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Sent: Friday, 18 September 2020 5:20 PM
To: Plan Hearings
Cc: Pizzey, Brent
Subject: Christchurch City Council PC7 rebuttal evidence
Attachments: LWRP CCC Geoff Butcher Rebuttal 2020-09-18.pdf; LWRP Carter Rebuttal 2020-09-18.pdf; LWRP CCC Bridget OBrien rebuttal 2020-09-18.pdf; LWRP CCC Mike Thorley rebuttal 2020-09-18.pdf

Follow Up Flag: Follow up
Flag Status: Completed

Kia ora,

Please find attached the Christchurch City Council's rebuttal evidence for Plan Change 7 of the Land and Water Regional Plan.

Attached is the rebuttal evidence of:

- Geoff Butcher
- Janice Carter
- Bridget O'Brien
- Mike Thorley

We will be filing Dr. Belinda Margett's rebuttal evidence soon.

Ngā mihi,

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Christchurch City Council

BEFORE THE CANTERBURY REGIONAL COUNCIL

HEARING COMMISSIONERS

IN THE MATTER	of the Environment Canterbury (Transitional Governance Arrangements) Act 2016
AND	
IN THE MATTER	of submissions on Proposed Plan Change 7 to the Land and Water Regional Plan and Proposed Plan Change 2 to the Waimakariri River Regional Plan

REBUTTAL EVIDENCE OF MICHAEL JAMES THORLEY FOR THE CHRISTCHURCH CITY COUNCIL

Dated 18 September 2020

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INTRODUCTION

1. My full name is Michael James Thorley. I here provide rebuttal evidence for the Christchurch City Council (Council) in relation to the evidence of other experts on the Council's submission on the Environment Canterbury proposed Plan Change 7 (PC7).

2. My qualifications and experience are set out in my evidence in chief (EIC) dated 17 July 2020.

3. Whilst this is not an Environment Court hearing, I again confirm I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014. I have complied with it in preparing this evidence and I agree to comply with it in presenting evidence at this hearing. The evidence I give is within my area of expertise except where I state that my evidence is given in reliance on another person's evidence. I have considered all material facts that are known to me that might alter or detract from the opinions that I express in this evidence.

SCOPE

4. My rebuttal evidence is provided in response to the Evidence in Chief filed by the following parties on 17 July 2020:

    4.1. Mr Neil Thomas for Waimakariri Irrigation Limited (submitter 349)
    4.2. Dr Helen Rutter for DairyNZ (submitter 357)

JOINT WITNESS STATEMENT – GROUNDWATER SCIENCE

5. I have participated in caucusing with several other expert witnesses on 19 August 2020 and 31 August 2020 concerning Groundwater Science topics in relation to PC7. I have contributed to and agreed with the Joint Witness Statement (JWS) which was provided to the Hearing Panel on 2 September 2020.

CLARIFICATIONS TO MY EVIDENCE IN CHIEF

6. Mr Zeb Etheridge clarified in caucusing the modelled nitrate-nitrogen concentrations provided in the report Waimakariri Land Wand Water Solutions Programme - Options

and Solutions Assessment – Nitrate Management (Kreleger and Etheridge, 2019). As noted in paragraph 20 of JWS, the modelled concentrations presented in Kreleger and Etheridge (2019) did not incorporate measured, modelled or estimates of future nitrate concentrations from source areas south of the Waimakariri River. Hence, the nitrate concentrations could be higher than indicated in Table 4-10 Good Management Practice (GMP) and Current Pathways – Nitrate modelling results for Christchurch aquifer areas (Kreleger and Etheridge, 2019) if the interzone transfer of nitrate-nitrogen combines with the existing nitrate-nitrogen concentrations in groundwater south of the Waimakariri River.

