BEFORE THE ENVIRONMENT COURT OF NEW ZEALAND
CHRISTCHURCH REGISTRY
I MUA I TE KŌTI TAIAO O AOTEAROA
KI ŌTAUUTAHI

ENV-2018-CHC-0037
ENV-2018-CHC-0050

UNDER	the Resource Management Act 1991
IN THE MATTER OF	an appeal under clause 14 of Schedule 1 of the RMA in relation to decisions on the Proposed Southland Water and Land Plan
BETWEEN	ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND INC
	Appellant
AND	SOUTHLAND FISH AND GAME COUNCIL
	Appellant

WILL SAY STATEMENT OF KATHRYN JANE MCARTHUR

Dated 5 November 2021

AND	SOUTHLAND REGIONAL COUNCIL
	Respondent

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INTRODUCTION

1. My full name is Kathryn (Kate) Jane McArthur. I am an independent freshwater ecologist and water quality scientist based in Kahuterawa near Palmerston North.

2. I hold a Bachelor of Science degree with Honours in Ecology and a Master of Applied Science with Honours in Natural Resource Management, both from Massey University. My post-graduate research included the influence of land use on freshwater macroinvertebrates and the interaction between policy and science in resource management, focussing on water quality objectives and limits in regional plans. I have 20 years of post-graduate experience in freshwater resource management.

3. I started my own consultancy (KM Water) in August 2020. Prior to starting KM Water, I was the Practice Leader – Water with The Catalyst Group for eight years. My work with The Catalyst Group included providing expert advice and evidence on eleven regional plans across Aotearoa New Zealand. Before this, I held the role of Senior Scientist – Water Quality with Horizons Regional Council (Manawatū-Whanganui Region). In this role I coordinated monitoring programmes for State of the Environment (SOE), periphyton, macroinvertebrate, indigenous fish, and point-source discharges, and produced expert evidence for many resource consent hearings, enforcement actions, and the Horizons 'One' Plan Council-level and Environment Court hearings (the Horizons 'One' Plan being a combined regional plan/regional policy statement).

4. I have authored and co-authored a range of reports and publications, including technical reports on water quality and aquatic biodiversity to support the Horizons One Plan and the draft Nelson Resource Management Plan. I have authored and co-authored papers in peer-reviewed journals on the relationship between flow and nutrients in rivers; nutrient limitation; methods for monitoring indigenous fish; the calculation of in-river nutrient loads and limits, and the setting of water quality objectives and limits in water policy. I have provided evidence in these topic areas before the Environment Court and in Board of Inquiry, Special Tribunal, and council hearings processes across the country.

5. I have provided ecological, water quality, and freshwater policy advice to Nelson City Council, Northland Regional Council, Ngāti Kahungunu Iwi Incorporated, Te Rōpū Taiao o Ngāti Whakatere, Te Taiwhenua o Heretaunga, Te Rūnanga o Ngāti Whātua, Te Rūnanga o Ngāti Mutunga, Ngāti Pāhauwera Development Trust, Hawke's Bay Regional Council, the national Iwi Leaders Group, the Department of Conservation, the Ministry for

the Environment, Forest & Bird, Fish and Game, Environmental Defence Society and the Biodiversity Collaborative Group. I have recently been, or am currently involved in, freshwater plan processes in Northland, Auckland, Waikato, Bay of Plenty, Hawke's Bay, Manawatū-Whanganui, Wellington, Tasman, Nelson, Canterbury, and Southland.

6. I was appointed as a member of the National Objectives Framework reference group for the National Policy Statement for Freshwater Management (2017) by the Ministry for the Environment. Since 2016, I have co-led national workshops on best practice freshwater science and policy development for the New Zealand Planning Institute. I am a guest lecturer in environmental planning, freshwater resource management practice, and science at Massey and Canterbury Universities.

7. I have been a member of the New Zealand Freshwater Sciences Society since 2001 and I have been the Society's President since 2018. I am a member of the Resource Management Law Association of New Zealand (RMLA) and was the RMLA scholarship recipient in 2010 for my master's thesis work on water quality policy and limits for the Manawatū River.

8. I am an accredited and experienced RMA hearings commissioner with a hearing chair endorsement and have been appointed by the Minister for the Environment as a Freshwater Commissioner for the new Freshwater Planning Process under the RMA amendments (2020).

