BEFORE INDEPENDENT HEARING COMMISSIONERS IN CHRISTCHURCH

TE MAHERE Ā-ROHE I TŪTOHUA MŌ TE TĀONE O ŌTAUTAHI

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of the hearing of submissions on Plan Change 14 (Housing and Business Choice) to the Christchurch District Plan

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STATEMENT OF PRIMARY EVIDENCE OF JUSTIN MORGENROTH ON BEHALF OF CHRISTCHURCH CITY COUNCIL

TREE CANOPY COVER AND FINANCIAL CONTRIBUTIONS

Dated: 11 August 2023

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EXECUTIVE SUMMARY

1. My full name is **Justin Morgenroth**. I am employed as an Associate Professor in forestry at the University of Canterbury.

2. I have prepared this statement of evidence on behalf of the Christchurch City Council (the **Council**) in respect of matters related to tree canopy cover and financial contributions (**FC**) provisions arising from the submissions and further submissions on Plan Change 14 to the Christchurch District Plan (the **District Plan**; **PC14**).

3. I have previously prepared a research report[1] (**my report**) outlining the benefits of urban tree canopy cover in terms of ecosystem services that urban trees provide. My report was prepared to assist with the Section 32 assessment[2] of the proposed tree canopy/FC provisions in PC14 which, as explained in the section 42A report of **Anita Hansbury**, propose a requirement for provision of 20% canopy cover on residential development sites and 15% canopy cover in new road corridors (or the provision of an equivalent financial contribution).

4. In my report I concluded that carbon storage and sequestration, stormwater runoff attenuation, and urban heat island mitigation are all related to urban forest canopy cover. Simply put, more trees or tree cover, in clusters, with greater total biomass, will improve carbon storage and sequestration, stormwater runoff attenuation, and urban heat island mitigation. In contrast, development intensity and impermeable surfaces (buildings and/or pavements), which are associated with reduced tree cover, threaten the provision of carbon storage and sequestration, stormwater runoff attenuation, and urban heat island mitigation by trees.

5. I have assessed the submissions received relating to issues of urban tree canopy cover in terms of the extent of that cover and the ecosystem services they provide. The relevant submissions provide a range of viewpoints. The majority were in support of the proposal[3]. Some suggested amendments, including:

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[1] *Research Report: Urban trees and their ecosystem services.* Appendix 1 to the Financial Contributions and Tree Canopy Cover section 32 report: https://ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Plans/district-plan/Proposed-changes/2023/PC14/Section-32-Appendices-1/PC14-Financial-Contributions-Appendix-1-J-Morgenroth-Urban-trees-and-their-ecosystem-services-Report-FINAL.pdf

[2] https://ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Plans/district-plan/Proposed-changes/2023/PC14/Section-32/Plan-Change-14-HBC-NOTIFICATION-Section-32-Tree-canopy-Financial-Contributions-with-no-appendices.pdf

[3] I refer to the section 42A report of Anita Hansbury which outlines the exact numbers of submissions in support or partial support.

(a) increasing or reducing the canopy cover threshold,

(b) changing the way that canopy cover is measured,

(c) including other forms of green infrastructure (e.g., green roof/walls) in tree cover measurement,

(d) providing financial incentives for meeting canopy cover requirements,

(e) prioritising native species and increasing the diversity trees.

6. In my view, the 20% threshold for canopy cover is appropriate. It offsets some of the impacts of development, by providing carbon storage and sequestration, stormwater runoff attenuation, and urban heat island mitigation. That threshold is also consistent with the targets in the recently adopted Urban Forest Plan.

7. The other forms of green infrastructure (e.g., green roofs/walls) proposed by some submitters have merit in specific densely developed scenarios, but they do not provide the scale of benefits that trees do and should not be considered as equivalent to canopy cover.

8. While primarily a matter for Ms Hansbury, I consider that requiring financial contributions where the full tree canopy cover requirements cannot be met will help ensure tree canopy cover and associated benefits for residents are provided in the relatively high density residential areas enabled by PC14.

9. Finally, the use of incentives alongside other tools to retain trees on private residential land has merit. Whether, and how, such incentives might be provided is a matter for the Council and others to consider.