7. Furthermore, it is more appropriate to use the Good Management Practice (GMP) column because this is what the nitrogen reduction targets required by Table 8-9 of PC7 will be based on. Therefore, the quoted concentrations and paragraphs 90 and 91 of my evidence in chief, are revised below in paragraphs 7.1 and 7.2:

7.1. *The Kreleger and Etheridge (2019) assessment ~~goes on to add the existing concentration of 0.3 mg/L~~ should have added an estimate of existing concentrations to the modelled concentrations [Table 4-10] (shown below in Table 3). In my view, the maximum concentration of 2.9 mg/L from bores ~~deeper than 80 m~~ between 100 and 150 m shown in Table 1 should have been used. Once the 95th percentile modelling prediction under GMP is added, as shown in ~~Table 2 (7.1 7.6 mg/L)~~ Table 3 (6.9 - 7.4 mg/L), the total concentration is ~~10-10.5 mg/L~~ 9.8 – 10.3 mg/L which exceeds the threshold of 3.8 mg/L and comes close to reaching the current DWSNZ MAV for nitrate-nitrogen of 11.3 mg/L. As described earlier in this evidence, this may exceed other thresholds identified for human health.*

7.2. If the projected increases in nitrate-nitrogen concentrations shown in Table 3 under GMP are added to the maximum measured nitrate concentration of 3.77 mg/L for Aquifer 4 in Table 2, this would result in concentrations of ~~7.5 – 8.9 mg/L~~ 10.7 – 11.2 mg/L for the median scenario, with a range of ~~4.7 – 11.37 mg/L~~ 5.1 – 11.4 mg/L for the 5th and 95th percentile scenarios respectively. The ability to meet the nitrate-nitrogen target is a key assumption in Table 8-9 of PC7 and further nitrogen reductions are required when existing nitrate concentrations are taken into consideration.

8. Paragraphs 7.1-7.2 of my evidence in chief above provide minor clarifications and do not alter the significance of my previous statement.

MR NEIL THOMAS FOR WAIMAKARIRI IRRIGATION LIMITED

9. In paragraph 41, Mr Thomas refers to an Environment Canterbury technical report drafted in 2018[1] and goes on to paraphrase the report extensively. This report is a draft report however is available through Environment Canterbury's website. Mr Doug Rankin (Submitter 220) has also referenced this draft Environment Canterbury report and included material from it in his evidence in chief. The Etheridge, Hanson and Harris (2018) report provides a wider ranging and detailed assessment of potential water quality outcomes in the Christchurch Aquifer System based on the Environment Canterbury modelling results than that presented in Kreleger and Etheridge (2019) report. The Etheridge, Hanson and Harris report (2018) more clearly identifies the areas in Christchurch where nitrate concentrations are elevated, such as near the Islington Freezing Works site near Hornby, in south west Christchurch. This is consistent with the assessment in my evidence in chief (paragraph 81 and 95-100). It would have been helpful for Environment Canterbury to have finalised the 2018 report and included the material in the documents that informed PC7.

10. In paragraph 42, Mr Thomas refers to nitrate monitoring undertaken at the Russley monitoring bore M35/6791 (200 m deep). He describes the monitoring of nitrate as indicating generally low nitrate concentrations (0.3 mg/L) with some spikes of up to 0.8 mg/L in this bore. He then goes on to explain that he has modelled the concentrations arriving at this bore with a model describing vertical flow to the bore. His evidence provides no information about this model and therefore it is difficult to understand how Mr Thomas's comments are justified including the conclusion he reached that "…*these spikes in nitrate concentrations are due to shallow local groundwater being drawn down into the deeper strata by pumping and/or rainfall induced leakage from shallow local groundwater*".

11. In my evidence in chief, I show maps of measured nitrate concentrations (Figures 5, 9 and 10 in my evidence in chief) which indicate the area in which the Russley monitoring bore M35/6791 is located, is an area containing elevated nitrate concentrations.

[1] Etheridge, Z., Hanson, M., and Harris, S. 2018. Nitrate assessment for the interzone source area catchment. April 2018. https://www.ecan.govt.nz/document/download?uri=3437270.

Figures A1 and A2 in Attachment A to this evidence show the position of the Russley monitoring bore M35/6791 and indicate higher average nitrates and historical maxima in nearby bores in both shallow and deeper strata, not just shallow strata as Mr Thomas suggests. Whilst I agree, in part, with Mr Thomas that the spikes in nitrate concentrations could be somewhat explained by vertical leakage, it is also plausible that groundwater containing elevated nitrate concentrations could be drawn through laterally from surrounding areas too. When a bore is pumped, the zone of drawdown influence can extend several kilometres depending on the rate and duration of pumping, and can reasonably be expected to intercept groundwater containing elevated nitrate concentrations as it migrates through the aquifer system from further up-plain.