9. I gave expert evidence on behalf of the Royal Forest and Bird Protection Society Incorporated of New Zealand (Forest and Bird) and the Director-General of Conservation before the Environment Court in the Topic A hearings and participated in all technical expert conferencing associated with Topic A.[1]

CODE OF CONDUCT

10. I confirm that I have read the code of conduct for expert witnesses as contained in the Environment Court's Practice Note 2014. I have complied with the practice note when preparing this written statement and will do so when I give oral evidence before the Court.

[1] Joint witness statements (JWS) on water quality and aquatic ecology were produced from expert conferencing on 7 – 10 May, 4 September, 14 – 16 October and 20 – 22 November 2019. These are hereafter referred to as the May, September, October and November JWS.

11. The data, information, facts, and assumptions I have considered in forming my opinions are set out in this statement to follow. The reasons for the opinions expressed are also set out in the statement to follow.

12. 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 that I express.

13. As a member of the New Zealand Freshwater Sciences Society, a constituent organisation of the Royal Society of New Zealand - Te Apārangi, I am also bound by the Royal Society of New Zealand Code of Professional Standards and Ethics in Science, Technology, and the Humanities.[2]

SCOPE

14. I have been asked by Forest and Bird and the Southland Fish and Game Council (Fish and Game) to provide this will say statement, participate in expert conferencing and provide evidence in relation to water quality and ecosystem health with respect to the Topic B provisions of the Proposed Southland Water and Land Plan (SWLP). This will say statement covers the following themes:

    a. The national framework for ecosystem health
    b. The degraded state of ecosystem health in many Southland water bodies
    c. The need for improvement in water quality and ecosystem health now
    d. The use of physiographic zones
    e. Activities which require a plan response towards improvement
    f. Riparian setbacks from water bodies
    g. The importance of ephemeral streams to ecosystem health
    h. Definitions of gravel and sediment

NATIONAL BIOPHYSICAL FRAMEWORK FOR ECOSYSTEM HEALTH

15. Ecosystem health is a compulsory national value under the National Policy Statement for Freshwater Management 2020 (NPS FM). National work to define a consistent

[2] https://royalsociety.org.nz/assets/Uploads/Code-of-Prof-Stds-and-Ethics-1-Jan-2019-web.pdf

framework for ecosystem health to implement the NPS FM (Clapcott et al. 2018) has identified the five core components of ecosystem health as:

a. Aquatic life,
b. Physical habitat,
c. Water quality,
d. Water quantity, and
e. Ecological processes.

16. The Clapcott et al. (2018) framework is directly referenced in the NPS FM (2020) and the definition of ecosystem health in Appendix 1A acknowledges the five biophysical components of ecosystem health. To my knowledge, most experts in fresh water agree[3] that this framework is the most appropriate method to define ecosystem health in Aotearoa New Zealand and to determine the attributes of healthy freshwater ecosystems, building on earlier national work to define and assess ecological integrity (Schallenberg et al. 2011).

17. In expert conferencing completed between May and November 2019, the experts used the definition of ecosystem health from the NPS FM (2017) Appendix 1, rather than the five component framework of Clapcott et al. (2018). However, in determining the attributes and setting the thresholds for degradation in the October and November JWS the experts were informed by the Science and Technical Advisory Group (STAG) 2019 report on attributes for the (then draft) NPS FM (2020). That report (STAG 2019) recommended attributes consistent with the five component framework for ecosystem health from Clapcott et al. (2018).

18. In the November JWS, the experts also considered thresholds of degradation for human health values.

DEGRADATION OF WATER BODIES IN SOUTHLAND

19. Many of Southland's rivers, lakes, wetlands, lagoons and estuaries are in a poor state with respect to water quality and ecosystem health. Shallow groundwater is also affected in many areas. The state of water quality has been declining over the last two decades, and this is largely attributable to expansion and intensification of land used for

[3] For example, the New Zealand Freshwater Sciences Society ran two national consultation workshops for members prior to providing a submission to government supporting the Clapcott et al. (2018) framework for ecosystem health.

dairying, winter feeding of dairy stock and associated land management and drainage practices. Diffuse contamination of surface and groundwater is the primary source of contamination of Southland's aquatic ecosystems. Anthropogenic impacts are degrading freshwater values across multiple aquatic ecosystem types.[4]

