over a 90-year lifespan. Total emissions for such a dwelling would therefore be 130.3 tCO2e plus the behavioural emissions such as transport that would vary depending on location and access to amenities such as public transport routes; and

    a. Materials used to construct 'townhouse' style dwellings contain approximately 31.6 tCO2e. The dwellings then use approximately 0.3 tCO2e per year resulting in 29.3 tCO2e over a 90-year lifespan. Total emissions for such a dwelling would therefore be 60.9 tCO2e plus the behavioural emissions such as transport, although access to public transport routes and travel distances would likely be shorter in most cases due to the location of the Medium Density Residential Zone ("**MRZ**").

17. As can be seen, from an emissions reduction perspective multi-unit development is preferable, even in the absence of specific emissions reduction measures.

18. While I understand the intent behind these submissions, a requirement for a developer to demonstrate how they reduce, minimise or offset greenhouse gas emissions would inevitably require the developer to incur the additional cost of preparing the requisite reporting.

19. Given the likely emissions reduction from denser development typologies and the likely non-negligible cost of greenhouse gas reporting, additional requirements to further reduce or eliminate emissions may in effect deter multi-unit development in favour of cheaper, traditional development, resulting in a worse outcome overall.

20. In my view, any rules or restrictions set out in the district plan should err on the side of encouraging (and not introducing additional barriers to the development of) multi-unit development to realise aggregate emissions savings.

21. Accordingly, I consider that additional provisions to require emissions reductions are not necessary and may be counterproductive.

[4] Tons of emissions measured in CO2 equivalent taking account of the relative warming potential of different gases.

22. PC:I includes objectives, standards and rules requiring 'resilience to', 'allowance for', 'adaptation to' or 'consideration of', the likely effects and consequences of climate change. It is therefore important that the plan change includes a clear indication of how these consequences will be modelled and modelling results so that appropriate guidance and minimum specifications can be developed based on the best available information.[5]

23. The best available information is in future climate scenarios published by the Intergovernmental Panel on Climate Change ("**IPCC**") and downscaled for New Zealand by the National Institute of Water and Atmospheric Research ("**NIWA**"). The scenarios outline possible outcomes of climate change, based on a set of assumptions about the effect of the concentration of greenhouse gas in the atmosphere (Representative Concentration Pathways - RCPs) and the economic and political response to climate change as an issue (Shared Socioeconomic Pathways - SSPs) among other things. More detail is provided in **Appendix 1**.

24. The 5th International Panel on Climate Change Annual Report (AR5 - 2014) includes RCP4.5, RCP6.5 and RCP8.5 (amongst others) as a basis for its projections. The 6th Annual Report (AR6 - 2024) replaces these with SSP2-4.5, SSP3-7.0 and SSP5-8.5. The NAP therefore requires the use of AR6 data where it's available and AR5 data where AR6 is not available.

25. The NAP provides guidance about the appropriate climate change standards to use, stating:[6]

> When making or changing policy statements or plans under the RMA … councils should use the recommended climate change scenarios outlined below, as a minimum:
>
> - for detailed hazard and risk assessments in coastal and non-coastal areas, use both the middle-of-the-road scenario (SSP2-4.5) and the fossil fuel intensive development scenario (SSP5-8.5) where available, RCP4.5 and RCP8.5, to 2130, for areas at high risk of being affected,

[5] This information would also ideally be updated annually as new data is published, however, this may be more frequent than is practicable given the RMA requirements for plan changes.

[6] At Chapter 4.

adding the relevant rate of vertical land movement locally. Where SSP2-4.5 and SSP5-8.5 are not available, use RCP4.5 and RCP8.5 to 2130, adding the relevant rate of vertical land movement locally

- for all other climate hazards and risks, use the most recent downscaled climate projections for Aotearoa.

26. I take from this that SSP2-4.5 and SSP5-8.5 are to be used as reference scenarios for "risk assessment" in "areas at high risk of being affected". This would provide two values for issues such as likely flood depth from a particular rainfall event (e.g. days with over 25mm of rain or High Intensity Rainfall Design System ("**HIRDS**") values). In order to specify requirements for measures such as minimum floor heights a single value is needed to avoid confusion.