12. Figures A1 and A2 in Attachment A to my rebuttal evidence indicate widespread elevated nitrate concentrations in many bores across the plains (in shallow and deeper bores) including across western and northern areas of Christchurch. The influence of river recharge is also apparent in nitrate concentrations in groundwater with marked spatial changes in concentrations in the north-west of Christchurch, such as across the West-Melton area.

13. This variability in nitrate concentrations was not discounted by Environment Canterbury in their modelling, rather their model was at a regional scale which was not sufficiently detailed to predict localised variability and concentrations at individual bores. It is unrealistic then for Mr Thomas to compare the Environment Canterbury model to localised modelling and assessment at an individual bore scale in his paragraph 42.

14. Mr Thomas agrees in paragraph 21 of the JWS that localised sources could contribute further nitrate and be in addition to a more distal source such as from the Waimakariri Plains, if nitrate migrates into the Christchurch aquifer system from the Waimakariri Plains.

15. In paragraph 45, Mr Thomas refers to a report he prepared for Environment Canterbury about the potential for groundwater flow across and beneath the Waimakariri River. No reference is provided to the report and so the basis for his comments in paragraphs 45.1 to 45.5 is unclear.

16. In paragraph 45.5, Mr Thomas states "…*if movement across the river does occur, it is of a minor scale compared to the much greater quantities of seepage from the*

Waimakariri River that provide the major source of recharge to the Christchurch Aquifers.".

17. Mr Etheridge clarified in expert witness caucusing, paragraphs 31 to 32 in the JWS, that the median modelled rate of groundwater flow from the Waimakariri Plains to the Christchurch Aquifer System is 4.1 m^3/s, with a range of 2.4 to 5.7 m^3/s within the 90^{th} percentile confidence interval. Mr Etheridge clarified that the median rate of groundwater exchange is 23% of the total water budget for Christchurch Aquifer System. Therefore, the rates of flow used in Environment Canterbury technical assessment are not "*of a minor scale*" as Mr Thomas states.

18. In paragraph 50, Mr Thomas describes inferred flow directions from three monitoring bores (BX23/770, BX23/773 and BX23/763) as being approximately parallel to the Waimakariri River. I do not agree with this analysis or interpretation. The analysis oversimplifies the data and does not account for a range of other factors such as differences in bore elevations and wider patterns of piezometric heads. Bore BX23/770 is located 4.5 km across and up-slope of bores BX23/773 and BX23/763. The screen of Bore BX23/770 also sits at a higher elevation than bores BX23/773 and BX23/763, which means bore BX23/770 could be measuring water levels in overlying strata and these could be higher due to the downwards flow pattern in the area. Similarly, there is an approximate difference in piezometric head (groundwater pressure elevation) of 4 – 5 m from bore BX23/773 to BX23/763 towards the south across the Waimakariri River, however the bore screen in the eastern bore is at a slightly lower elevation. Environment Canterbury has provided groundwater level and screen information about the clusters of bores at the three sites which are mapped in Figure 1 and plotted in terms of relative elevation in Figure 2 below.

