BEFORE THE INDEPENDENT HEARINGS PANELS APPOINTED TO HEAR AND MAKE RECOMMENDATIONS ON SUBMISSIONS AND FURTHER SUBMISSIONS ON PROPOSED PLAN CHANGE 1 TO THE NATURAL RESOURCES PLAN FOR THE WELLINGTON REGION

UNDER	the Resource Management Act 1991 (the Act)
AND	
IN THE MATTER	of Hearing of Submissions and Further Submissions on Proposed Plan Change 1 to the Natural Resources Plan for the Wellington Region under Schedule 1 of the Act

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STATEMENT OF EVIDENCE OF DR MICHAEL JOHN CRAWSHAW GREER

ON BEHALF OF GREATER WELLINGTON REGIONAL COUNCIL

TECHNICAL EVIDENCE

HEARING STREAM TWO – OBJECTIVES, ECOSYSTEM HEALTH AND WATER QUALITY POLICIES

28 FEBRUARY 2025

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INTRODUCTION

1 My name is Michael John Crashaw Greer. I am the Principal Freshwater Scientist at Torlesse Environmental Ltd.

2 I have read the submissions relevant to the Section 42A report on Objectives and the Section 42A report on Ecosystem Health and Water Quality Policies.

3 I have prepared this statement of evidence on behalf of Greater Wellington Regional Council (**the Council**) in respect of technical matters arising from the submissions and further submissions on Proposed Change 1 (**PC1**) to the Natural Resources Plan for the Wellington Region (**NRP**).

4 Specifically, this statement of evidence relates to the matters in the Section 42A Report – Objectives and Ecosystem Health and Water Quality Policies. These matters are considered from a scientific perspective only, and I do not make policy recommendations.

QUALIFICATIONS AND EXPERIENCE

5 I hold a PhD in Ecology and a Bachelor of Science in Zoology from the University of Otago.

6 I have over 14 years of work experience in freshwater quality and ecology, and have worked for local government, the Department of Conservation and NIWA. Since the 6th of June 2022 I have been the Principal Scientist at Torlesse Environmental Ltd. Prior to that I was employed by Aquanet Consulting Ltd as a Senior Freshwater Scientist, the Council as a Senior Environmental Scientist and Environment Canterbury as an Ecology Scientist.

7 Since 2018 I have been engaged by 19 different regional, district or city councils; the Department of Conservation; and various industry bodies, private companies, and corporations to provide a variety of technical and scientific services in relation to water quality and aquatic ecology. My work routinely involves:

7.1 Providing assessments of effects on water quality and/or aquatic ecology, recommending or assessing compliance with resource consent conditions;

7.2 Designing or implementing water quality/aquatic ecology monitoring programmes at the scale of a specific activity and at a wider catchment or regional scale; and

7.3 Advising regional councils on regional plan development and National Policy Statement for Freshwater Management (**NPS-FM**) implementation.

8 I was the Council's technical lead for the Surface Water Quality and Ecology Expert Panels for the Whaitua Te Whanganui-a-Tara (**TWT**) and Whaitua Kāpiti processes, and have sat on expert panels for Environment Canterbury, West Coast Regional Council and the Tasman District Council as part of their NPS-FM implementation processes. I have also authored or co-authored a number of catchment and region-wide water quality reports to inform the NPS-FM Implementation programmes of the Council (TWT, Ruamāhanga Whaitua and Whaitua Kāpiti), West Coast Regional Council (whole region), Environment Southland (whole region), and Environment Canterbury (Lower Waitaki Water Zone and Waimakariri Water Zone).

9 Between 2017 and 2022 I acted on behalf of the Council during the council hearings and environment court appeal processes for the NRP. That role involved writing evidence for Council and Environment Court hearings, contributing to mediation and attending expert conferencing on matters relating to the freshwater quality and aquatic ecosystem health, stream reclamation and drain management provisions in the NRP. I also authored the Council's guidance documents on implementing the vegetation clearance rules and watercourse classification definitions in the NRP and led the mapping of highly modified rivers and streams in the Wellington Region.

10 Since 2022 I have acted as a technical advisor for PC1. This role involved/involves:

10.1 Planning and preparing the technical work underpinning the process by which the freshwater and coastal objectives recommended in the TWT and Te Awarua-o-Porirua (**TAoP**) Whaitua Implementation Programmes (**WIP**s) were refined into the target attribute states (**TAS**), coastal objectives and contaminant load reduction targets in the notified version of PC1;

10.2 Developing the nutrient outcomes in PC1 to ensure consistency with the requirements of Clause 3.13 of the NPS-FM 2020 (as amended February 2023) and the associated national guidance;

10.3 Contributing to the drafting of provisions where necessary to ensure consistency with the relevant TAS and coastal objectives;

10.4 Using the best available information to assess the extent to which the regulatory provisions of PC1 will contribute to the achievement of the TAS; and

10.5 Providing on-going technical advice to officers and S42A report authors during the hearing process.

11 I have acted on behalf of appellants/submitters during the Environment Court appeals on Plan Change 10 (Lake Rotorua Nutrient Management) to the Bay of Plenty Regional Natural Resources Plan and Waikato Plan Change 1, and the Council hearings on Proposed Plan Change 9 (TANK Catchments) to the Hawke's Bay Regional Resource Management Plan. I also acted on behalf of the Southland Regional Council during Environment Court mediation on the Proposed Southland Water and Land Plan.

12 I have worked as a technical advisor on behalf of both consenting authorities and applicants on well over 200 resource consent applications, compliance assessments and/or prosecution cases. These applications have been for a wide range of activities, including stream reclamation, and stormwater discharges.

13 I am a member of New Zealand freshwater sciences society.

CODE OF CONDUCT

14 I have read the Code of Conduct for Expert Witnesses set out in the Environment Court's Practice Note 2023 (Part 9). I have complied with the Code of Conduct in preparing this evidence. My experience and qualifications are set out above. Except where I state I rely on the evidence of another person, I confirm that the issues addressed in this evidence are within my area 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

15 My statement of evidence addresses the following matters:

15.1 The biophysical background to the freshwater environments in TWT and the TAoP Whaitua, including their current water quality and ecology;

15.2 The origin and impact of the TAS in Tables 8.2, 8.4 and 9.2 in PC1 including:

15.2.1. The source and significance of the different attributes;

15.2.2. The process through which the TAS were set;

15.2.3. The method used to select the part Freshwater Management Units (**part-FMUs**) and sites in Tables 8.4 and 9.2; and

15.2.4. The meaning and intent of the footnotes and narrative TAS in Tables 8.4 and 9.2.

15.3 The expected outcome of achieving the different TAS in relation to the values of ecosystem health and human contact, including identification of any inconsistencies in the TAS set for each part-FMU. I.e., where a target for one attribute that is set at a level that is likely to prevent the achievement of the environmental endpoints sought by the other TAS, or where a target for an attribute is set at a level that goes beyond what is necessary to achieve the outcome sought by the other TAS;

15.4 The technical work conducted to inform the development of PC1, both during and after the Whaitua processes;

15.5 The source of the sediment load reductions in Tables 8.5 and 9.4 of PC1;

15.6 The actions required to achieve the TAS and the extent to which the provisions of PC1 contribute; and

15.7 Responses to the technical matters raised in submissions related to freshwater quality and ecology.

16 To achieve some level of brevity, this statement of evidence does not fully repeat information included in previously published technical reports. Instead, it provides summaries of key points, along with section number references and hyperlinks for the relevant reports.

BACKGROUND CONTEXT

17 PC1 implements the NPS-FM 2020 for TWT and the TAoP Whaitua. This involves setting objectives, policies, rules and other methods to manage activities such as urban development, earthworks, stormwater, wastewater and rural land use. Accordingly, PC1:

17.1 Defines TAS for the compulsory attributes in Appendix 2A and 2B of the NPS-FM 2020 and other attributes recommended in the WIPs; and

17.2 Establishes provisions that will contribute to the achievement of those TAS.

18 The primary purpose of this statement of evidence is to document the details of the PC1 TAS setting process (as required by Clause 3.6 of the NPS-FM 2020) and to assess the extent to which the regulatory provisions of PC1 will achieve the TAS.

BIOPHYSICAL SETTING OF TWT

19 TWT encompasses the area between the Remutaka ranges and the west coast and extends from the Akatarawa Saddle in the north to Cook Strait in the south (

20 **Figure 1**). While the northern boundary of the Whaitua extends beyond Te Awarua-o-Porirua Harbour, it does not include those streams within the harbour's catchment, or the coastal streams north of Porirua City. The main catchments in the Whaitua are the Hutt (Te Awa Kairangi), Ōrongorongo and the Wainuiomata river catchments and the Mākara Stream catchment. The Whaitua also includes several smaller catchments that either discharge directly to Wellington Harbour (e.g. the Kaiwharawhara, Korokoro and Waiwhetū streams), or the coast (e.g., the Ōwhiro, Karori and Oteranga streams). The Whaitua also encompasses the Parangārahu Lakes (Kōhangatera and Kōhangapiripiri) which are located near the mouth of Wellington Harbour to the east of Pencarrow heads. A fulsome description of the major catchments in the Whaitua can be found in Section 1.3 of Greer and Ausseil[1] (hyperlinked below[1]).

21 That analysis[1] concluded the following regarding the state and drivers of river water quality and ecology in TWT rivers:

21.1 Macroinvertebrate community health is generally degraded in catchments with a significant amount of urban or agricultural land-cover.

21.2 In urban catchments, ecological degradation is driven by a complex combination of modified flows, elevated toxicant concentrations, sedimentation and habitat degradation. In rural catchments, nutrient enrichment and associated algal growth appear to be the major drivers of degradation but it is likely that unmeasured factors, including instream and riparian habitat degradation, stock access and river engineering activities, also contribute.

21.3 Significant faecal contamination is generally limited to urban streams. The Mangaroa River (a major tributary of the Te Awa Kairangi/Hutt River) and the

[1] https://www.gw.govt.nz/assets/Documents/2022/05/REPORT-Whaitua-Te-Whanganui-a-Tara-River-and-stream-water-quality-and-ecology.pdf

Mākara Stream are the only non-urban waterways that were not considered swimmable under the NPS-FM 2020. The main source of faecal contamination in urban streams is human wastewater, while in the Mākara Stream and Mangaroa River the primary source is stock. Benthic cyanobacteria sometimes poses a potential health risk to recreational users in the Hutt River, but the causes for this are complex and not fully understood.