INTRODUCTION

10. My name is **Justin Morgenroth**, I am an Associate Professor at the University of Canterbury (2011 – present).

11. In preparing this evidence I have:

(a) Reviewed the PC14 proposal on tree canopy cover and FCs, the related section 32 assessment[4]. and the relevant submissions (as

[4] Section 32 Part 7 – Tree canopy cover – Financial contributions - https://www.ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Plans/district-plan/Proposed-changes/2023/PC14/Section-32/Plan-Change-14-HBC-NOTIFICATION-Section-32-Tree-canopy-Financial-Contributions-with-no-appendices.pdf

alluded to above). I have also reviewed the now adopted Urban Forest Plan.

(b) Read the draft section 42A report of **Anita Hansbury** on PC14 which deals with the planning aspects of tree canopy cover and FCs, and the related submissions.

12. I am authorised to provide this evidence on behalf of the Council.

QUALIFICATIONS AND EXPERIENCE

13. I hold the qualifications of BSc (Computer Science 2002), Masters (Forest Conservation (2006) and PhD (Forestry 2011).

14. I have 17 years of experience researching urban forest related topics. I have been an Editor for the leading urban forestry scientific journal 'Urban Forestry and Urban Greening' (2013-2020), the Chair for the Science and Research Committee of the International Society of Arboriculture (closely related to urban forestry) (2016-2018), and I am currently a Deputy Coordinator for the Urban Forestry Division (6.07) of the International Union of Forest Research Organizations. I have edited an urban forestry textbook, contributed chapters to others, and have authored dozens of peer-reviewed scientific publications on urban forestry.

15. I have prepared reports for Christchurch City Council on its canopy cover in 2015/16[5] and 2018/19[6]. Likewise, I have undertaken and prepared a canopy cover report for Wellington City Council. I prepared a report[7] for Christchurch and Wellington City Councils reporting on canopy cover targets globally, seeking to provide best practices for setting canopy cover targets.

16. I am a member of the New Zealand Institute of Forestry, the New Zealand Arboriculture Association, and the International Society of Arboriculture.

CODE OF CONDUCT

17. While this is a Council hearing, I have read the Code of Conduct for Expert Witnesses (contained in the 2023 Practice Note) and agree to comply with it. 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

[5] https://ccc.govt.nz/assets/Documents/Environment/Trees/Tree-cover-in-Christchurch-final-report.pdf
[6] https://ccc.govt.nz/assets/Documents/Environment/Trees/Urban-Forests/Christchurch-City-Canopy-Cover-report-2018-2019.pdf
[7] https://ir.canterbury.ac.nz/handle/10092/103852

of expertise, and I have not omitted to consider material facts known to me that might alter or detract from my expressed opinions.

SCOPE OF EVIDENCE

18. My statement of evidence addresses the following matters:

    (a) Overview of the urban canopy cover in Christchurch;

    (b) Ecosystem services provided by urban trees;

    (c) Matters raised in relevant submissions;

        (i) Increasing or reducing the canopy cover threshold.

        (ii) Changing the way that canopy cover is measured.

        (iii) Including other forms of green infrastructure (e.g., green roof/walls) in tree cover measurement.

        (iv) Providing financial incentives for meeting canopy cover requirements.

        (v) Supporting financial contributions, reducing, or removing the financial contributions.

        (vi) Prioritising native species and increasing the diversity trees.

    (d) Conclusions.

19. I address each of these points in my evidence below.

OVERVIEW OF THE URBAN CANOPY COVER IN CHRISTCHURCH

20. Canopy cover in Christchurch has been measured twice, once in 2015/16[5] and a second time in 2018/19[6]. The most recent report estimates canopy cover in the city to be 13.56%, a decline from 15.59% three years prior. The recent estimates show canopy cover ranging between 6.51%-27.6% in different wards, suggesting that tree cover is distributed inequitably across the city (**Figure 1**). Tree cover in the Residential District Plan Zone Type is 13.44%.