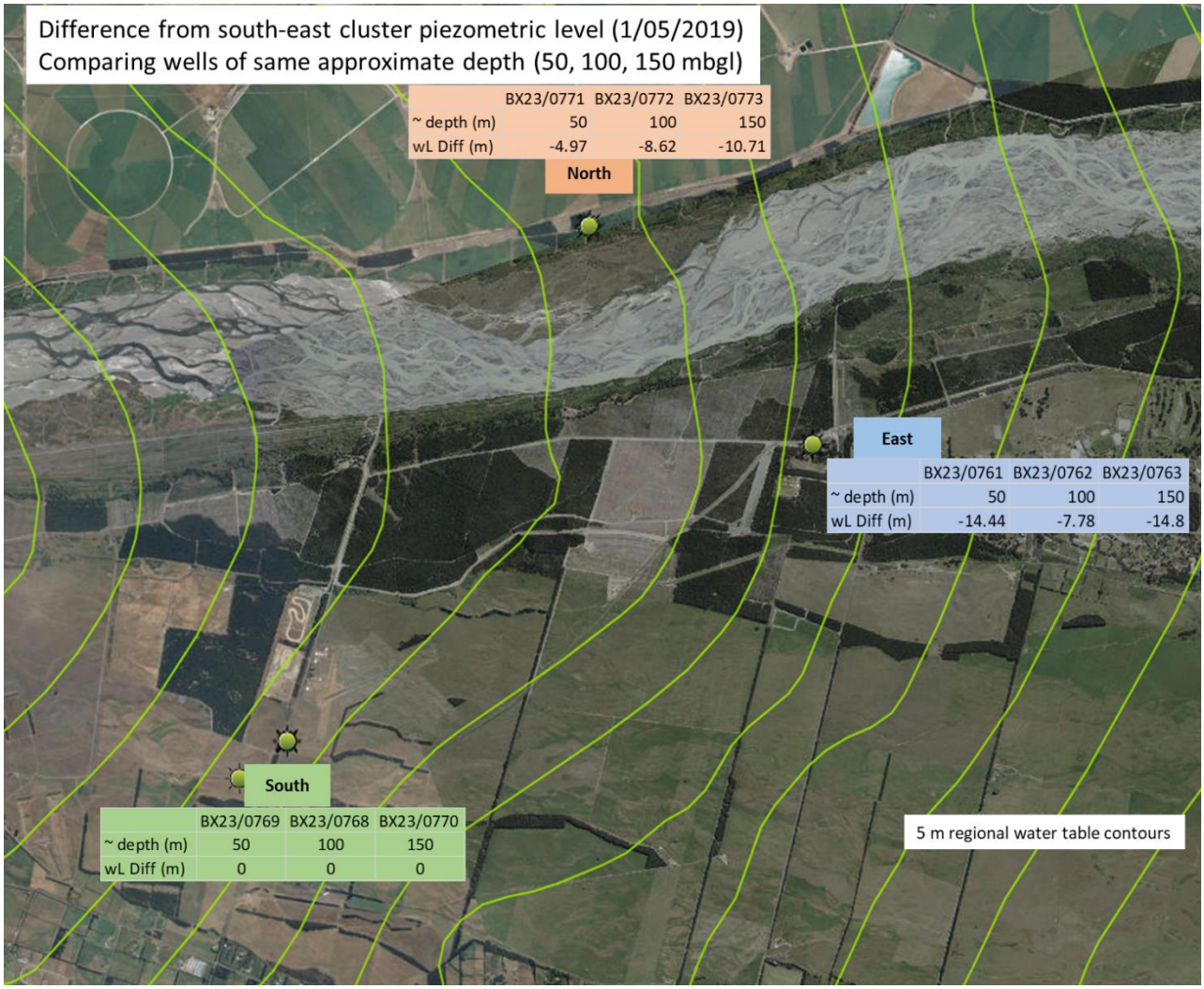

Figure 1: Locations of Environment Canterbury monitoring bores in the West-Melton area showing approximate screen depths and differences in piezometric head from the south site. Regional water table contours included for context to show the expected groundwater flow direction is south-east in the area. The western most piezometric contour is 100 mRL and eastern most piezometric contour is 45 mRL (data and map supplied by Environment Canterbury, September 2020)