BIOPHYSICAL SETTING OF TAOP WHAITUA

22 The TAoP Whaitua encompasses all of Porirua City and the Wellington suburbs of Tawa, Churton Park, Grenada, Paparangi and Glenside. North to south it covers the area between Paekākāriki and Churton Park, with its inland boundary extending almost to the Hutt River (**Figure 2**). The vast majority of the Whaitua is in the catchment of the Te Awarua-o-Porirua Harbour, with only a small number of short catchments discharging directly to the open coast between Titahi Bay and Paekākāriki. The largest catchments in the Whaitua are the Porirua Stream, which discharges to the southern Onepoto Arm of the harbour, and the Pāuatahanui and Horokiri streams which both discharge to the northern Pāuatahanui Inlet of the harbour. Other important catchments are Duck Creek and Kakaho Stream, which discharge to Pāuatahanui Inlet, and Taupō Stream, which discharges to the harbour outlet at Plimmerton.

23 To date, the Council is yet to compile a fulsome current state assessment of the TAoP Whaitua (other than a baseline modelling report[2]) or identify the drivers of degradation in different catchments in a published report. However, macroinvertebrate community health is generally degraded in all monitored catchments, currently reflecting only fair or poor ecological condition (**Table 4**). In urban streams, the main pressures are likely modified flows, elevated toxicant (metal) concentrations and habitat degradation. Deposited fine sediment appears to be less of a concern than in the urban streams in TWT, with median bed cover less than 20% in Duck Creek and Porirua Stream (**Table 4**) and Taupo Stream being naturally soft-bottomed. In the rural streams, deposited fine sediment appears to be an important stressor in the Pāuatahanui Stream, with median bed cover currently at 67%, while in the Horokiri Stream periphyton is likely to be a larger issue, combined with unmeasured site conditions, such as habitat quality.

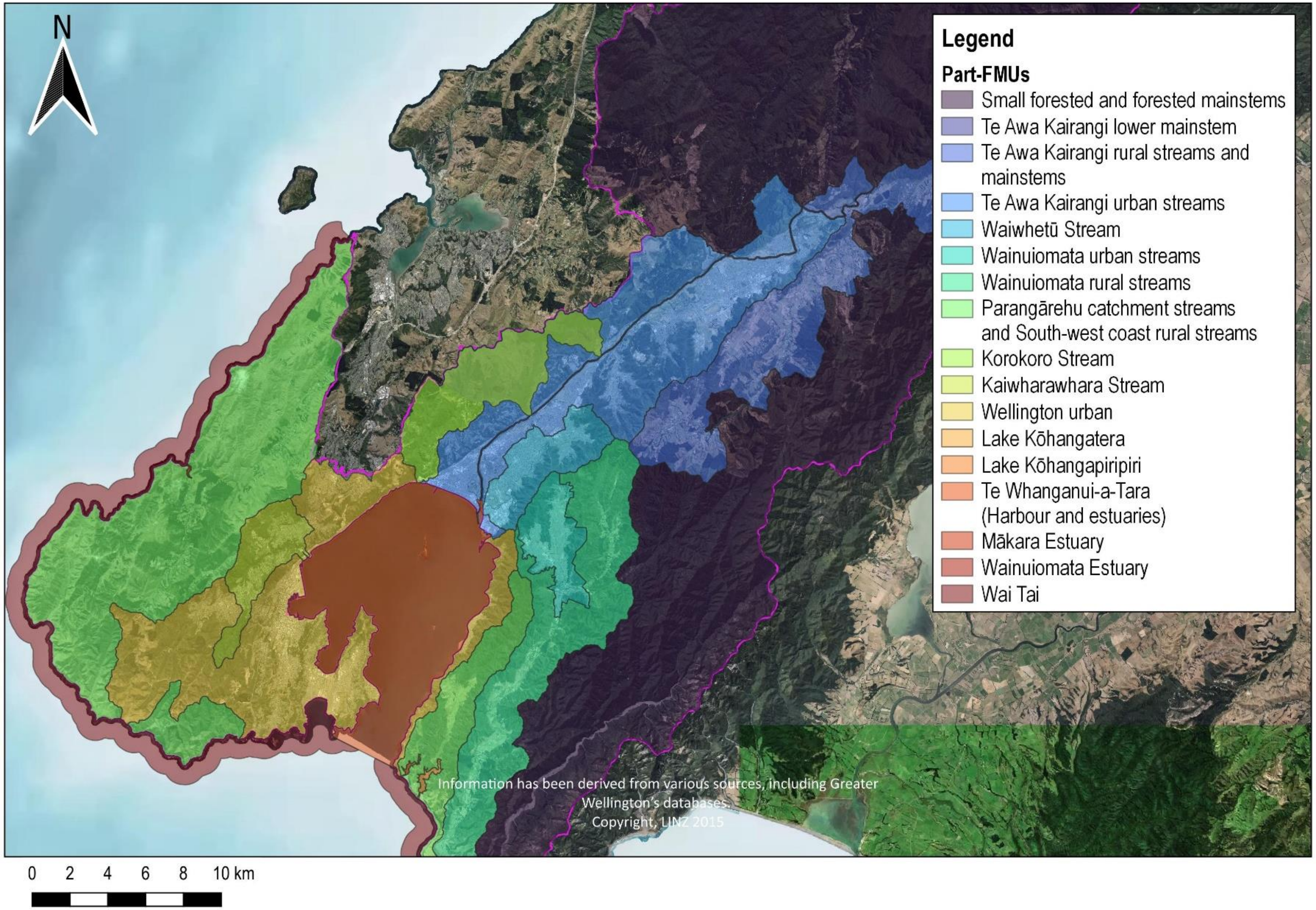

Figure 1: Map of TWT Whaitua (purple boundary) and the PC1 part-FMUs.

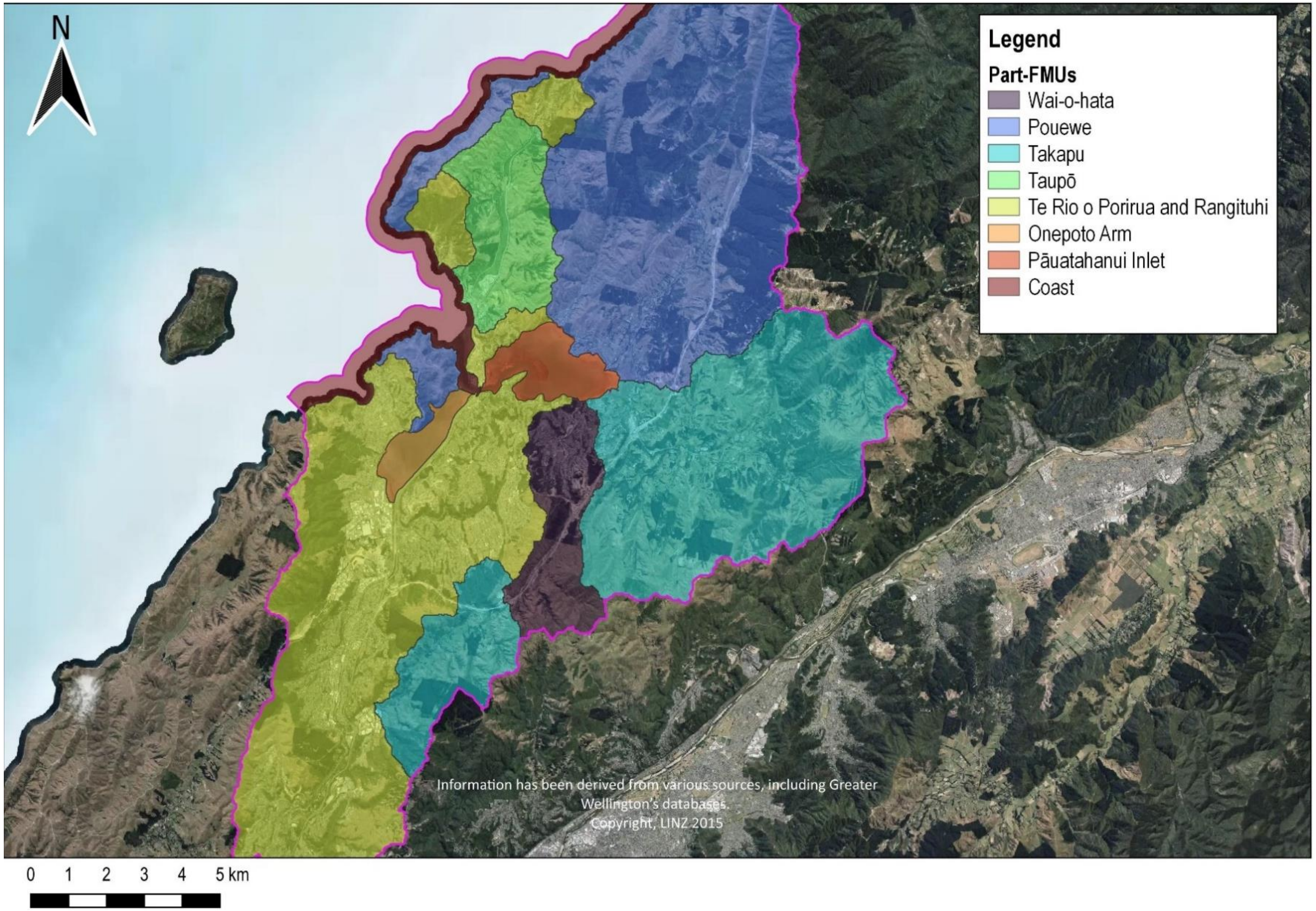

Figure 2: Map of TAoP Whaitua (purple boundary) and the PC1 part-FMUs.

DESCRIPTION OF THE ATTRIBUTES IN TABLES 8.2, 8.4 AND 9.2 OF PC1

24 The freshwater attributes included in Tables 8.2, 8.4 and 9.2 of PC1 are described in paragraph 25 (rivers) and paragraph 26 (lakes) below. Included in these descriptions is a scientific explanation of the type and level of environmental protection achieved at the different attribute state (letter grades) thresholds. In many cases, these descriptions differ from the less detailed and often inaccurate narrative attribute states included in Appendix 2A and 2B of the NPS-FM 2020.