20. Water quality in Southland is degraded by land use (human activities) and is 'over-allocated' with respect to the pervasive level of water quality degradation, degrading trends in water quality, and the adverse effects this is having on freshwater values such as ecosystem health, human contact, drinking water, threatened species and tangata whenua cultural values, including mahinga kai. The poor state and declining trends in water quality and indicators of ecosystem health warrant an urgent and effective management response at the regional level. Southland presents a clear case for the need to <u>improve</u> water quality, not simply halt decline until a later plan process.[5]

21. The November JWS (and previous JWS) define the agreed positions of the experts on what constitutes degradation of waterways in Southland and what the specific attributes and thresholds of ecological degradation should be for regional planning purposes.[6] The experts agreed that there was sufficient data to make reliable decisions for planning purposes.[7]

22. The list of degraded waterbodies agreed by the experts is contained in the November JWS at Appendix 1. The grading of river sites against the thresholds of degradation agreed by the experts shows 62 State of the Environment (SOE) sites are degraded by one or more attribute, most are degraded for multiple attributes.

Lake, lagoon and wetland degradation and loss

23. Waituna Lagoon and Lake Vincent are degraded ICOLL/lakes,[8] modelling shows degradation of lakes is likely to be more widespread but measured data is limited to seven lakes. Southland wetlands are also degraded, threatened by agricultural activities and drainage, and are declining in extent (Robertson et al. 2018).[9]

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[4] Evidence in chief of K McArthur, 15 February 2019, paragraphs 16 – 18, 23 – 39 and Appendix 1. Also see evidence in chief of Mr Rodway, Dr Ward and Mr Hodson for the Council and the May, September, October and November JWS.
[5] Evidence in chief of K McArthur, paragraph 18.
[6] November JWS paragraphs 18 to 20 and Appendix 4.
[7] November JWS, paragraphs 18 and 20.
[8] November JWS , Figure 17 (lakes/lagoons) and Table 25 (ICOLLs).
[9] May JWS.

Estuary degradation

24. Jacobs River Estuary (Aparima) and New River Estuary (Ōreti) are both degraded, as indicated by macroalgae growth, extensive eutrophic areas, sites with low dissolved oxygen and high organic carbon. New River Estuary is also degraded by Nickel and has elevated chlorophyll *a*.[10] Fortrose Estuary (Mataura) is close to triggering the status of degraded.[11]

NEED FOR IMPROVEMENT NOW

25. The consequences of inaction or delaying nutrient source reductions for New Zealand rivers, lakes and estuaries were described by Graham et al. (2020) to inform and support the government's current freshwater reforms through the NPS FM (2020). Graham et al. (2020) described compelling reasons not to delay nutrient reductions affecting waterbodies, including:

    a. Stocks of nutrients stored in sediment will increase as long as inputs continue, and the release of nutrients from these internal storages will continue long after inputs are reduced.

    b. Sediment deposition exacerbated by nuisance river macrophytes and nutrient storage by algae prolong recovery and become more likely with the duration of high nutrient source loading.

    c. Risks of ecological states resistant to rehabilitation (e.g., phytoplankton-dominated shallow lakes, deep lakes with high trophic levels, streams dominated by degradation-tolerant species that block re-establishment of more desirable biota) increase the longer that source reductions are delayed.

    d. Competitive exclusion of sensitive taxa by degradation-tolerant riverine biota are likely to make remediation less effective and may require additional interventions.

[10] November JWS, Table 31, page 40.
[11] November JWS, paragraph 78: "*The macroalgae growth variable for Fortrose (0.453 EQR) is close to triggering the status of 'degraded' (<0.4 EQR). Additionally, gross eutrophic zones have been detected in the last three years where they have not previously existed in the system. The Fortrose Estuary is a well-flushed estuary and hence has lower susceptibility to eutrophication than the other monitored estuaries. Therefore, the presence of these indications of degradation in this estuary is concerning. This represents the physical expression of problem conditions that are likely to be hard to reverse*."

e. Additional remediation options may be required that may not have been necessary if nutrient management action were taken earlier.

f. For lakes, reductions of external loading may need to be greater, compared with loadings required to achieve outcomes if the lake had not been degraded in the first place.

g. Delays in reducing nitrogen leaching will result in increased peak loading to streams and protracted recovery for groundwater systems that have not yet responded fully to past increases in loading.