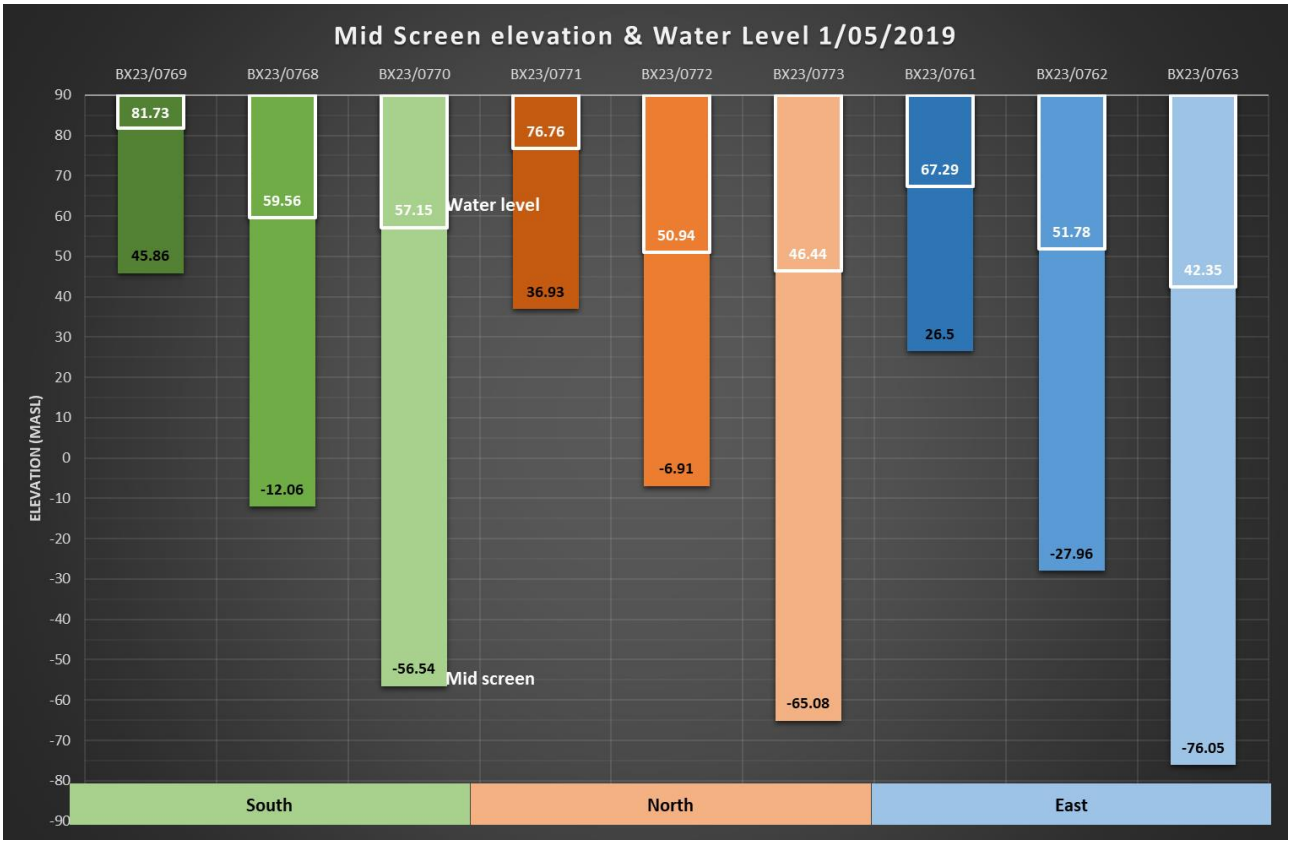

Figure 2: Plot of Environment Canterbury monitoring bores in the West-Melton area showing the elevation of the bore screens and piezometric head (data and plot supplied by Environment Canterbury, September 2020)

19. As noted in paragraph 15 of the JWS, the Environment Canterbury groundwater model replicates the relative piezometric head difference albeit with misfit between the measured and modelled levels. On page 15, 3rd paragraph, Etheridge, Hanson and Harris (2018) state "*The experts generally had medium/high confidence that our suite of model results encapsulate the true outcome in regard to impacts on nitrate concentrations in Christchurch.* ***The results from all models show some increase in nitrate concentrations in Christchurch wells****; it was therefore inferred that the experts had medium-high confidence that there will be some increase in nitrate concentrations due to inter-zone transfer.*" [emphasis added]. This statement confirms that all the Environment Canterbury model (2131) realisations, flow and nitrate transport was towards the south across the Waimakariri River.

20. I note that the aquifer system has at least another 100 m of aquifer thickness beneath the monitoring bores (BX23/773, BX23/763, and BX23/770) which is roughly double the depth of those bores and there is significant additional thickness in the aquifer system in which groundwater flow can continue downwards and southwards towards Christchurch. I do not agree with Mr Thomas's interpretation of the groundwater flow

directions based on such a limited dataset, ignoring the downward flow pattern in the area, excluding other pertinent piezometric data across the wider area and the presence of deeper strata below.

21. Based on my review of Mr Thomas's interpretation of the piezometric data and the information provided by Environment Canterbury, I consider there is evidence to support groundwater flow towards the south-east from the Waimakariri Plains to the Christchurch Aquifer System.