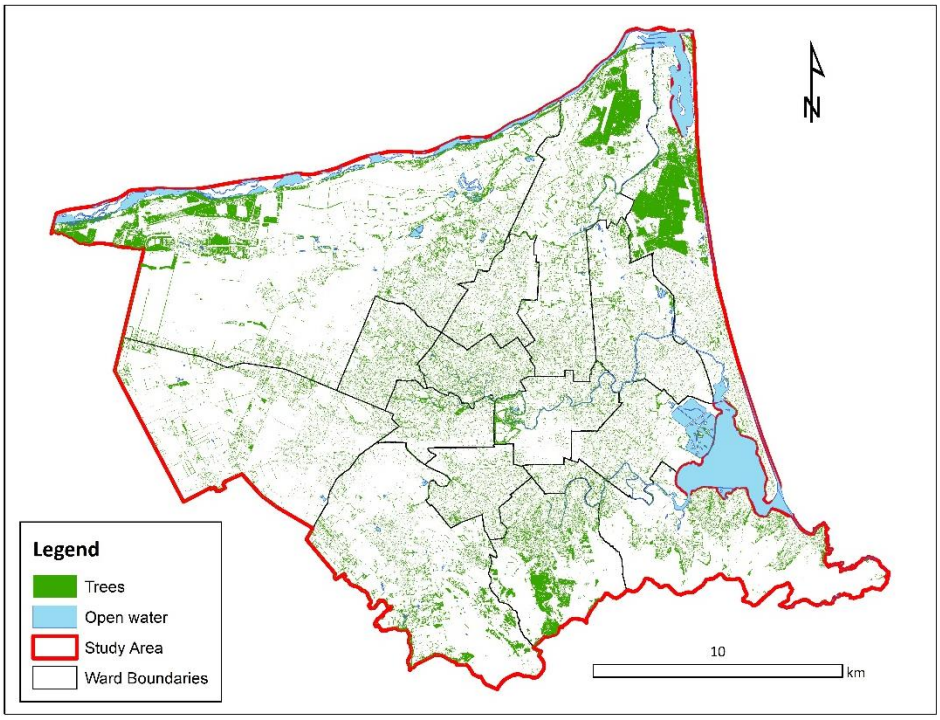

Figure 1 – Tree cover in Christchurch[6].

21. A review of canopy cover in 124 cities around the world[7] showed that, in comparison to other cities in grassland biomes, Christchurch's canopy cover is relatively low (**Figure 2**). Average canopy cover in grassland biomes is 18.2%, nearly 5% higher than Christchurch's canopy cover. The 20% target specified in PC14 and in the recently adopted Urban Forest Plan is consistent with this grassland biome average.

22. It should be noted that while Christchurch was considered to have a grassland biome, based on global terrestrial ecoregion mapping[8], that may be disputed. In his report on the biodiversity and related benefits of tree canopy cover that was appended to the section 32 report[9], Colin Meurk regards Christchurch to be a forest biome, rather than a grassland biome and suggests a more ambitious target of 25% canopy cover.

[8] Olson, D.M. et al., 2001. Terrestrial Ecoregions of the World: A New Map of Life on Earth: A new global map of terrestrial ecoregions provides an innovative tool for conserving biodiversity, BioScience, 51(11): 933–938. https://doi.org/10.1641/0006-3568(2001)051[0933:TEOTWA]2.0.CO;2

[9] *Tree Canopy Cover Benefits Affected by Urban Intensification: Biodiversity and Related Issues*. Appendix 2 to the Tree Canopy Cover / Financial Contributions section 32 report: PC14-HBC-Notification-Tree-coverFCs-S32-report-C-Meurk-evidence-Appx-2-with-Addendum-updated-15-2-23.PDF (ccc.govt.nz)