Note: *Attributes are described in paragraph 25 and paragraph 26 as compulsory under the NPS-FM 2020 if they included in Appendix 2A or 2B of that document.*

25 For rivers, TAS have been set for the following attributes:

25.1 **Periphyton biomass** – Periphyton is the slime and algae found on the bed of streams and rivers. As a primary producer, periphyton is an important foundation of many river and stream food webs, particularly in rivers with hard, cobbly substrate. However, an over-abundance of periphyton can reduce ecological habitat quality[3]. Large standing crops of periphyton can smother stream-bed substrate and cause large daily fluctuations in dissolved oxygen concentrations and pH. Therefore, it is important to manage rivers and streams to reduce the risk of nuisance growths. Periphyton biomass, measured in milligrams of chlorophyll *a* per square metre of riverbed, is the most commonly used periphyton measure for assessing ecosystem health. It is also a compulsory attribute in the NPS-FM 2020, which categorises periphyton biomass into the following attribute states:

25.1.1. **A** state – The guideline value recommended by Biggs[4] for the protection of benthic biodiversity is met and there are only "*rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat*"[5];

25.1.2. **B** state – The filamentous periphyton biomass guideline recommended by Biggs[4] for the protection of aesthetic/recreational values and trout habitat/angling values is met and there are only "*occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat*"[5];

25.1.3. **C** state – The diatoms/cyanobacteria (mat) biomass guideline recommended by Biggs[4] for the protection of trout habitat/angling values is met and there are only "*periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or moderate alteration of the natural flow regime or habitat*"[5];

25.1.4. **D** state – The diatoms/cyanobacteria (mat) biomass guideline recommended by Biggs[4] for the protection of trout habitat/angling values is not met and there are "*regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat*"[5].

25.2 **Ammonia (toxicity)** and **Nitrate (toxicity)** – Nitrate-nitrogen is toxic to invertebrates and fish in high concentrations as it interferes with oxygen transport in the blood, and consequently, metabolic function[6]. In humans this effect is known as methemoglobinemia, and is often referred to as blue baby syndrome, due to the cyanosis (blue skin colouration) commonly observed in affected children[7]. Susceptibility to nitrate toxicity varies between species and even different life stages of a particular species[6]. Ammonia toxicity occurs when accumulations inside the body interfere with metabolic processes and increase body pH[6,8]. When exposed to extreme concentrations of ammonia, fish go into convulsions followed by coma, and death. As with nitrate, susceptibility to ammonia toxicity is species and life stage dependent. Nitrate (toxicity) and Ammonia (toxicity) are compulsory attributes under the NPS-FM 2020 with the following attribute states:

25.2.1. **A** state – The 99% species protection guidelines recommended by Hickey[9,10] are met. In this attribute state nitrate and ammonia toxicity effects are not expected on any species. Under the Australian and New Zealand guidelines for fresh and marine water quality (**ANZG**) 2018[11] Water Quality Management Framework this is the default level that should be set to protect high conservation or ecological value systems;

25.2.2. **B** state – The 95% species protection guidelines recommended by Hickey[9,10] are met. In this attribute state nitrate and ammonia toxicity are only expected to occasionally impact the development growth and/or reproduction of 1% to 5% of the most sensitive species. Under the ANZG 2018[11] Water Quality Management Framework this is the default level that should be set to protect slightly to moderately disturbed systems;

25.2.3. **C** state – The 80% species protection guidelines recommended by Hickey[9,10] are met. In this attribute state nitrate and ammonia toxicity start to regularly impact the development, growth and/or reproduction of 5% to 20% of the most sensitive species. While there is a low risk of acute toxicity effects in this attribute state, the native fingernail clam (*Sphaerium novaezelandiae*) is not protected against chronic survival effects[10]; and

25.2.4. **D** state – The 80% species protection guidelines recommended by Hickey[9,10] are not met. In this attribute state nitrate and ammonia toxicity impacts the development growth and/or reproduction of >20% of species. As this attribute state has no upper limit, concentrations may exceed acutely toxic (i.e., lethal) levels.

Note: *From a plant growth perspective, even the B nitrate attribute state exceeds the level required to facilitate unconstrained periphyton growth*[12] *(i.e., significant adverse effects associated nitrate-driven periphyton growth can occur in the A, B or C state even in the absence of toxicity effects). Thus, the nitrate attributes states only provide an indication of toxicity risk, not the risk of all adverse effects associated with this form of nitrogen.*

25.3 **Suspended fine sediment** – At high concentrations, suspended sediments can have a range of direct and indirect negative ecological effects. Physical abrasion and reduced light penetration at high suspended sediment concentrations can reduce periphyton and macrophyte abundance[13,14,15,16,17], thereby limiting food availability to macroinvertebrates[16,18]. This, combined with increased drift as invertebrates are dislodged by sediment, can lead to reduced abundance[18,19]. Fish can also be impacted by high suspended sediment concentrations by reduced recruitment of migrating juveniles, clogged gills, reduced feeding performance, and diminished food availability[18,20,21,22,23,24]. The compulsory suspended fine sediment attribute in the NPS-FM 2020 includes different numeric attribute states for visual clarity (a measure of how far the human eye can see in water) for rivers within each of four sediment classes[2]. These attribute states were set to achieve the following outcomes for fish[25]:

25.3.1. **A** state – Less than 7% reduction in probability of capturing seven sediment sensitive (i.e., prefer less sediment) fish species due to impact of suspended fine sediment;

25.3.2. **B** state – Greater than 7% reduction in probability of capturing sensitive fish species due to impact of suspended fine sediment;

25.3.3. **C** state – Greater than 13% reduction in probability of capturing sensitive fish species due to impact of suspended fine sediment; and

25.3.4. **D** state – Greater than 20% reduction in probability of capturing sensitive fish species due to impact of suspended fine sediment.

25.4 ***E. coli*** – *Escherichia coli* (***E. coli***) is a bacterium that naturally occurs in the lower intestines of humans and animals; for that reason, its presence in freshwater is indicative of faecal contamination. *E. coli* does not generally pose a significant risk to human health in itself. However, the level at which it is present can be used to quantify the risk of infection from faecal pathogens, generally *Campylobacter*. *E. coli* is the primary attribute used in New Zealand to assess the microbiological health risks associated with contact with recreational waters. *E.* is a compulsory attribute under the NPS-FM 2020 and its attribute states[3] contain four assessment statistics:

25.4.1. % samples over 540 coli forming units (**CFU**)/100 mL

25.4.2. % samples over 260 CFU/100 mL

25.4.3. Median CFU/100 mL

25.4.4. 95th percentile CFU/100 mL

With the exception of the 95th percentile for attributes states B to D (which act as data distributional controls to limit the occurrence of 'spikes' in waters with

[2] The class framework is intended to account for the natural variability between rivers with different climates, source of flow and catchment geology.

[3] In Appendix 2A of the NPS-FM 2020 (Table 9). The NPS-FM 2020 Appendix 2B *E. coli* attribute (Table 22) is not included in Tables 8.2, 8.4 and 9.2. Instead, it has its own table (8.3) that is specific to primary contact sites.

otherwise low *E. coli* concentrations), the thresholds for these statistics correlate to a specific risk of *Campylobacter* infection for people undertaking activities involving full immersion in water, as outlined in the New Zealand Microbiological water quality guidelines for marine and freshwater recreational areas[26]. The attribute states[3] are set to achieve the following:

25.4.5. **A** state – ≤ 0.1% risk of *Campylobacter* infection at least 50% of the time; average infection risk ≤ 1%[5];

25.4.6. **B** state – ≤ 0.1% risk at least 50% of the time; average risk ≤ 2%[5];

25.4.7. **C** state – ≤ 0.1% risk at least 50% of the time; average risk ≤ 3%[5];

25.4.8. **D** state – ≥5% risk 20% to 30% of the time; average risk ≥ 3%[5]; and

25.4.9. **E** state – ≥5% risk more than 30% of the time; average risk > 7%[5].

25.5 **Fish** – The Fish Index of Biotic Integrity (**Fish-IBI**) a composite of index species richness developed for use in New Zealand by Joy and Death[27]. It is composed of six metrics of fish community composition:

25.5.1. Total number of native species;

25.5.2. Number of native riffle-dwelling species;

25.5.3. Number of native benthic pool-dwelling species;

25.5.4. Number of native pelagic species;

25.5.5. Number of intolerant or sensitive native species; and

25.5.6. Proportion of non-native species.

The Fish-IBI is a compulsory attribute under the NPS-FM 2020. While the narrative attribute state thresholds in the NPS-FM 2020 refer to achieving a specific level of fish community integrity, this is not the case. Attribute states reflect where a site sits in relation to equal quantiles of measured Fish-IBI scores collected at different sites around New Zealand between 2010 and 2017[28]. I.e.:

25.5.7. **A** state – Reflects the Fish-IBI scores recorded in the top 25% of sites sampled between 2010 and 2017;

25.5.8. **B** state – Reflects the scores recorded in the top 50% of sites;

25.5.9. **C** state – Reflects the scores recorded in the top 75% of sites; and

25.5.10. **D** state – Reflects the scores recorded in the worst 25% of sites.

Importantly, the Fish-IBI is a presence-absence metric that primarily reflects one component of fish community health; diversity. For the Fish-IBI to change at a site a species must be introduced or extirpated. Managing discharges, controlling works on the bed and conducting restoration works can improve the structure and composition of the resident fish community. However, the impact on diversity is likely to be limited in many cases due to the migratory nature of many native fishes, which facilitates the constant colonisation of even the most degraded rivers and streams.