DR HELEN RUTTER FOR DAIRYNZ LIMITED

22. In paragraph 12.12 Dr Rutter states that "*I consider that what that has been proven is that we cannot discount the hypothesis that there is flow at depth under the Waimakariri River. Conversely, the work has not proven that there is, and it is not the only hypothesis that is a possibility with the available data. The resulting stochastic model will be biased by using the anisotropy ratios derived from the assumptions and uncertainties in the supporting data*." There are conflicting statements here which attempt to cast uncertainty on the modelling and analyses completed by Environment Canterbury rather than produce evidence demonstrating that the Environment Canterbury modelling and assessment is incorrect.

23. Dr Rutter in paragraph 11.1 of her evidence in chief quotes Section 8.152 of the S42A Officer report, as stating "*The Aqualinc presentation does not contain any evidence to support the claim that groundwater in the Waimakariri zone is more likely to flow to the east rather than towards Christchurch. In lieu of evidence, the presentation instead focuses on the paucity of data on the deep aquifer system and concludes that the available data is inconclusive and therefore the groundwater model cannot be used to predict deep flow towards Christchurch*". Whilst I agree there is uncertainty, I consider the modelling completed by Environment Canterbury is sufficient to establish the potential for groundwater flow from the Waimakariri Plains to Christchurch which is consistent with other information such as piezometric gradients and water chemistry. I note in paragraph 33 of the JWS, that Dr Rutter agrees there is the potential for parts of the Waimakariri Plains to form part of the Christchurch drinking water catchment.

24. Dr Rutter's main issue with the Environment Canterbury groundwater model seems to relate to the use of anisotropy in the model such as at paragraph 5.2 of her evidence in chief. I note that she does not provide in her evidence a copy of the memorandum referenced as Aqualinc (2019) and it is not clear what the entire Aqualinc review says.

25. I do not agree with her contention that anisotropy[2] is a major issue in the Environment Canterbury model. Many of the parameters estimated by the Environment Canterbury modellers, were used as a starting point for the stochastic calibration process. Mr Etheridge clarifies in paragraph 26 of the JWS that he does not consider that anisotropy has had a major bearing on the model outputs. Whilst I agree with Dr Rutter that aspects of the model could have been better reported and documented, I do not agree that anisotropy had a major effect on the model outputs compared to other factors in the model, such that it could not be used to inform management of nutrients in the groundwater system.

26. In paragraph 12.4, Dr Rutter states that there is evidence of increasing trends in nitrate concentrations in groundwater beneath Christchurch, particularly in south-west Christchurch. In paragraph 10.9 Dr Rutter also discusses the evidence of increasing trends in a well in the north of Christchurch (Christchurch City Council water supply bore M35/10632 which is screened in Aquifer 3 in Belfast). Dr Rutter explains in the same paragraph (10.9) that this bore also has indications from isotope sampling that it contains signatures of higher land-surface recharge sources. However, in my opinion the isotopes, on their own, cannot indicate where that recharge has originated i.e. from north and/or south of the Waimakariri River. Dr Rutter seems to diminish the corresponding information from the Environment Canterbury model that indicates at least some of the recharge source area of the aquifer system in northern Christchurch likely comes from north of the Waimakariri River.

27. I note that on page 14, last paragraph in Etheridge, Hanson and Harris (2018) there is reference to unanimous agreement of the experts that there is interzone groundwater flow "*The expert panel agreed unanimously that at least some groundwater from the Waimakariri zone is likely to flow under the river and into the northern Christchurch aquifer. Some members of the panel believed that central and southern Christchurch could also be affected, but others did not. All members of the panel inferred that any*

[2] Properties of a material that depend on the direction, i.e. the hydraulic conductivity is higher in the X direction compared to the Y direction

increase in nitrate associated with under-river flow is likely to be lower in the southern part of Christchurch.".

28. Furthermore, Dr Rutter's concluding remarks in paragraphs 12.15 and 12.16 again appear to both acknowledge there is a "plausible" pathway and then states "*we do not believe there is sufficient evidence to conclude that nitrate-laden water from the Waimakariri zone will influence groundwater quality under Christchurch city*". I disagree with Dr Rutter's statement and I consider that there are multiple lines of evidence consisting of geochemistry, piezometric data, and groundwater modelling information that indicates groundwater flows beneath the Waimakariri River from the Waimakariri Plains to the Christchurch Aquifer System that could influence groundwater quality beneath parts of Christchurch.