26. Delay or inaction to reduce nutrients at source has serious ecological and remediation costs across all freshwater ecosystems (Graham et al. 2020). The consequences outlined by Graham et al. (2020) are highly relevant to Southland's water bodies and should be considered when assessing the appropriateness of Council's approach, the SWLP provisions and, as indicated in the evidence of Mr McCallum-Clark, the intention to address degradation through future plan processes.

27. Similarly, failure to reduce inputs of sediment and toxicants (e.g., metals) will have synergistic and multi-stressor adverse effects on ecosystem health that also become more difficult and more expensive to remedy the longer action is delayed.

28. Recent research shows that degraded stream macroinvertebrate communities in Aotearoa New Zealand can be highly resistant and resilient, making restoration difficult (Barrett et al. 2021). Macroinvertebrate communities in degraded streams become dominated by hyper-tolerant species, preventing recolonisation of more sensitive species, even after water quality improvement.

PHYSIOGRAPHIC ZONES

29. The physiographic zones and application of the overland flow and artificial drainage variants is an excellent and parsimonious[12] 'model' of water quality risk for Southland. Physiographic zones provide a useful tool to inform future FMU processes, appropriate and effective on-farm mitigations in Farm Environmental Management Plans (FEMP) and

[12] A parsimonious model is a model that accomplishes a desired level of explanation or prediction with as few predictor variables as possible.

can inform resource consents for land use.[13] In my view it is useful for these maps to be included within the SWLP.

ACTIVITIES REQUIRING A PLAN RESPONSE

30. Generally, in Southland, water quality decreases with decreasing elevation and increasing proportion of the catchment in pasture (November JWS para 24).

31. To counter the pervasive effects of intensive agricultural land use (including winter grazing) on the ecosystem health of water bodies in Southland a multi-faceted response to reducing contaminant inputs is needed. Whilst we do not (and will likely never) have perfect information, there is good and reliable information to support the need for remedial actions and a plan response now, including:

    a. The degree of degradation of various waterbodies and ecosystem types
    b. Where degraded waterbodies are located
    c. The physiographic nature of the landscape
    d. The risk pathways for contaminant transport (both by physiographic zone and from drainage and overland flow)
    e. The likely causes of degradation
    f. How various activities can be mitigated to reduce effects and improve ecosystem health and water quality.

32. We also know that delaying action will have ecological and economic costs and will make future restoration more difficult and expensive (Graham et al. 2020; Barrett et al. 2021).

RIPARIAN SETBACKS

33. Cultivation and grazing of land adjacent to waterways exacerbates and accelerates the transport of sediment and phosphorus to water (Basher et al. 1997). If cultivated land adjacent to waterbodies is used for grazing of fodder crops *in situ,* microbial pathogens also become problematic contaminants of water. Cultivation, stock access or earthworks on land adjacent to waterways can impact on riparian spawning habitat through direct disturbance of spawning areas and eggs, sedimentation, and removal of vegetation.

[13] Evidence in chief of K McArthur, 15 February 2019, paragraphs 20 and 90.

34. Setback distances and vegetated riparian margins can alleviate or reduce many of the effects of cultivation and grazing adjacent to waterbodies on water quality. They contribute to reducing the influx of sediment to water from the largest load contributors: pastoral agriculture and streambank erosion.

35. Good riparian management (including stock exclusion, vegetated buffers and setbacks) has multiple benefits for water quality, including: nutrient, microbial and sediment interception and processing, shading, input of wood and leaves to freshwater ecosystems, and enhanced fish, spawning and invertebrate habitat (Parkyn 2004; McKergow et al. 2016).

36. Setbacks from water for sediment generating activities are a key method to avoid or reduce the adverse effects on water quality, ecosystem health and critical spawning habitats. Wider margins also have significant concomitant benefits for reducing other contaminants associated with cultivation, arable cropping and grazing, particularly nitrogen and microbial pathogens.

37. The ideal width required for trapping of particulate contaminants in surface runoff differs because the effectiveness of riparian buffer width varies as a function of slope, soils, drainage/hydrology, vegetation, rainfall and mode of contaminant transport (Collier et al. 1995; Parkyn 2004; Liu et al. 2008; McKergow et al. 2016).

38. There are key conclusions that can be drawn from the literature on riparian management and buffers: slope is an important factor – steeper land requires wider buffers (Liu et al. 2008), small headwater streams also require setbacks and buffers as they are important for ecosystem health (Greenwood et al. 2012) and for nutrient contaminant reductions at the catchment scale (McDowell et al. 2017), and wider is usually better for effective contaminant removal (Parkyn 2004). Generally, buffer widths need to widen as the slope length, angle, and clay content of the adjacent land increase and as soil drainage decreases (Collier et al. 1995; Quinn and McKergow 2007).