25.6 **Fish community health (abundance, structure and composition)** – As set out in paragraph 25.5 above, the Fish-IBI only responds to changes in diversity, it is not sensitive to other important aspects of fish community health such as abundance, structure and composition. The TAoP WIP included a narrative fish attribute that attempted to capture these components of fish. However, this used vague and inconsistent terminology that would have significantly hindered benchmarking in the future. Instead, the existing narrative fish objectives in Objective O19 of the operative NRP were adapted into a four-band A to D framework for PC1. The resulting narrative attribute state requires that an expert consider abundance, structure and composition of fish communities to assess an overall level of community health. While the various components of these narrative attribute states cannot currently be benchmarked against the prescribed level of ecosystem health (see paragraph 163 for limitations of this approach), the wording allows for the adoption of any future relevant community health indices provided they are graded in the four-category scale that has become ubiquitous in ecosystem health metrics. The narrative attribute states for the Fish community health attribute are as follows:

25.6.1. **A** state – The abundance, structure and composition of fish communities are reflective of an excellent state of aquatic ecosystem health;

25.6.2. **B** state – The abundance, structure and composition of fish communities are reflective of a good state of aquatic ecosystem health

25.6.3. **C** state – The abundance, structure and composition of fish communities are reflective of a fair state of aquatic ecosystem health; and

25.6.4. **D** state – The abundance, structure and composition of fish communities are reflective of a poor state of aquatic ecosystem health.

Further detail on the development of the Fish community health can be found in Section 4.1 of Greer *et al*.[29] at the link below[4].

25.7 **Macroinvertebrate Community Index and Quantitative Macroinvertebrate Community Index (Macroinvertebrates (1 of 2))** - The Macroinvertebrate Community Index (**MCI**) is frequently used in New Zealand to capture the macroinvertebrate community response to stressors such as organic material and nutrients[30,31]. As its name suggests, the Quantitative Macroinvertebrate Community Index (**QMCI**) is the quantitative version of the MCI. That is, while the MCI only considers whether a taxon is present or absent, the QMCI responds to changes in taxonomic and numerical composition or the relative abundances of different taxa. Invertebrate communities with high MCI and QMCI scores are dominated by taxa that are sensitive to water quality and habitat disturbance, such as stoneflies, mayflies, and caddisflies; communities with low MCI and QMCI scores are dominated by tolerant taxa, such as snails, worms, and midges. MCI and QMCI are combined in a compulsory attribute in the NPS-FM 2020 (hereafter referred to as **Q/MCI**). The attribute state thresholds are based on generic thresholds developed by Stark and Maxted[31], which have been widely used in New Zealand to describe ecological quality. However, these were subjectively increased (MCI +10; QMCI + 0.5) before being included in the NPS-FM 2020, following recommendations of a Freshwater Science and Technical Advisory Group[32]. The attribute states for Q/MCI were set to achieve the following:

[4] https://www.gw.govt.nz/assets/Documents/2023/10/Greer-M.J.C.-Blyth-J.-Eason-S.-Gadd-J.-King-B.-Nation-T.-Oliver-M.-Perrie-A.-2023.-Technical-assessments-undertaken-to-inform-the-target-attribute-state-framework-of-proposed-Plan-Change-1-to-the-.pdf

25.7.1. **A** state – Macroinvertebrate community health reflects an excellent state of ecosystem health, indicative of what would be expected in undisturbed pristine ecosystems;

25.7.2. **B** state – Macroinvertebrate community health reflects a good state of ecosystem health, indicative of mild organic pollution or nutrient enrichment;

25.7.3. **C** state – Macroinvertebrate community health reflects a fair state of ecosystem health, indicative of moderate organic pollution or nutrient enrichment; and

25.7.4. **D** state – Macroinvertebrate community health reflects a poor state of ecosystem health, indicative of severe organic pollution or nutrient enrichment.

25.8 **Macroinvertebrate Average Score Per Metric (Macroinvertebrates (2 of 2))** – The Average Score Per Metric was developed by Collier[33] as a method for assessing ecosystem health in wadable rivers by considering the individual responses of key macroinvertebrate metrics. The average score per metric is composed of three individual metrics, the MCI; Ephemeroptera (mayflies); Plecoptera (stoneflies) and Trichoptera (caddisflies) (**EPT**)[5] richness and % EPT abundance, which, in combination capture the structure, composition, and tolerance of a macroinvertebrate community. It is calculated by standardising each metric by their observed maximum value and calculating an overall mean. In theory, the use of multiple metrics means the average score per metric captures a wider range of responses to different stressors than a single metric indicator like the MCI. However, its use is still in its infancy in New Zealand, and far less common than Q/MCI, especially in consenting and compliance. Nevertheless, it is a compulsory attribute in the NPS-FM 2020, the attribute state thresholds for which are set to achieve the following:

[5] EPT are typically sensitive to degradation. Thus, as stream health declines, the lower their abundance and richness relative to more tolerant taxa.

25.8.1. **A** state – Macroinvertebrate communities have high ecological integrity, similar to that expected under reference (pristine) conditions[5];

25.8.2. **B** state – Communities have mild to moderate loss of ecological integrity[5];

25.8.3. **C** state – Communities have moderate to severe loss of ecological integrity[5]; and

25.8.4. **D** state – Communities have severe loss of ecological integrity[5].

Note: *the Freshwater Science and Technical Advisory Group*[32] *that recommended the inclusion of the Average Score Per Metric attribute in the NPS-FM 2020 noted some uncertainty in the attribute state thresholds.*

25.9 **Deposited fine sediment** – Deposited fine sediment has a range of negative effects on stream ecosystems. Excessive fine sediment deposition reduces food and benthic habitat availability to invertebrates[18] by smothering periphyton and macrophytes[15,34,35,36] and infilling interstitial spaces[37,38]. In addition, sediment deposition can affect benthic invertebrates by reducing dissolved oxygen near the substrate[39]. Consequently, benthic sediment cover is an important regulator of invertebrate communities, especially when streambed cover exceeds 20%[40,41]. The effects of sediment deposition on macroinvertebrates can alter food availability to the fish species that prey upon them, which can affect growth rates and community structure[16,38,42,43]. Deposited sediment can also affect the reproductive performance of freshwater fish species. The availability of spawning habitat is a major determinant in the success or failure of fish populations, and large amounts of deposited sediment can have significant impacts on fish species that spawn in or on the bed substrate. Clapcott *et al.*[44] recommended a guideline value of <20% fine sediment cover to protect stream biodiversity and fish (both native and exotic). Deposited fine sediment is a compulsory attribute in the NPS-FM 2020, with an attribute state framework that can be described as[25]:

25.9.1. **A** state – Less than 7% reduction in probability of capturing sediment sensitive (i.e., prefer less sediment) macroinvertebrate taxa due to impact of deposited fine sediment;

25.9.2. **B** state – Greater than 7% reduction in probability of capturing sensitive taxa due to impact of deposited fine sediment;

25.9.3. **C** state – Greater than 13% reduction in probability of capturing sensitive taxa due to impact of deposited fine sediment; and

25.9.4. **D** state – Greater than 20% reduction in probability of capturing sensitive taxa due to impact of deposited fine sediment.

25.10 **Dissolved oxygen** – Dissolved oxygen is an important driver of ecosystem health, it both impacts (macroinvertebrates and fish) and is impacted by aquatic life (periphyton and macrophytes). Photosynthesis and respiration by plants typically drives a daily cycle in dissolved oxygen[45]. Oxygen concentrations increase during photosynthetic activity by day and decrease with respiration at night[45,46]. The amount of oxygen fish and macroinvertebrates can absorb across the membranes of respiratory organs is heavily dependent on environmental oxygen conditions, so reductions in external dissolved oxygen limits the supply of oxygen to body tissues[47]. Long-term exposure to moderately reduced oxygen conditions can hinder reproductive success, reduce growth rates and decrease mobility[48]. Hypoxia becomes lethal when oxygen supply is no longer adequate to meet the energy demands essential for life functions[49]. Dissolved oxygen is a compulsory attribute in the NPS-FM 2020, the attribute states of which are as follows:

25.10.1. **A** state – There is no impairment on salmonid fishery production associated with low dissolved oxygen and no behavioural response to low dissolved oxygen in inanga (*Galaxias maculatus*) or salmonids[50];

25.10.2. **B** state – Most fish communities are protected from moderate chronic effects associated with low dissolved oxygen and salmonid fishery production is protected from moderate impairment[50];

25.10.3. **C** state – Most fish communities are protected from significant chronic and acute (i.e., lethal) effects associated with low dissolved oxygen[50];

25.10.4. **D** state – Fish communities are subject to significant chronic and/or acute effects associated with low dissolved oxygen.

25.11 **Dissolved inorganic nitrogen** – Dissolved inorganic nitrogen is composed of nitrate-nitrogen, nitrite-nitrogen and ammoniacal-nitrogen, and is the component of nitrogen that is readily available for plant uptake. As concentrations increase so too does the risk of nuisance periphyton growths in hill-fed systems and nuisance macrophyte (aquatic plants) growths in spring-fed systems. The NPS-FM 2020 does not include an attribute state framework for dissolved inorganic nitrogen, but does require that regional councils set nutrient outcomes to achieve the target attribute state for nutrient attributes and attributes affected by nutrients (clause 3.13). Dissolved inorganic nitrogen concentrations have been included in PC1 as nutrient outcomes in relation to the TAS for ammoniacal-nitrogen, nitrate-nitrogen and periphyton (further detail provided in paragraphs 44 to 47).

25.12 **Dissolved reactive phosphorus** – Dissolved reactive phosphorus is the component of phosphorus that is readily available for plant uptake. As with dissolved inorganic nitrogen, the higher the dissolved reactive phosphorus concentration the greater the risk of nuisance periphyton and macrophyte growths. Dissolved reactive phosphorus is a compulsory attribute in the NPS-FM 2020, and the attribute states were developed by Canning[51]. They are based on correlations between modelled nutrient concentrations and measured values for the following attributes:

25.12.1. Periphyton;

25.12.2. Fish-IBI;

25.12.3. Q/MCI;

25.12.4. Average score per metric; and

25.12.5. Ecosystem metabolism.

The NPS-FM 2020 narrative attribute states for dissolved reactive phosphorus are set out below:

25.12.6. **A** state – Ecological communities and ecosystem processes are similar to those of natural reference conditions. No adverse effects attributable to dissolved reactive phosphorus enrichment are expected[5];

25.12.7. **B** state – Ecological communities are slightly impacted by minor dissolved reactive phosphorus elevation above natural reference conditions. If other conditions also favour eutrophication, sensitive ecosystems may experience additional algal and plant growth, loss of sensitive macroinvertebrate taxa, and higher respiration and decay rates[5];

25.12.8. **C** state– Ecological communities are impacted by moderate dissolved reactive phosphorus elevation above natural reference conditions. If other conditions also favour eutrophication, dissolved reactive phosphorus enrichment may cause increased algal and plant growth, loss of sensitive macro-invertebrate and fish, taxa, and high rates of respiration and decay[5]; and

25.12.9. **D** state – Ecological communities impacted by substantial dissolved reactive phosphorus elevation above natural reference conditions. in combination with other conditions favouring eutrophication, dissolved reactive phosphorus enrichment drives excessive primary production and significant changes in macroinvertebrate and fish communities, as taxa sensitive to hypoxia are lost[5].