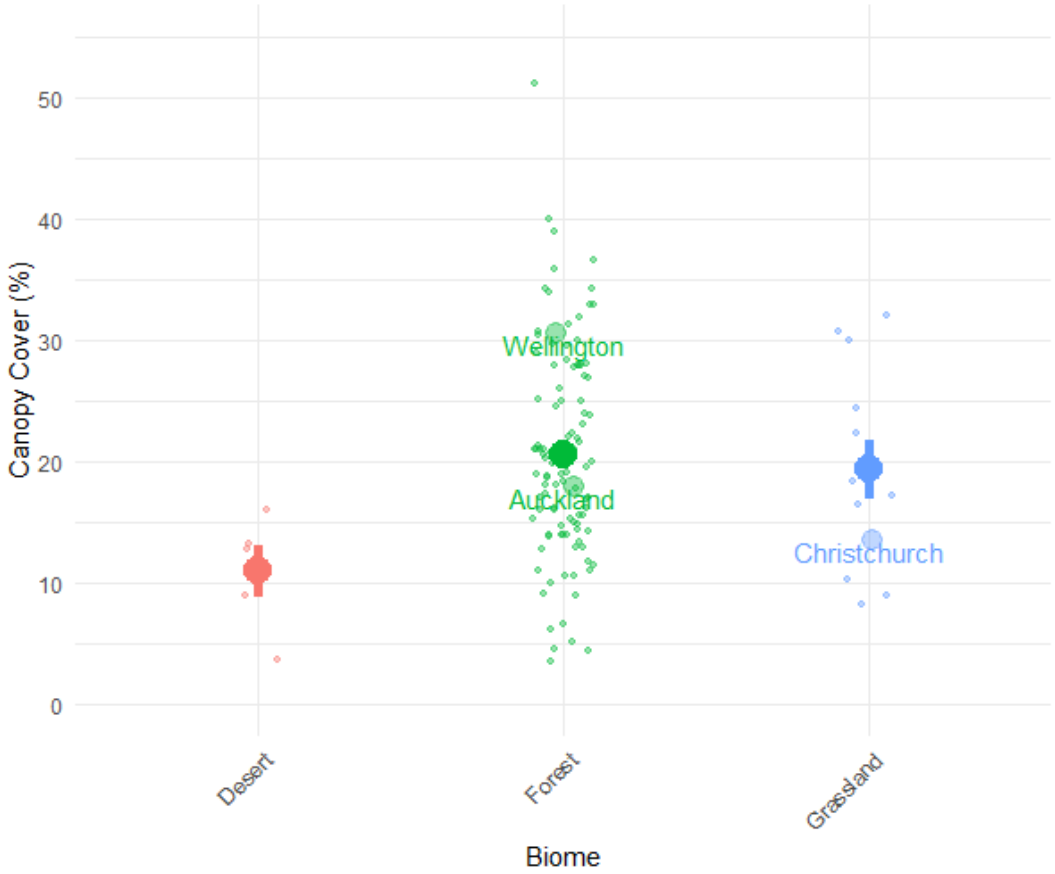

Figure 2 - Canopy cover for 124 cities in differing global biomes[7]. Small, filled points show individual canopy cover values reported for each city. Medium, light, filled circles show canopy cover for Auckland, Christchurch, and Wellington. Large, dark, filled circles represent means; lines extending from these represent one standard error from the mean.

ECOSYSTEM SERVICES PROVIDED BY URBAN TREES

23. A review of urban forest ecosystem services concluded that urban trees provide a range of 'services' for urban residents including: [10]

(a) carbon sequestration and storage;

(b) improving urban air quality;

(c) attenuating storm-water flooding;

(d) mitigating the effects of urban heat islands;

(e) conserving energy;

(f) reducing noise;

[10] Roy, S., Byrne, J., Pickering, C. 2012. A systematic quantitative review of urban tree benefits, costs, and assessment methods across cities in different climatic zones, Urban Forestry & Urban Greening, 11(4): 351-363. https://doi.org/10.1016/j.ufug.2012.06.006.

(g) providing habitat for urban wildlife; and

(h) providing diverse social, economic, psychological, medical, and aesthetic benefits.

24. In my report, I explained (by reference to various studies) that:

(a) above-ground carbon storage density for trees averaged 11.5 kg of carbon per square metre of tree canopy cover (range 1.7–28.9 kg C/m^2), while total carbon (above and below ground) storage density for trees had an average value of 7.95 kg/m^2 (range 0.8–36.1 kg C/m^2);[11]

(b) tree canopy reduced stormwater runoff, primarily by intercepting between 9% and 61% of total rainfall;[12] and

(c) ground surface temperatures were 0.6–22.8°C and air temperatures were 0.8–7°C cooler beneath tree cover than in surrounding non-treed environments.[13]

25. These benefits all increased with increasing tree size, leaf area, canopy cover, age and decreased fragmentation.

26. Urban forests can also have negative effects, such as infrastructure conflicts, health and safety impacts, aesthetic issues, and environmentally detrimental consequences (e.g., greenhouse gas emissions, invasive habit)[14]; these are collectively known as ecosystem disservices. Despite these disservices, studies have concluded that urban forest benefits far exceed costs, with average benefit:cost ratios of 5.43[15], meaning that for every $1 spent on urban forests, $5.43 of benefits are provided.