Dated at Christchurch this 18th day of September 2020

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Michael James Thorley

Attachment A – Maps of Measured Nitrate Concentrations

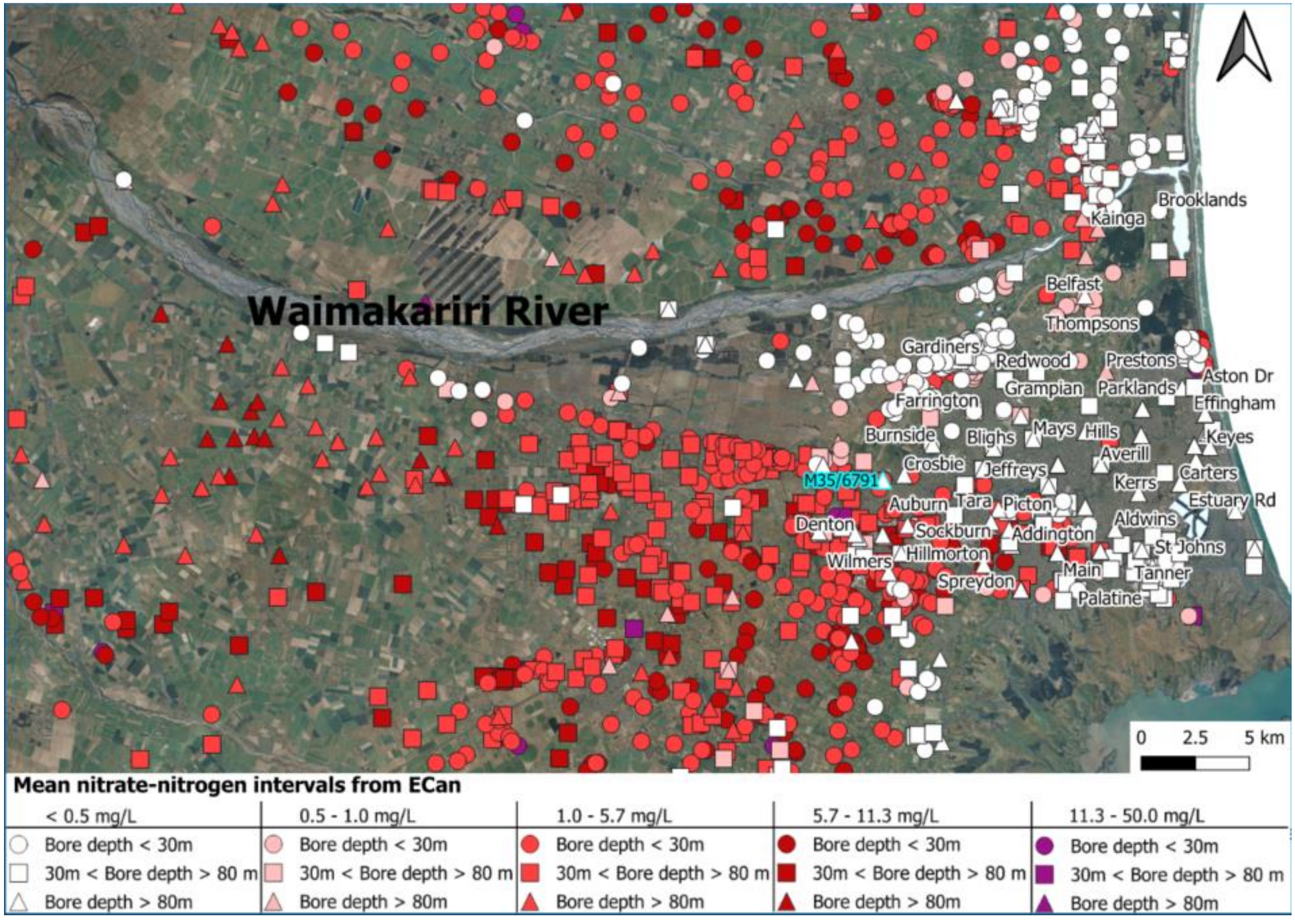

Figure A1: Mean nitrate-nitrogen concentrations from all bores containing water quality data in the Environment Canterbury Wells Database across the Waimakariri-Christchurch-Selwyn areas with Christchurch City Council pumping stations overlaid and showing the Russley monitoring bore M35/6791 (data supplied by Environment Canterbury, July 2020)