Note: *The approach used to develop these attributes states does not acknowledge that while elevated nutrients and degraded ecological health often co-occur, this can be because both are driven by an increase in intensive land-use (which affects a range of environmental factors), and that any causative link is generally indirect and complex. As such, the narrative attribute states set out in paragraphs 25.12.6 to 25.12.9 are, in my opinion, oversimplified descriptors of the environmental outcome of their achievement. Periphyton growth is the primary mechanism through which phosphorus directly and/or indirectly affects the attributes listed in paragraph 25.12.2 to 25.12.4. Thus, in my opinion dissolved reactive phosphorus targets should primarily be set to control plant growth rather than achieve a specific NPS-FM 2020 attribute state, and this is the approach taken in PC1 (see paragraphs 44 to 47 for a description of how the dissolved reactive phosphorus nutrient outcomes in Table 8.4 and 9.2 were set).*

25.13 **Dissolved Copper** and **Dissolved Zinc** – At elevated concentrations copper and zinc (particularly in the dissolved phase) can be toxic to aquatic fauna and flora.

What is more, these contaminants may accumulate in bed sediments and the flesh of exposed animals, meaning that toxicity effects can build up over time[52]. Metal toxicity is dependent on a number of factors, including water temperature, pH, dissolved organic matter and hardness[52]. Species sensitivity to contaminants also depends on the life-stage of exposure (juvenile versus adult), the ability to regulate body-burdens, as well as the duration and frequency of exposure (e.g. pulse disturbance of first flush stormwater discharges). The dissolved copper and zinc attribute states in PC1 are based on 'strawman' attribute states developed for Auckland[53] and were drafted by the Council[54,55] during the TAoP Whaitua process. For each both copper and zinc the attribute the states used in PC1 are as follows:

25.13.1. **A** state – The 99% species protection guideline values are met and copper and zinc toxicity effects are not expected on any species. Under ANZG 2018[11] Water Quality Management Framework this is the default level that should be set to protect high conservation or ecological value systems;

25.13.2. **B** state – The 95% species protection guideline values are met and dissolved copper and zinc are only expected to occasionally impact the development growth and/or reproduction of 1% to 5% of the most sensitive species. Under the ANZG 2018[11] Water Quality Management Framework this is the default level that should be set to protect slightly to moderately disturbed systems;

25.13.3. **C** state – The 80% species protection guideline values are met and copper and zinc toxicity starts to regularly impact the development growth and/or reproduction of 5% to 20% of the most sensitive species.

25.13.4. **D** state – The 80% species protection guideline values are not met and copper and zinc toxicity impacts the development growth and/or reproduction of >20% of species.

25.14 **Ecosystem metabolism** – In freshwater environments ecosystem metabolism is a measure of the uptake and release of organic carbon. Carbon enters an aquatic ecosystem via plant photosynthesis (converts carbon dioxide to oxygen) and leaves via the respiration by living things (including plants, animals and microbes). Total carbon uptake and release from an aquatic ecosystem is measured as gross primary production and ecosystem respiration rate respectively (as proxies). Ecosystem metabolism in rivers is driven by a range of factors (light, temperature, nutrients, physical habitat etc.), all of which can be affected by human activities. As such, gross primary production and ecosystem respiration rate can be useful functional indicators of human impact when paired with conventional structural measures[56]. Despite being a compulsory attribute in the NPS-FM 2020, there are no nationally applicable thresholds that can be adopted into PC1. While Young *et al.*[56] does provide some guideline values these were not considered appropriate for inclusion as attribute states in the NPS-FM 2020, with MfE[57] noting that there is still insufficient knowledge "*about ecosystem metabolism in New Zealand's lakes and rivers to define a bottom line or bands for this attribute*". Hence the NPS-FM 2020 and PC1 do not set numeric thresholds for this attribute (see paragraph 159 for further detail regarding the value of including this this attribute in Tables 8.4 and 9.2 of PC1).

26 For lakes, TAS have been set for the following attributes:

26.1 **Phytoplankton, Total nitrogen** and **Total phosphorus** – Total phosphorus and total nitrogen are measures of the combined concentration of all forms of nitrogen and phosphorus, dissolved and particulate, in the water column of a lake. Nutrients cycle between these forms in lakes due to their residence time and internal nutrient recycling[58]. Thus, total nitrogen and total phosphorus provide a better indication of the risk of phytoplankton growths in lakes than dissolved inorganic nitrogen and dissolved reactive phosphorus[59]. Phytoplankton blooms in response to elevated total nitrogen and total phosphorus, can reduce dissolved oxygen concentrations, degrade habitat quality, alter food webs, and reduce recreational value by affecting colour and clarity. In some cases, they may also lead to algal toxin production when cyanobacteria are present (see paragraph 25.4 below). Total phosphorus, total nitrogen and phytoplankton are all compulsory attributes in the NPS-FM 2020, and their attribute state frameworks are all based on the trophic lake index[6]

[6] Just these three parameters are considered in the trophic lake index 3 which forms the basis of the NPS-FM 2020 attribute states. There is also a trophic lake index 4 which incorporates a measure of water clarity[60].

developed by Burns *et al*.[60]. The trophic lake index is an integrated measure that characterises how enriched a lake is by nutrients. The lower the trophic lake index the better the condition of the lake. The Total nitrogen, Total phosphorus and Phytoplankton attribute states in the NPS-FM 2020 are based on values drawn directly from Burns *et al*.[60] and can be described as follows:

26.1.1. **A** state – Oligotrophic conditions with low levels of nutrients and algae;

26.1.2. **B** state – Mesotrophic conditions with moderate levels of nutrients and algae;

26.1.3. **C** state – Eutrophic conditions with high amounts of nutrients and algae; and

26.1.4. **D** state – Supertrophic conditions with very high amounts of phosphorus and nitrogen and excessive algal growths.

26.2 **Ammonia (toxicity)** – See paragraph 25.2 for details.

26.3 ***E. coli*** – See paragraph 25.4 for details.

26.4 **Cyanobacteria (planktonic)** – Cyanobacteria are photosynthetic prokaryotic (simple single-celled) organisms that are an integral part of many aquatic ecosystems. However, under favourable conditions cyanobacterial cells can multiply and form blooms which can be toxic. Toxins produced by cyanobacteria (cyanotoxins) are a threat to humans and other animals when consumed in drinking water or by contact during recreational activities in rivers and lakes[61]. Planktonic cyanobacteria grow in the water column of lakes and slow flowing rivers. Planktonic species produce a number of cyanotoxins[62,63,64], exposure to which can cause skin rashes, nausea, tummy upset and tingling and numbness around the mouth or tips of fingers. The health risks associated with planktonic cyanotoxins are greatest during bloom events, and people using water bodies for recreational purposes are most likely to experience maximum exposure when a cyanobacterial bloom develops or forms surface scums near water entry points[61]. Cyanobacteria (planktonic) is a compulsory attribute in the NPS-FM 2020, and the attribute states described below are scientifically underpinned by the MfE/MoH *New Zealand guidelines for managing Cyanobacteria in recreational fresh waters – Interim guidelines*[61]:

26.4.1. **A** state – Greater than 80% of samples have cyanobacteria concentrations below the 'alert' guideline recommended by MfE/MoH to indicate that cyanobacteria is detectable "at low levels in water samples, signalling the early stages of a possible bloom"[61];

26.4.2. **B** state – The 'alert' guideline recommended by MfE/MoH is exceeded in more than 20% of samples [61];

26.4.3. **C** state – Cyanobacteria concentrations are at least twice as high as the 'alert' guideline recommended by MfE/MoH[61] in at least 20% of samples; and

26.4.4. Note: This attribute state has not been set to achieve a specific level of health risk.

26.4.5. **D** state – More than 20% of samples have cyanobacteria concentrations above the 'action' guideline recommended in the MfE/MoH[61] which is set to protect against "health effects of repeated exposure to cyanobacterial toxins ingested during recreational activity" and "an increased probability of respiratory, irritation and allergy symptoms".

26.5 **Lake bottom dissolved oxygen** – Lake bottom dissolved oxygen is a measure of dissolved oxygen concentrations in the bottom one-metre of the water column. It is a compulsory attribute in the NPS-FM 2020 and it is my understanding it was developed by members of a Freshwater Science and Technical Advisory Group[32]. Unlike the rivers dissolved oxygen attribute described above in paragraph 25.10, this attribute is not designed to prevent against direct adverse effects on aquatic life. Instead, it is designed to control the nutrient (ammoniacal-nitrogen and dissolved reactive phosphorus) release that can occur from bed sediments in anoxic conditions, especially when a lake is stratified (i.e., it is related to the total nitrogen, total phosphorus and phytoplankton attributes). Specifically, in the:

26.5.1. **A** state – There is no risk from lake-bottom dissolved oxygen of biogeochemical conditions causing nutrient release from sediments[5];

26.5.2. **B** state – There is minimal risk from lake-bottom dissolved oxygen of biogeochemical conditions causing nutrient release from sediments[5];

26.5.3. **C** state – There is a risk from lake-bottom dissolved oxygen of biogeochemical conditions causing nutrient release from sediments[5]; and

26.5.4. **D** state – There is a likelihood from lake-bottom dissolved oxygen of biogeochemical conditions resulting in nutrient release from sediments[5].