27. As a further complication AR6 data and the subsequent NZ specific data from NIWA was only released in the middle of this plan change process (after the flood modelling had been completed) which is why two sets of data were presented in the Climate Change Technical Report.

28. The updated AR6 data was released online on 18th September 2024 and included SSP1-2.6, SSP2-4.5 and SSP3-7.0 only. A further update was released on 17th February 2025 that included SSP5-8.5.

29. The impacts of the two reference scenarios, i.e. RCP4.5/SSP2-4.5 and RCP8.5/SSP5-8.5, vary over the presumed 90-year lifespan of a building in the following ways (values in brackets indicate the range of possible results from different models):

| | Palmerston North (AR6) | | Manawatu (AR5)[7] | | |
|---|---|---|---|---|---|
| **Climate Variable (MfE Summary Dashboard)** | **2080-2099 (SSP2-4.5)** | **2080-2099 (SSP3-7.0)** | **2080-2099 (RCP4.5)** | **2080-2099 (RCP6.0)** | **2080-2099 (RCP8.5)** |
| Average Temperature | +2.0°C | +3.0°C | +1.4◦C<br>(+0.9 to +2.1) | +1.8◦C<br>(+1.1 to +2.9) | +3.1◦C<br>(+2.2 to +4.4) |
| Average number of days per year over 25°C | +30.7 days<br>(14.2 to 36.4) | +55.2 days<br>(32.6 to 62.2) | +36.7 | +44.2 | +65.5 |
| Annual precipitation (%) | -0.8%<br>(-1.7 to +0.3) | -4.2%<br>(-3.3 to -5.5) | +1%<br>(-5 to +11) | +4%<br>(-12 to +30) | +2%<br>(-11 to +10) |
| Average number of days per year with over 25mm of rain (base 13.8) | +0.9 days<br>(+0.7 to +1.1) | +1.1 days<br>(+0.8 to +1.3) | Not tabulated directly; using AR5 extreme-rainfall scaling (≈ 8 % intensity rise °C-¹ ➜ +1.4 - 2.8 more very rainy days at RCP4.5–8.5) | | |
| Expected rainfall intensity for a 1 in 10 year event lasting 1 hour (mm/m2) [8] | n/a | n/a | 27.2 | 28.1 | 31.0 |

[7] Climate-change-projections-2nd-edition-final.pdf.
[8] High Intensity Rainfall System.

30. I understand that the modelling underpinning the Stormwater Servicing Assessment was undertaking using RCP 6.0. Section 2.3.1 of the Stormwater Servicing Assessment references a sensitivity check that was carried out by Tonkin & Taylor by modelling the RCP 4.5 and RCP 8.5 climate change scenarios for the 50- and 100-year Average Recurrence Interval ("**ARI**") rainfall events. Due to the relatively flat nature of Palmerston North, increases in rainfall in major, infrequent events, have minimal effect as the rainfall is spread across a wider area than is already predicted to be inundated. The depth difference between the different climate change scenarios is comparatively minor, and therefore I consider the standard of using RCP 6.0 for design is acceptable.

31. I therefore determined in the Climate Change Technical Report that assessment against SSP5-8.5 was not necessary for determining rules for all new developments within the MRZ, but that it may form part of a risk assessment for sites identified as high risk and in need of a site-specific assessment due to falling within the Stormwater Overlay.

32. Accordingly, I consider that additional provisions to require the assessment of RCP8.5 are not necessary. However, these should be included in subsequent specific guidance and may be relevant to determination of site-specific requirements.

*Submission Theme C – Urban Heat and Shading*

33. Climate projections indicate increased air temperature and an increase in the number of hot and very hot days under all climate scenarios. As demonstrated in the s 32 report, urban environments accumulate heat over time leading to the Urban Heat Island effect with consequences for public health, infrastructure and energy use. Submissions sought a variety of remedies, from increased requirements for shade tree planting to removal of shade provisions as permeable paving and landscaping was thought to provide sufficient resilience to heating. It is therefore necessary to determine what scale of response would be sufficient to mitigate temperature accumulation during the hottest parts of the year as a basis for developing provisions.