27. In my report, I explained that many benefits, but specifically carbon storage and sequestration, stormwater runoff attenuation, and urban heat island mitigation are:[16]

> "… *related to the quantity of trees (e.g., tree density or canopy cover), their configuration (fragmentation, clustering), and their structural*

[11] Refer to section 3 of my report (see footnote 1 for a link).
[12] Refer to section 4 of my report.
[13] Refer to section 5 of my report.
[14] Roman LA, Conway TM, Eisenman TS, Koeser AK, Ordóñez Barona C, Locke DH, Jenerette GD, Östberg J, Vogt J. 2021. Beyond 'trees are good': Disservices, management costs, and tradeoffs in urban forestry. Ambio. 50(3):615-630. https://doi.org/10.1007/s13280-020-01396-8.
[15] Song, X.P., Tan, P.Y., Edwards, P., Richards, D. 2018. The economic benefits and costs of trees in urban forest stewardship: A systematic review, Urban Forestry & Urban Greening, 29:162-170, https://doi.org/10.1016/j.ufug.2017.11.017.
[16] See the abstract to my report (see footnote 1 for a link).

characteristics (e.g., height, crown volume and shape, stem diameter, leaf area or density, wood density), the latter of which is influenced by tree species and age. More trees or tree cover, in clusters, with greater total biomass and wood density, will improve [these] regulating services."

Matters raised in relevant submissions

28. As discussed by Ms Hansbury in her Section 42A Report, the Council received a relatively large number of submissions on the proposed tree canopy cover and FC provisions. Many of those submissions broadly support the provisions (and the importance of providing tree canopy cover), while a smaller number of submissions oppose the provisions or seek that the requirements be relaxed. Below I make specific comments on a number of the relevant submissions.

Increasing or reducing the canopy cover threshold

29. Submission number 30.2 (Doug Latham) called for a reduction in the required canopy cover threshold from 20% down to 10%, while submission 900.5 (Summit Road Society) suggested increasing the threshold to 25%.

30. Given the benefits associated with canopy cover identified above, as well as Christchurch's relatively low (and declining) current canopy cover, I would not support a reduction in the tree canopy cover threshold.

31. While an increase to 25% may be desirable from the perspective of increasing ecosystem services, previous research shows there are risks in setting over-ambitious canopy cover targets[7]. Many cities have set canopy cover targets that are over-ambitious and unlikely to ever be achieved. Such targets will require rigorous, costly, and impractical planting schemes, as well as a combination of incentives and regulations to minimise tree removal. Other factors resulting in tree mortality will also have to be identified and mitigated. Moreover, cities will need to ensure the long-term resources required to manage the expanding urban forest. Finally, focusing solely on achieving overly-ambitious canopy cover targets can result in ignoring other strategic and more comprehensive approaches to urban forest management.

32. On balance, I am of the opinion that the 20% canopy cover target strikes a good balance between optimising ecosystem services and minimising the

risks in setting over-ambitious targets. It is also consistent with the recently adopted Urban Forest Plan.

Changing the way that canopy cover is measured

33. Submission 112.7 (Nikki Smetham) suggested that canopy cover be measured not at maturity, but rather at 10 years. I believe the submitter's argument is that trees in urban settings are not likely to achieve their mature sizes, so using a 10-year size would be more appropriate. The submitter's argument was bolstered by providing examples of where the Council's web-based tree classification guide[17] provided unreasonable (in the submitter's opinion) mature sizes for lancewood and kōwhai.

34. I appreciate the submitter's concern and agree with their assessment of unreasonable sizes for lancewood and kōwhai in the Council's tree classification guide. However, I do not believe that the best solution to this problem is to change the way that canopy cover is measured. Measuring at 10 years rather than maturity does not solve the problem of unreasonable Council tree size data. Rather, I suggest that resources are put towards improving the Council's tree classification guide to better reflect the likely mature sizes in Christchurch for all species. This would be something for the Council to consider following the PC14 process.