26.6 **Submerged plants (natives)** and **Submerged plants (invasive species)**. Submerged macrophytes (plants) play an important role in lake function, especially in shallow systems where they contribute to biodiversity, productivity and bed stability[65]. The composition, structure and abundance of macrophyte communities in lakes can be impacted by eutrophication (nutrient accumulation), which increases phytoplankton that can shade out macrophytes[66]. This in turn increases sediment suspension and further reduces light penetration, resulting in an increased presence of invasive species, which can outcompete and replace native species[67,68]. Submerged plants (natives) and submerged plants (invasive species) are both compulsory attributes in the NPS-FM 2020. Their attribute state frameworks are drawn from the Lake Submerged Plant Indicator. The Lake Submerged Plant Indicator is a management tool that uses these attributes as indicators to assess the ecological condition of New Zealand lakes[69] based on what plants are currently present compared to what would be expected under natural conditions. The attribute states in the NPS-FM 2020 for these attributes are based on lake condition categories developed by NIWA[7] for the Ministry for the Environment and are as follows:

26.6.1. Submerged plants (natives)

(a) **A** state – Excellent ecological condition. Native submerged plant communities are almost completely intact;

[7] https://niwa.co.nz/freshwater/lakespi-keeping-tabs-lake-health/reporting-guidelines

(b) **B** state – High ecological condition. Native submerged plant communities are largely intact;

(c) **C** state – Moderate ecological condition. Native submerged plant communities are moderately impacted; and

(d) **D** state – Poor ecological condition. Native submerged plant communities are largely degraded or absent.

26.6.2. Submerged plants (invasives)

(a) **A** state – No invasive plants present in the lake. Native plant communities remain intact;

(b) **B** state – Invasive plants having only a minor impact on native vegetation. Invasive plants will be patchy in nature co-existing with native vegetation. Often major weed species not present or in early stages of invasion;

(c) **C** state – Invasive plants having a moderate to high impact on native vegetation. Native plant communities, likely displaced by invasive weed beds particularly in the 2 – 8 m depth range; and

(d) **D** state – Tall dense weed beds exclude native vegetation and dominate entire depth range of plant growth. The species concerned are likely hornwort and Egeria.

DESCRIPTION OF HOW THE TAS IN TABLES 8.2, 8.4 AND 9.2 OF PC1 WERE SET

WIP OBJECTIVES AS THE PRIMARY SOURCE

27 The TAS in PC1 are based on those published by TWT and TAoP Whaitua Committees (**the Committees**) in their WIPs.

28 In the TAoP WIP the objectives were set for the following attributes:

28.1 *E. coli*;

28.2 Ammoniacal-nitrogen;

28.3 Nitrate-nitrogen;

28.4 Dissolved copper;

28.5 Dissolved zinc;

28.6 Periphyton biomass;

28.7 Macroinvertebrate community index; and

28.8 Native fish (narrative)

for the following Water Management Units:

28.9 Taupō;

28.10 Rangituhi;

28.11 Pouewe;

28.12 Takapū; and

28.13 Te Riu o Porirua.

29 In the TWT WIP objectives were set for the following attributes:

29.1 In rivers:

29.1.1. Periphyton biomass;

29.1.2. Ammoniacal-nitrogen;

29.1.3. Nitrate-nitrogen;

29.1.4. Suspended fine sediment;

29.1.5. Deposited sediment;

29.1.6. E. coli;

29.1.7. Fish;

29.1.8. Macroinvertebrates ;

29.1.9. Dissolved oxygen;

29.1.10. Dissolved reactive phosphorus;

29.1.11. Dissolved copper; and

29.1.12. Dissolved zinc.

29.2 In lakes:

29.2.1. Submerged plants (native)

29.2.2. Submerged plants (invasive)

29.2.3. Phytoplankton;

29.2.4. *E. coli*;

29.2.5. Cyanobacteria;

29.2.6. Ammoniacal-nitrogen;

29.2.7. Total nitrogen;

29.2.8. Total phosphorus; and

29.2.9. Lake bottom dissolved oxygen.

for the following sub- catchment areas:

29.3 Ōrongorongo;

29.4 Wainuiomata small forested;

29.5 Wainuiomata urban streams;

29.6 Wainuiomata rural streams;

29.7 South-west coast rural streams;

29.8 Korokoro Stream;

29.9 Te Awa Kairangi small forested;

29.10 Te Awa Kairangi Forested mainstems;

29.11 Te Awa Kairangi Lower mainstem;

29.12 Te Awa Kairangi Rural mainstems;

29.13 Te Awa Kairangi rural streams;

29.14 Te Awa Kairangi urban streams;

29.15 Waiwhetū Stream;

29.16 Kaiwharawhara Stream;

29.17 Wellington urban; and

29.18 Parangārehu catchment streams.

30 While the TAS in PC1 were set at a level and spatial scale that is generally consistent with the objectives in the WIP, they have been refined by the Council in the notified version of PC1 to ensure robustness and consistency with the NPS-FM 2020 (paragraph 39 to paragraph 51).

TECHNICAL WORK PROVIDED TO THE TAOP COMMITTEE TO INFORM OBJECTIVE SETTING

31 The objectives set by the TAoP Committee in the WIP were informed by the outputs of a Collaborative Modelling Project (**CMP**). The CMP was designed and led by an expert panel known as the Modelling Leadership Group whose purpose was to develop a broad multidisciplinary modelling framework that:

31.1 Covered the effect of urban and rural land and water resource use on water quantity and quality, in freshwater, harbour and coastal waters; and

31.2 Encompassed environmental, social, cultural and economic aspects.

32 Ultimately a set of multiple interacting and stand-alone models (described in full in Mr James Blyth's Statement of Primary Evidence[8]) were required to deliver this on this brief. The purpose of those models was to test the effects of the following scenarios on various biophysical attributes (the full assumptions of each scenario can be found in Appendix B of Greer[70] at the link below[9]):

32.1 Business as usual (**BAU**) – Represented the regulatory and management approach at the time[10];

32.2 Improved – Included a range of actions with the potential to minimise the impact of urban and rural land uses, such as stormwater treatment, wastewater

[8] Evidence of James Mitchell Blyth on Behalf of Greater Wellington Regional Council (dated 28th February 2025).

[9] https://www.gw.govt.nz/assets/Documents/2023/10/Greer-M.J.C.-2023b.-Assessment-of-alignment-between-the-regulatory-provisions-and-target-attribute-states-in-proposed-Plan-Change-1-to-the-Natural-Resources-Plan-Te-Awarua-o-Porirua-Whaitua.pdf

[10] September 2016. Note that the provisions of the NRP received limited consideration in this scenario.

network upgrades, riparian planting, space planting and retirement of farmland; and

32.3 Water Sensitive – Included much the same actions as Improved, but with an increase in their extent and efficacy.

33 The purpose of scenario testing was to inform the Committee about the direction and magnitude of effects of different actions on specific attributes so they could ultimately:

33.1 Make informed decisions regarding TAS and coastal objectives; and

33.2 Understand the actions required to achieve those TAS and objectives.

34 The CMP scenarios were not presented to the Committee as potential solutions whose assumptions could be carried over directly into the WIP and NRP. Rather, they were intended to highlight the effects of various actions so that the TAS, coastal objectives and recommendations in the WIP could be tailored to reflect the values of the community.

34.1 The impacts of the CMP scenarios on freshwater quality and contaminant loads into Te Awarua-Porirua Harbour were tested with an integrated catchment model developed by Jacobs (Jacobs New Zealand Ltd) using the eWater Source (**Source**) modelling framework[2]. That model utilised environmental data from a range of sources, including Whaitua specific contaminant yields generated by the following models:

(a) The Catchment Land Use for Environmental Stability (**CLUES**) model[71]; and

(b) The urban Contaminant Load Model (**CLM**)[72].

35 The impacts of the CMP scenarios on freshwater ecological attributes were assessed through expert opinion. Background information on this process, and who was involved, is limited. However, based on the outputs, it is clear that results of the Source modelling were considered[11].

[11] https://www.gw.govt.nz/assets/Documents/2022/05/Ecological-assessment-summary-sheets.pdf

TECHNICAL WORK PROVIDED TO THE TWT COMMITTEE TO INFORM THEIR OBJECTIVE SETTING

36 The objectives set by the TWT Committee in the WIP were informed by the outputs of three expert panels that were convened for the Te Whanganui-a-Tara Biophysical Science Programme (**BSP**). These panels inputted into one another, and covered river flows and allocation, freshwater quality and ecology, and coastal water quality and ecology. As for the TAoP CMP the purposes of convening these panels was to test the biophysical effects of a BAU[12], Improved and Water Sensitive scenarios (see paragraph 32. The full assumptions of each scenario can be found in Appendix B of Greer[73] at the link below[13]).

37 The impacts of the BSP scenarios on river[14] freshwater quality and ecology attributes were tested by a Freshwater Quality and Ecology Expert Panel[74] (hereafter referred to as 'the Freshwater Expert Panel'). That expert panel utilised environmental data from a range of sources, including:

37.1 A proxy catchment assessment based on the extensive, well calibrated and validated Source modelling results for the TAoP Whaitua[2,75]. This provided an estimate of how water quality may change in certain catchments under the different scenarios based on the modelled results for similar characteristics in the TAoP Whaitua[76].

37.2 Baseline contaminant yields generated by the an urban CLM[77];

37.3 Sediment loads generated using the Source dSedNet plugin for Source[78];

37.4 A detailed assessment of the current state and drivers of water quality and ecology in TWT Whaitua[1].

38 The methodology employed by the Freshwater Expert Panel and their outputs are documented in Sections 2 and 3[15] of Greer *et al.*[74].

[12] This scenario differed from the TAoP BAU scenario[10] in that it included the stock exclusion provisions of the NRP.

[13] https://www.gw.govt.nz/assets/Documents/2023/10/Greer-2023a-Assessment-of-alignment-between-the-regulatory-provisions-and-target-attribute-states-in-proposed-Plan-Change-1-to-the-Natural-Resources-Plan-Whaitua-Te-Whanganui-a-Tara-1.pdf

[14] The impacts of the scenarios on lakes were not tested as part of BSP.

[15] https://www.gw.govt.nz/assets/Documents/2022/07/Whaitua-Te-Whanganui-a-Tara-Water-Quality-and-Ecology-Scenario-Assessment.pdf

NEED FOR REFINEMENT OF WIP OBJECTIVES

39 At the beginning of the PC1 development process, I conducted a detailed review of the TAoP and TWT WIPs and associated technical reports. This review identified a number of issues with the approach used to set the WIP objectives that needed to be addressed in order to ensure that the TAS in PC1 were as robust as possible, but not vastly different from the WIPs. The identified issues were then addressed, based on the recommendations of a Technical Advisory Group[416][29].