34. To more fully explore the basis of SO166.28, research has shown that fully permeable road pavement loses accumulated heat faster than semi-

permeable or solid road pavement.[9] This will help reduce heat accumulation, particularly overnight. The study did not test whether this loss effect reduced temperatures enough to prevent cumulative heating overall in urban settings. Novel designs such as capillary columns and permeable interlocking paving also show reductions in cumulative heating but are not mentioned in MRZ-S9 and would likely be over and above the required minimum standard. Even if the conclusion of the research applies equally to urban environments, paving still heats up significantly more than vegetation during the day and this will require additional mitigation. Removal of MRZ-S6 on the basis of permeability alone is therefore not a viable mitigation option.

35. The most likely source of permeability (under MRZ-S9) and landscaping (under MRZ-S5) is grass lawns. Landscaping, especially grass, has also been subject to academic studies. Park et al (2021) (as referenced in the Climate Change Assessment Report) shows that unshaded areas, including permeable surfaces such as grass, are positively correlated with land surface temperature (i.e. warmer) whilst shaded surfaces, including roading, were negatively correlated (i.e. cooler). Shading different surfaces provides different levels of cooling, with grass and other vegetation reducing heating the most (-0.016°C/m$^2$), facades and rooftops about half as much (-0.008°C/m$^2$) and paving approximately one quarter of the cooling (-0.004°C/m$^2$).

36. Using the above cooling rates and projected increase in average air temperature under SSP2-4.5 as a guide, additional heating from climate change could be effectively mitigated by 28% shading by 2055 and 54% by 2105 (see **Appendix 2**). This would effectively mitigate all additional warming on site and could be supported by surrounding off-site vegetation with cumulative cooling from shade in neighbouring properties or from street trees. In addition, for much of the year the building itself casts some shade, especially multi storey developments, but critically this reduces at the hottest part of the year and the hottest part of the day. It is also notable that where shade is provided by trees evapotranspiration reduces air temperature more than equivalent non-vegetation shading for the same coverage. This is not easily quantified without site specific information.

[9] Ching-Che Yang and others *A Study on Heat Storage and Dissipation Efficiency at Permeable Road Pavements* (Materials, *14*(12), 3431, 21 June 2021).

37. This study demonstrates the value of shading to mitigating heating and ensuring built up areas are resilient to the urban heat island effect. Accordingly, I consider that the outcomes of provision MRZ-S6 are needed and the 15% shading requirement will provide minimum levels of mitigation to reduce the likely cumulative impacts of climate change on urban surface heating and provide resilience. Any alteration to, or removal of, this provision would need to replicate these outcomes elsewhere.

38. One option for replicating these outcomes would be to alter provision 3 of MRZ-S5 to require the mandatory new tree to be at least 4m high and 5m wide (2.5m radius to the drip line). This would provide an area of shade approximately 15m$^2$ per unit at year 4 that would grow over time as the climate changes, ideally reaching 25m$^2$ (7.95m wide) by 2090. If the tree is deciduous, it will also allow solar heating during colder parts of the year, reducing energy demands for heating. The matters of discretion wording from MRZ-S6 would be retained under MRZ-S5.

**25 July 2025**

**David Watson**

**APPENDICES**

**APPENDIX 1: FUTURE CLIMATE SCENARIOS**

1. The IPCC Sixth Assessment Report (AR6) published in 2024 summarises the state of knowledge of climate change, its widespread impacts and risks, and climate change mitigation and adaptation, based on the peer-reviewed scientific, technical and socio-economic literature since the publication of the IPCC's Fifth Assessment Report (AR5) in 2014.

2. Unlike AR5, which projected possible futures based on atmospheric carbon concentrations (Representative Concentration Pathways ("**RCPs**")), AR6 relies on Shared Socioeconomic Pathways ("**SSPs**") to produce narratives that originate from a wide array of socioeconomic drivers.