Including other forms of green infrastructure (e.g., green roof/walls) in tree cover measurement

35. Submission 790.4 (Jade McFarlane) asks that green infrastructure, such as green roofs and walls, qualify to make up 5% of the 20% (one quarter) tree cover threshold. Similarly, submission 260.7 (Scentre (New Zealand Limited)) seeks to "*[e]nsure that the unit of measurement of "tree canopy coverage" takes into account green / living walls and roofs*".

36. Green roofs can have a variety of vegetation structure characteristics, but most tend to be extensive, with shallow substrate and drought-resistant vegetation (e.g., succulents)[18]. Intensive green roofs have deeper substrates and can support a greater diversity of plant types. Despite that, the engineering requirements, space limitations, impracticality, and cost of including woody vegetation, especially medium- or large-statured trees,

[17] https://ccc.govt.nz/environment/trees-and-vegetation/urbanforest/tree-planting-guide
[18] Nguyen, C.N., et al., Quantifying the Benefits and Ecosystem Services Provided by Green Roofs - A Review. Water, 2022. 14(1): p. 68.

almost always precludes their inclusion, even in intensive green roofs. Green or living walls do not include large woody vegetation either.

37. This limitation (i.e., the types of vegetation used in green roofs and walls) has a direct impact on the scale of some of the ecosystem services they provide. Carbon sequestration, stormwater runoff mitigation, and heat island mitigation are all influenced by the not only horizontal canopy cover (which green roofs can provide), but also by depth of vegetation cover. This is because they are directly influenced by total leaf area. Total leaf area is the most important factor influencing these ecosystem services. The evidence is clear that these ecosystem services increase with increasing leaf area[19].

38. Because of this, trees (in particular large-statured trees) are the greatest contributor to these ecosystem services. However, it is not always possible (or appropriate) to include trees in urban areas. Where site constraints or other factors preclude inclusion of trees, green roofs and green walls can be important alternatives to tree cover. Compared to standard roof designs, green roofs do provide improvements in air quality through particulate matter deposition, heat island mitigation, stormwater runoff mitigation, and carbon sequestration[18].

39. In terms of the specific submission (subm. no. 260.7) comment that "the unit of measurement *of "tree canopy coverage" takes into account green / living walls and roofs*", this would be better incorporated into a separate measure of greenspace coverage. Tree canopy cover and greenspace cover are two different, but complimentary metrics that can be used to quantify vegetation within urban areas. Greenspace is not an adequate replacement for tree cover (due to their limited ecosystem service provision, as above), so it is better to measure them separately. Alternatively, Christchurch could consider developing a so-called green factor score for different vegetation typologies. These have been used in other cities to

[19] Mitchell, M.G.E., et al., Identification of fine scale and landscape scale drivers of urban aboveground carbon stocks using high-resolution modeling and mapping. Science of the Total Environment, 2018. 622-623: p. 57-70;
Nowak, D.J. and D.E. Crane, Carbon storage and sequestration by urban trees in the USA. Environmental Pollution, 2002. 116(3): p. 381-389;
Wang, V. and J. Gao, Estimation of carbon stock in urban parks: Biophysical parameters, thresholds, reliability, and sampling load by plant type. Urban Forestry & Urban Greening, 2020. 55: p. 126852;
Hartigan, M., et al., Developing a metropolitan-wide urban forest strategy for a large, expanding and densifying capital city: Lessons from Melbourne, Australia. Land, 2021. 10(8);
Helletsgruber, C., et al., Identifying tree traits for cooling urban heat islands—a cross-city empirical analysis. Forests, 2020. 11(10): p. 1-14.

encourage urban green infrastructure[20]. But again, this is distinct from a tree canopy coverage metric.

40. Submissions 834.121 and 834.181 (Kāinga Ora – Homes and Communities) go further than the submission asking that green roofs / walls be accounted for. The submission suggests deleting Section 6.10A and all associated provisions to allow for flexibility in choice of landscaping to meet a 20% landscaped area. That area could include trees, but not require them. In effect, that would remove the tree canopy cover requirement entirely.