40 The changes made to the WIP objectives are set out in paragraphs 39 to 51 below. Full documentation of these changes can be found in Part 2 of Greer *et al*.[29]

SPATIAL AMENDMENTS TO WIP OBJECTIVES

41 The TWT and TAoP WIPs split Whaitua into different water management units and sub-catchment areas (see paragraphs 28 and 29) and set objectives that apply across those management zones. In contrast, Clause 3.11(1)(b) of the NPS-FM 2020 requires regional councils to "*identify the site or sites to which the target attribute state applies*". To address this difference in approach, the Council commissioned Collaborations (Taylor Collaborations Ltd) to define a TAS site list based on the existing monitoring network that captures the variability between the WIP TAS, without imposing arduous and redundant monitoring restrictions on them (i.e., by requiring monitoring at multiple sites with similar current states, catchment characteristics and future mitigations). The TAS site list developed by Collaborations was then used to further refine the water management units and sub-catchment areas used in the WIPs, into the part-FMUs included in PC1. The philosophy behind this refinement process was:

41.1 Each part-FMU ideally has a single TAS site;

41.2 The management units recommended in the WIPs are an appropriate starting point for selecting part-FMUs; and

41.3 The list of TAS sites recommended by Collaborations provides an appropriate indication of where TAS need to be set to detect the impact of practice change on water quality and ecology across the TAoP and TWT Whaitua. As such, overlaying that list of sites with the management units in the WIPs is an

[16] The technical advisory group consisted of myself, Mr Ned Norton (Land Water People); Mr James Blyth (Taylor Collaborations Ltd); Dr Amanda Valois (the Council), Mr Dougall Gordon (the Council) and Mr Brent King (the Council).

appropriate method of identifying where those management units need to be refined.

42 The WMUs and sub-catchment areas listed in paragraph 28 and 29 that were retained as part-FMUs (green cells), merged (orange cells) or split (red cells) are identified in Table 1 below. The resulting part-FMUs are mapped in

43 Figure **1** and Figure 2.

Table 1: How the management sub-catchment areas and water management units in the TWT and TAoP WIPs were refined into the part-FMUs in PC1. The green shading indicates where a sub-catchment area/water management unit was unchanged, orange shading indicates where it was merged with another and red shading indicates where it was split into multiple part-FMUs.

Whaitua	WIP Sub-catchment area (TWT) or WMU (TAoP)	PC1 part-FMU
TWT	Te Awa Kairangi lower mainstem	Te Awa Kairangi lower mainstem
	Te Awa Kairangi rural mainstems	Te Awa Kairangi rural streams and rural mainstems
	Te Awa Kairangi rural streams	
	Te Awa Kairangi urban streams	Te Awa Kairangi urban streams
	Korokoro Stream	Korokoro Stream
	Waiwhetū Stream	Waiwhetū Stream
	Te Awa Kairangi small forested	Te Awa Kairangi and Wainuiomata small forested, Te Awa Kairangi forested mainstems and Ōrongorongo
	Te Awa Kairangi forested mainstems	
	Ōrongorongo	
	Wainuiomata small forested	
	Wainuiomata urban streams	Wainuiomata urban streams
	Wainuiomata rural streams	Wainuiomata rural streams
	South-west coast rural streams	Parangārehu catchment streams and South-west coast rural streams
	Parangārehu catchment streams	
	Kaiwharawhara Stream	Kaiwharawhara Stream
	Wellington urban	Wellington urban
TAoP	Taupō	Taupō
	Pouewe	Pouewe
	Rangituhi	Te Rio o Porirua and Rangituhi
	Te Rio o Porirua	
	Takapū	Takapū
		Wai-O-Hata

INCORPORATION OF NUTRIENT OUTCOMES TO WIP OBJECTIVES

44 The NPS-FM 2020 requires regional councils to:

44.1 Set appropriate instream concentrations and exceedance criteria, or instream loads, for nitrogen and phosphorus (nutrient outcomes) - clause 3.13(1).

44.2 Identify limits on resource use that will achieve any nutrient outcomes – clause 3.12(1)(a)(ii).

45 However:

45.1 The nutrient outcomes in the TAoP WIP were developed prior to the release of the NPS-FM 2020 and so were no longer relevant when PC1 was prepared; and

45.2 The TWT WIP is silent on nutrient outcomes.

46 Consequently, it was necessary for the Council to define the nutrient outcomes in PC1. To that end, the available national guidance from MfE[79,80] was used to identify median dissolved inorganic nitrogen and dissolved reactive phosphorus concentrations that could be used as nutrient outcomes for the TAoP Whaitua and TWT. Specifically, these median concentrations were identified by:

46.1 Selecting periphyton biomass thresholds (based on the WIP TAS) and under-protection risk thresholds[17] (based on the guidance by MfE);

46.2 Obtaining nutrient outcomes from updated versions of the tables in Snelder and Kilroy[12];

46.3 Assessing confidence in the nutrient outcomes through the approach specified in MfE [12]; and

46.4 Applying the nutrient outcomes or one of the following alternative criteria:

46.4.1. The baseline concentration where lower than the nutrient outcomes;

46.4.2. The WIP target states for nitrate-nitrogen or dissolved reactive phosphorus where lower than the nutrient outcomes;

[17] Under-protection risk is the probability that a site will exceed a specified periphyton TAS despite the specified nutrient outcomes[12] being achieved. The under-protection risk concept is based on the uncertainty associated with the statistical models underlying the look-up tables in Snelder and Kilroy[12]. Further information can be found on page 10 of MfE[80].

46.4.3. The saturation concentrations for periphyton where lower than the nutrient outcomes; and

46.4.4. The relevant reference concentration from McDowall *et al.*[81] where the identified nutrient outcomes = 0.

47 A fulsome description of the process by which nutrient outcomes were set can be found in Section 6[4] of Greer *et al*.[29] while a review of the process can be found in the Dr Antonius Snelder's Statement of Primary Evidence[18].

INCORPORATION OF NPS-FM 2020 ATTRIBUTES NOT INCLUDED IN THE WIPS

48 The 2020 version of the NPS-FM introduced several attributes that were either not monitored by the Council until recently and/or were not included in the TAoP or TWT WIPs. The NPS-FM 2020 does not allow local authorities to "*delay making decisions solely because of uncertainty about the quality or quantity of the information available*". Thus, the approach described in paragraph 49 to 51 below was used to set baseline states and TAS for these attributes (see Greer *et al*. [29] for full detail[4]).

49 The general approach for the river attributes considered in the WIPs:

49.1 Do not set baseline states where monitoring and modelling data are demonstrably inadequate to do so, instead simply acknowledge that there are "*insufficient data*":

49.2 Adopt all WIP TAS except where they:

49.2.1. Do not meet the relevant NPS-FM National Bottom Line (**NBL**); or

49.2.2. Are below the baseline state,

in which case set the TAS at the better of the NBL (does not apply to Fish-IBI or dissolved reactive phosphorus) or baseline state.

49.3 Include a new Fish community health attribute (see paragraph 25.6) without baseline states and TAS set at the same band as those for Q/MCI objectives; and

49.4 Do not define baseline state for ecosystem metabolism and set a narrative TAS that ensures the attribute is at least maintained.

[18] Evidence of Antonius Hugh Snelder on Behalf of Greater Wellington Regional Council (dated 28th February 2025)

50 The approach for river attributes not considered in the TAoP WIP:

50.1 Suspended fine sediment:

50.1.1. Set baseline states from:

(a) Monitoring data; or

(b) The results of the sediment concentration modelling conducted as part of the TAoP CMP[75] and the regional sediment-clarity relationships developed by Collaborations (see paragraph 57 to 60); and

50.1.2. Set TAS at the better of baseline state or the NBL.

50.2 Deposited fine sediment:

50.2.1. Set baseline states based on monitoring data where available; and

50.2.2. Set TAS at the better of baseline state or NBL.

50.3 Macroinvertebrate Average score per metric:

50.3.1. Set baseline states based on monitoring data where available; and

50.3.2. Set TAS at same level as Q/MCI.

50.4 Fish-IBI and dissolved oxygen:

50.4.1. Do not set baseline states given lack of monitoring data; and

50.4.2. Set a narrative TAS that ensures the attribute is at least maintained.

50.5 Dissolved reactive phosphorus:

50.5.1. Set baseline state based on monitoring data or the results of the water quality modelling conducted as part of the TAoP CMP[75]; and

50.5.2. Set TAS for the 95th percentile concentration at the baseline state and set a separate TAS for the median concentrations that reflects recommended nutrient outcomes developed in accordance with Clause 3.13 of the NPS-FM 2020 and the associated national guidance (see paragraph 44 to 46).

51 General approach for lake attributes in TWT:

51.1 For attributes with existing monitoring data:

51.1.1. Set baseline states using all available data, regardless of whether they meet the requirements of the NPS-FM 2020 and/or were collected outside of the NPS-FM 2020 prescribed baseline period; and

51.1.2. Adopt all WIP TAS where available, except where they are less stringent than the baseline state, in which case set the TAS at the better of the NBL or baseline state.

51.2 Lake bottom dissolved oxygen:

51.2.1. Do not set baseline states given lack of monitoring data; and

51.2.2. Set TAS in accordance with the TWT WIP.

51.3 Submerged plants (natives and invasive species):

51.3.1. Set baseline state based on results of LakeSPI surveys carried out in 2016; and

51.3.2. Set TAS in accordance with the TWT WIP except where that would allow a degradation from baseline state.

MEANING OF 'MAINTAIN' WHERE THE TAS HAS BEEN SET AT 'M' IN TABLES 8.2, 8.4 AND 9.2 OF PC1

52 Many of the objectives in the WIPs simply required the attribute to be maintained at the baseline state. However, it is clear from the NPS-FM 2020 definition of degrading[19] that, when setting TAS, maintain does not mean 'within an attribute state'. Thus, 'maintain' TAS need to capture the baseline state in a more specific way, rather than simply denoting an attribute state. One option for doing this is to set hard numeric objectives that reflect the baseline state. However, this would likely result in sites fluctuating between meeting and not meeting that TAS due to natural temporal variability in water quality and freshwater ecosystems[82]. Consequently, in Section 8[4] of Greer *et al*,[29] it is recommended that a narrative 'Maintain' (**M**) TAS be set where that is the end-point being sought by PC1. The

[19] "***degrading***, *in relation to an FMU or part of an FMU, means that any site or sites to which a target attribute state applies is experiencing, or is likely to experience, as a result of something other than a naturally occurring process, a deteriorating trend*"[5]

achievement of these TAS should be assessed using the approach set out in paragraphs 53 and 52, which relies on using trend analysis or statistical comparisons between monitoring periods to identify whether an attribute has been maintained.