3. The five published SSPs follow concise "storyline" summaries used by IPCC AR6; adapted from Riahi et al., 2017 and reproduced by the New Zealand Ministry for the Environment:

    a. SSP1 – Sustainability ("Taking the Green Road")

        (i) The world pivots to inclusive, environmentally bounded growth: better education and health accelerate the demographic transition; stewardship of global commons improves; material consumption and energy intensity fall; inequality narrows. → low challenges to both mitigation and adaptation.

    b. SSP2 – Middle-of-the-Road

        (i) Socio-economic and technological trends largely mirror recent decades. Progress toward the Sustainable Development Goals is uneven; population growth levels off after mid-century; resource and energy efficiency improves only gradually. → moderate challenges to mitigation and adaptation.

    c. SSP3 – Regional Rivalry ("A Rocky Road")

        (i) Resurgent nationalism and security concerns foster regional fragmentation. Investment in education and technology stalls; economic growth is sluggish and material-intensive; population rises fastest in developing regions; environmental degradation

accelerates. → very high challenges to both mitigation and adaptation.

d. SSP4 – Inequality ("A Road Divided")

(i) A sharply unequal world emerges: a connected, high-tech global elite co-exists with a large, poor majority. Social cohesion erodes; conflict is more common; environmental policies focus on affluent regions. → high adaptation challenges for vulnerable groups; moderate mitigation challenge overall.

e. SSP5 – Fossil-fuelled Development ("Taking the Highway")

(i) Rapid, market-driven growth is powered by abundant fossil fuels and energy-intensive lifestyles. Strong investment in human capital and institutions boosts adaptive capacity, while local pollution is managed technologically. → low adaptation but very high mitigation challenge due to soaring emissions.

4. These SSPs seek to describe the state of the world and the likely atmospheric carbon concentration that would result. This leads to SSP-RCP pairs that present a possible 'how the world develops' and a resulting 'what happens to the atmosphere'. While some of the AR6 SSP-RCP based scenarios and AR5 RCP based scenarios reach the same warming by 2100 (e.g. SSP2-4.5 and RCP4.5), the greenhouse gas concentration pathways taken to reach that end point are not necessarily the same. In addition to this the level of uncertainty for future climate projections 100 years into the future varies considerably, making the range of possible outcomes under each scenario very broad.

5. In September 2024 NIWA published downscaled (5km grid square resolution) climate projections for New Zealand. This included SSP1-2.6, SSP2-4.5, and SSP3-7.0 only – the report notes that "an additional project at NIWA is underway to downscale SSP5-8.5". This additional update was published in February 2025.

**APPENDIX 2: WORKED EXAMPLE OF MINIMUM SHADE PROVISION**

1. MRZ-S4 requires the buildings to occupy at most 50% of the site. MRZ-S7 requires a minimum 30m$^2$ of outdoor living space. MRZ-S5 requires 20% of the site to be landscaped. Assuming these two outdoor areas are the same area a minimum site would be 50% building, 30% driveway(presumably concrete) and 20% grass.

2. Assuming a 200m$^2$ site with 100m$^2$ of roof and another 100m$^2$ of building facades, 40m$^2$ of landscaping and 60m$^2$ of other non-building space (presumed to be concrete driveway) we can calculate the shade coverage required to offset predicted heating increases resulting from climate change. Using values from Park et al 40m$^2$ of shaded grass provides 0.64$^o$C of net cooling with a further 0.36$^o$C achievable through shading 45m$^2$ of building façade or concrete driveway. This is sufficient to offset the projected 1.1$^o$C of warming by 2050 under SSP2-4.5.

3. As temperatures continue to increase over time a further 78m$^2$ of concrete façade and roof will require shading to offset the projected 1.6$^o$C of warming by 2090.

4. The predicted increase in ambient temperature provided by SSP2-4.5 could therefore be offset by 85m$^2$ of shading by 2050 growing to 163m$^2$ of shading by 2090. This equates to between 28.3% and 54% of the site. This % increases for smaller sites and decreases for larger sites or sites with more grass coverage.

*Notes and Caveats*

5. The assumption of 30% of the site being devoted to concrete driveway is a conservative estimate. MRz-S10 may in practice reduce this % in favour of grass most cases.

6. This calculation does not consider shading from the building itself, so assumes sun is coming from directly overhead. The shading of façades is used as a proxy for this effect.

7. Shading the façade does not directly translate to site area (as it is a vertical surface) so direct translation of shaded area to % of the site area is non-linear. Taller buildings or buildings with more complex typologies will present different roof and façade ratios.