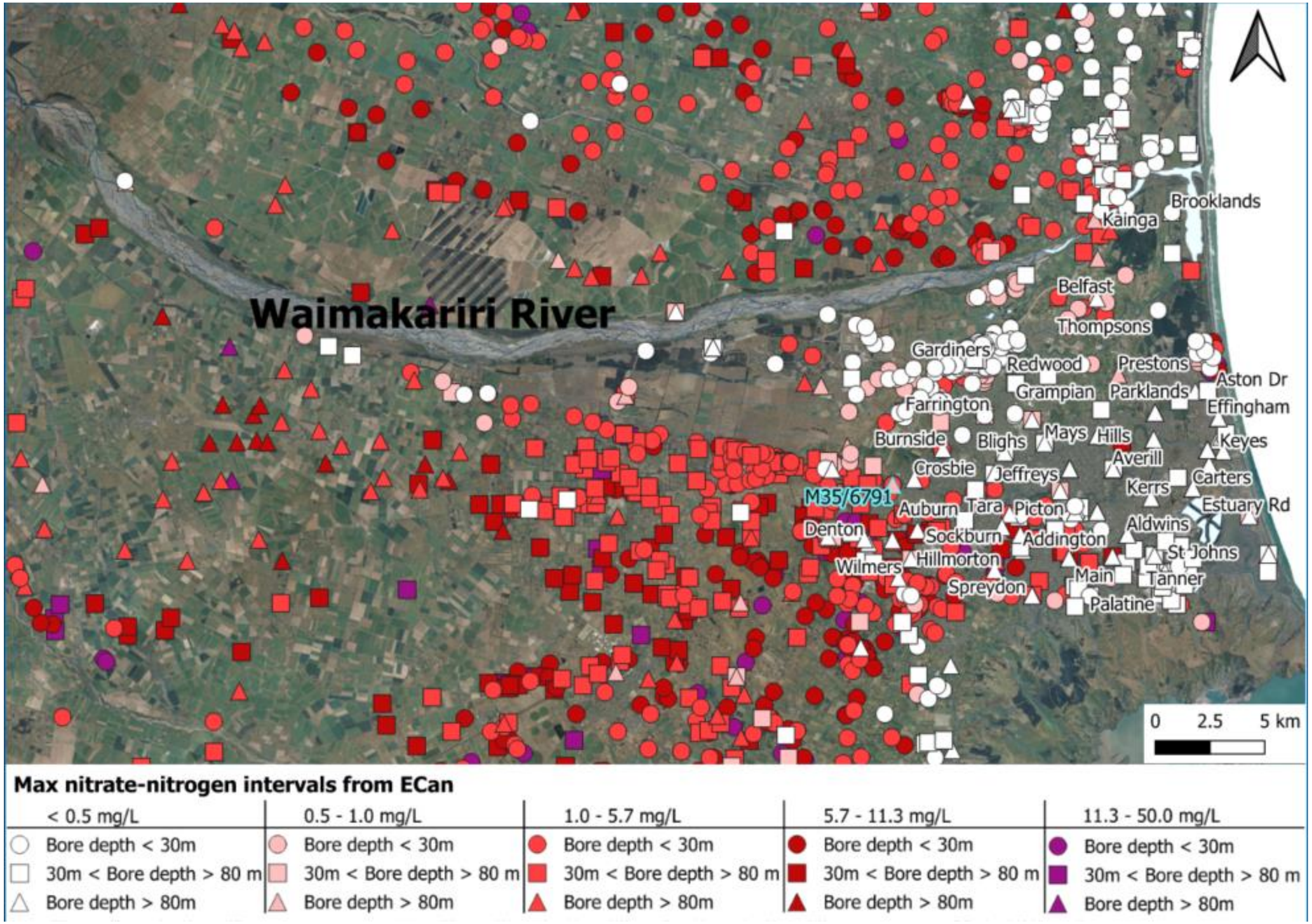

Figure A2: Maximum nitrate-nitrogen concentrations from all bores containing water quality data in the Environment Canterbury Wells Database across the Waimakariri-Christchurch-Selwyn areas with Christchurch City Council pumping stations overlaid and showing the Russley monitoring bore M35/6791 (data supplied by Environment Canterbury, July 2020)