41. As stated above, ecosystem services increase with increasing leaf area[21]. Because of this, trees are the greatest contributor to ecosystem services. Removing the tree canopy cover requirement would fail to help the council meet its stated goal of 20% canopy cover across the city and would also deprive residents of the benefits provided by canopy cover.

Providing financial incentives for meeting canopy cover requirements

42. Submissions 470.2 and 470.3 (Dew & Associates (Academic Publishers)) were not entirely clear, but I believe that they were suggesting a financial incentive for retaining trees on development sites: "*Consider offering once in a lifetime at the time of taking up land or building ownership a one-off per site one-month-rate-holiday to an appropriate recipient*". Submission 790.4 (Jade McFarlane) also supports incentives, suggesting that "*a rates rebate should be explored alongside standard controls*".

43. The concept of incentives for tree retention is not uncommon and has merit. A recent review of the scientific literature found that best practices for protecting and retaining trees on private urban land should include more than just penalties[22]. The authors conclude that a combination of regulations and incentives is critical to protecting trees on private land in cities. They refer to examples of incentives including "*grants, tax rebates,*

[20] Bush, J., et al., Integrating green infrastructure into urban planning: Developing Melbourne's green factor tool. Urban Planning, 2021. 6(1): p. 20-31.
[21] Mitchell, M.G.E., et al., Identification of fine scale and landscape scale drivers of urban aboveground carbon stocks using high-resolution modeling and mapping. Science of the Total Environment, 2018. 622-623: p. 57-70;
Nowak, D.J. and D.E. Crane, Carbon storage and sequestration by urban trees in the USA. Environmental Pollution, 2002. 116(3): p. 381-389;
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Hartigan, M., et al., Developing a metropolitan-wide urban forest strategy for a large, expanding and densifying capital city: Lessons from Melbourne, Australia. Land, 2021. 10(8);
Helletsgruber, C., et al., Identifying tree traits for cooling urban heat islands—a cross-city empirical analysis. Forests, 2020. 11(10): p. 1-14.
[22] Ordóñez-Barona, C., et al. (2021). "International approaches to protecting and retaining trees on private urban land." Journal of Environmental Management 285: 112081.

provision of arboricultural advice or free tree-care services, as well as supporting citizen-led activities focused on planting or protecting trees on private land or awarding prizes for volunteer activities".

44. These types of incentives – including whether they should be somehow referenced in the District Plan – are a matter for consideration by the Council.

Supporting financial contributions, reducing, or removing the financial contributions

45. Submission 826.4 (LMM Investments 2012 Limited) proposes delete the FC policy in its entirety. Submission 900.5 (Summit Road Society) supports the FC provisions to ensure tree canopy cover targets are met. . Submission 790.4 (Jade McFarlane) suggests that the amount of the FC payable be reduced to a maximum of $1000 per tree.

46. Ms Hansbury explains the way the tree canopy cover and FC provisions work together. In my view, requiring FCs to be paid where the tree canopy cover requirements are not met is a positive step in addressing Christchurch's tree canopy cover deficit.

47. In particular, the FC provisions will enable the provision of canopy cover (by the Council) on public land near developments where constraints precluded a minimum of 20% canopy cover. The relatively high-density residential areas enabled by PC14 are precisely where canopy can provide the greatest benefit for the largest number of residents.

48. I am not in a position to comment on the appropriate dollar value of the FCs, other than to say that they should cover the costs of providing the necessary canopy cover.

Financial contributions and riparian planting

49. Submission 900.6 (Summit Road Society) states that the submitter "*would like the Financial Contribution expanded to include riparian planting along waterways including small creeks*".

50. FCs will enable the Council to carry out tree planting on public land in lieu of required on-site canopy cover. How Council allocates FCs to various land uses is an operational decision for Council. I note that Christchurch's Urban

Forest Plan identifies goals of 30% canopy cover in waterways by 2030 and 75% cover by 2070, the highest canopy cover goals for any land use type.

Prioritising native species and increasing the diversity trees

51. Submissions 914.2 and 900.5 both make suggestions around tree species selection. As discussed above, and in more detail in my report, the benefits of tree canopy cover may vary by species. However, given that PC14 pertains to private residential land, decisions about species selection are likely best left to individual landowners. In my view the most important thing is for tree canopy cover to be provided (with species being secondary).

11 August 2023

Justin Morgenroth