39. Parkyn (2004) reviewed the New Zealand and international literature on the effectiveness of riparian buffer zones, reporting that in studies of perennial ryegrass filter strips the first five metres were critical for removal of larger particles of sediment removal and that 20 metre filter strips were able to remove 90% of sediment along with sediment-bound and particulate nutrients due to increased infiltration within the wider buffer. Liu et al. (2008) reported an optimal buffer width of 10 metres for sediment removal and that

sediment removal did not appreciably increase beyond 10 metre wide filter strips. The effectiveness of even a 10 metre strip may be reduced because of clogging by fine sediment (whereby the capacity of the vegetation to filter sediment is overwhelmed over time if the flux of sediment from the landscape is not managed).

40. Smith (1989) in a New Zealand study, found removal of more than 80% of fine (suspended) sediment and particulate nutrients for vegetated filter strips of 10-13 metres. Infiltration capacity was improved through root structures of vegetation in buffer zones.

41. Parkyn's (2004) review also reported sediment and total phosphorus removal rates increase (between 53% and 98%) with increasing buffer width (4.6 metres to 27 metres). Critically, most large sediment particles will be removed within five metres of grass buffer, but 10 metres was needed to remove finer particles and will capture up to 95% of total sediment. These fine particles create poor water clarity in suspension and contribute significantly to fine sediment deposition. However, few studies specifically examined the efficacy of riparian buffers at slopes greater than 10 degrees.

42. I recommend a 10 metre minimum buffer width is needed to reduce fine sediment and nutrient inputs to water bodies through overland flow and that wider buffers are needed where land slope increases above 10 degrees. The greater the slope the higher the erosion potential where soil is exposed by land use activities. Therefore, wider buffers (i.e., 20 metres or greater) will be needed to reduce the potential for fine sediment to enter water from exposed soils on steep land. Stock should be excluded from any setback or buffer, including in ephemeral and intermittent streams.

EPHEMERAL AND INTERMITTENT STREAMS

43. Small headwater streams are important for ecosystem health (Storey et al. 2011; Greenwood et al. 2012) and are critical areas for determining catchment water quality (McDowell et al. 2017).

44. Headwater streams (including ephemeral streams with isolated pools and intermittent streams) are known to contain as many or more invertebrates (both in density and species richness) as perennial streams (Storey et al. 2011). Headwater streams are also considered crucial for sustaining the structure, function, productivity, and biodiversity of downstream ecosystems (Wipfli et al. 2007; Freeman et al. 2007).

45. Studies of stream macroinvertebrates in Aotearoa New Zealand indicate that headwaters have high biodiversity values (Storey and Quinn 2008). Intermittent and ephemeral headwater habitats can have high biodiversity even where there is only a thin film of water and may also harbour headwater specialist or endemic species (Collier and Smith 2006).

46. The inclusion of small waterways (including headwater, intermittent and ephemeral streams) in stock exclusion, winter grazing and fertiliser discharge provisions is critical to ensure impacts on freshwater ecosystem health and water quality are reduced or avoided not just within the streams themselves, but also in downstream catchments (Storey et al. 2011; Greenwood et al. 2012; McKergow et al. 2016; McDowell et al. 2017). These streams require setbacks and riparian buffers to reduce contaminant transport from land to water and direct avoidance of the discharge of fertiliser. Small streams contribute 77% of the national contaminant load of nitrogen and phosphorous (McDowell et al. 2017). Management of small headwater streams to reduce contaminant transport is therefore a critical component of any regulatory plan that seeks to reduce contaminant loads across the catchment.

47. Ephemeral streams are critical sources of contaminant transport from the land to water and should be identified on-farm within Farm Environment Management Plans and included in rules to mitigate the impacts of farming activities on water bodies.

GRAVEL AND SEDIMENT DEFINITIONS

48. Fine sediment is defined in the national guidelines and sediment assessment protocols by Clapcott et al. (2011) as silts or sands <2 mm in diameter. Coarser particles (i.e., >2mm) can be termed ‘gravel’ through a range of particle size classes depending on the scale used. Gravel is generally used as the term for all particles larger than 2mm diameter.

Kathryn Jane McArthur
5 November 2021

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