53 For attributes that are monitored continuously (i.e., at a regular interval over the period for assessment; e.g., monthly monitoring) maintenance and/or improvement relative to the baseline state shall be determined through benchmarking against the TAS thresholds and trend analysis. An attribute will not be considered to be maintained within an attribute state:

53.1 If trend analysis indicates a deteriorating trend is more likely than not since the baseline period;

53.2 The trend is inconsistent with what would be expected based on climate cycles over the period for assessment; and

53.3 There is evidence of a human activity contributing to the trend.

Note: *This approach means there may be instances where an attribute is considered to have been maintained despite it being in a worse attribute state than its baseline state.*

54 At sites where monitoring is intermittent (conducted in discrete blocks over the period for assessment; e.g., monthly monitoring for two years out of every ten) maintenance and/or improvement shall be determined using an appropriate statistical analysis such as the Kruskal-Wallis test. Water quality will not be considered to be maintained or improved if:

(a) Such an analysis detects statistically significant (if measured via a p-value) or meaningful (if measured via an effect size) degradation between monitoring blocks (including the baseline period);

(b) Changes in water quality are inconsistent with what would be expected based on climate cycles over the period for assessment; and

(c) There is evidence of a human activity contributing to changes in water quality

55 The footnote:

"M = Maintain; I = Improve. Maintenance, improvement or deterioration in the state of an attribute will be assessed through:

- *Benchmarking against the TAS thresholds and trend analysis or appropriate statistical analysis; and*

- *Taking the impact of climate and human activity into account"* in PC1 is intended to capture the intent of the approach described above in paragraphs 53 and 52 but has been significantly shortened for the sake of readability (see Section 2.8 of Greer *et al*.[29]). Nevertheless, it is my understanding the Council intends to assess whether an attribute has been maintained using the approach described above.

INTENT OF THE FOOTNOTES TO TABLES 8.2, 8.4 AND 9.2 OF PC1

56 Table 8.2, 8.4 and 9.2 contain a number of other footnotes. The purpose of these footnotes are as follows:

56.1 "*Baseline state based on limited data*" denotes where the baseline state has been calculated from data that do not meet the data requirements set out for a compulsory attribute state in the NPS-FM 2020 (either in terms of length of the data record or the number of data points). These estimates of baseline state were included in the Tables to give effect to the Clause 1.6 of the NPS-FM 2020 regarding the use of 'Best information'

56.2 "*Baseline state based on eWater Source model results. Further monitoring needed to confirm whether the attribute meets the TAS*" denotes where the baseline state has been drawn from the baseline state modelling conducted as part of the TAoP Whaitua process (see paragraphs 44 to 47). These estimates of baseline state were included in the tables to give effect to the 'Best information' requirements of the NPS-FM 2020 (Clause 1.6).

56.3 "*Median concentration targets reflect the nutrient outcomes required by Clause 3.13 of the National Policy Statement for Freshwater Management 2020*" identifies that the dissolved inorganic nitrogen and dissolved reactive phosphorus (median only) TAS also act as nutrient outcomes under Clause 3.13 of the National Policy Statement for Freshwater Management 2020 (see paragraphs 44 to 47)

56.4 "*The A,B,C and D states to be assigned on the basis of fish community health reflecting an excellent, good, fair and poor state of aquatic ecosystem health respectively*", specifies the banding system for the Council-defined fish community health attribute, as this is not done elsewhere in PC1 (see paragraph 25.6)

56.5 *"Further monitoring needed to define baseline state and develop attribute state framework"* acknowledges that no monitoring data or grading mechanism currently exist for ecosystem metabolism attribute (see paragraph 25.14)

56.6 "*All rivers in part Freshwater Management Unit naturally soft bottomed and unlikely to support periphyton growth (River Environment Classification group = WW/L/SS)*" and "*All rivers in part Freshwater Management Unit naturally soft bottomed (River Environment Classification group = WW/L/SS)*" identify where a deposited fine sediment and periphyton biomass TAS have not been set as the TAS site is considered 'naturally soft-bottomed' under Table 25 of the NPS-FM 2020.

DESCRIPTION OF HOW THE SEDIMENT LOAD REDUCTIONS IN TABLE 8.5 AND 9.4 OF PC1 WERE SET

57 The NPS-FM 2020 suspended fine sediment attribute uses visual clarity rather than a direct measure of suspended sediment concentration. Consequently, the difference between the baseline state and TAS for this attribute does not provide a clear indication of the degree to which sediment losses must be reduced to meet the TAS, since the relationship between visual clarity and sediment concentration/load is not linear. To address this, site and regional specific relationships between visual clarity and total suspended solid concentrations were developed. These relationships were then used to calculate the sediment load reductions required to meet the recommended PC1 suspended fine sediment TAS through the same methodology used by NIWA and Landcare Research to test the feasibility of suspended fine bottom lines in the NPS-FM 2020[83,84]. The full methodology used to calculate the sediment load reductions set out in Table 8.5 and 9.4 of PC1 is described in Section 9[4] of Greer *et al*.[29] and in Mr Blyth's Statement of Primary Evidence[20]. However, the general process is summarised by Equation 1 and Equation 2 below:

[20] Evidence of James Mitchell Blyth on Behalf of Greater Wellington Regional Council (dated 28th February 2025)

58

$$PR_v = 1 - (V_o/V_b)^{\frac{1}{\alpha}}$$

Equation 1

PR_v = proportional reduction in load required to achieve the objective
V_o = TAS median visual clarity
V_b = baseline median visual clarity
α = Site specific co-efficient based on the site or regional specific power-law relationships between suspended sediment concentration and visual clarity.

$$L_o = L_b \times (1 - PR_v)$$

Equation 2

L_o = Target sediment load to meet visual clarity TAS;
L_b = Modelled baseline sediment load derived by Easton *et al*.[2] and Easton and Cetin[78] through the Source dSedNet plugin to the Source Model (see link below[21]). Further details on this modelling is provided in Mr James Blyth's Statement of Primary Evidence[20].
PR_v = proportional reduction in load required to achieve the objective calculated from Equation 1.

59 While the sediment load reductions set out in Table 8.5 and 9.4 have been calculated in accordance with recommended practice, Mr Blyth has provided a potential update to these tables in his Statement of Primary Evidence which:

59.1 Considers data collected over a greater time period than originally considered when calculating the sediment load reductions in the notified version of PC1;

59.2 Accounts for naturally occurring influence of colour on visual clarity in the Mangaroa River (more detail in Dr Amanda Valois'[22] Statement of Primary Evidence and paragraph 150 to 151 below); and

59.3 Removes the baseline sediment loads

60 These potential updates to Table 8.4 and 9.5 of PC1 are set out in Table 21 below paragraph 234.

[21] https://www.gw.govt.nz/assets/Documents/2022/05/Freshwater-Baseline-Modelling-Technical-Report.pdf; and
https://www.gw.govt.nz/assets/Documents/2022/05/dSedNet-technical-memo-FINAL.pdf
[22] Evidence of Amanda Elizabeth Valois on Behalf of Greater Wellington Regional Council (dated 28th February 2025)

OUTCOMES OF THE TAS IN RELATION TO ECOSYSTEM HEALTH AND HUMAN CONTACT

61 I have been asked to describe what the TAS in PC1 achieve in terms of the compulsory values of ecosystem health and human contact.

62 Regarding the value of ecosystem health, Appendix 1A NPS-FM 2020 defines the biophysical components that contribute to this value, all of which must be managed. These are:

62.1 Water quality – the physical and chemical measures of the water, such as temperature, dissolved oxygen, pH, suspended sediment, nutrients and toxicants.

62.2 Water quantity – the extent and variability in the level or flow of water.

62.3 Habitat – the physical form, structure, and extent of the water body, its bed, banks and margins; its riparian vegetation; and its connections to the floodplain and to groundwater.

62.4 Aquatic life – the abundance and diversity of biota including microbes, invertebrates, plants, fish and birds.

62.5 Ecological processes – the interactions among biota and their physical and chemical environment such as primary production, decomposition, nutrient cycling and trophic connectivity.

63 The NPS-FM 2020 also notes that the component that ultimately determines whether the value of ecosystem health is provided for is aquatic life.

> *"In a healthy freshwater ecosystem, all 5 biophysical components are suitable to <u>sustain the indigenous aquatic life</u> expected in the absence of human disturbance or alteration"* (Appendix 1A of the NPS-FM 2020).

64 Based on this interpretation, it stands to reason that the aquatic life attributes in the WIP and PC1 provide the best indication of the likely outcome of achieving the TAS for the value of ecosystem health.

65 In rivers the relevant aquatic life attributes are:

65.1 Q/MCI;

65.2 Average score per metric.

66 While periphyton biomass, Fish-IBI and fish community health are also aquatic life attributes, they cannot, in my view, be treated as indicators of the outcome sought for ecosystem health because:

66.1 The periphyton biomass attribute in the NPS-FM 2020 is not designed to directly protect the health of periphyton communities. Instead, it serves as an indicator of nutrient enrichment in rivers and aims to protect benthic biodiversity, trout populations, and recreational/aesthetic values from nuisance blooms (see paragraph 25.1). Within this framework, periphyton is viewed primarily as an environmental stressor, and any increase in abundance beyond what is necessary to support healthy macroinvertebrate and fish communities is considered an adverse effect. This perspective overlooks any potential benefits such an increase might provide to the periphyton community itself. Consequently, the PC1 TAS for this attribute do not reflect the ecosystem health endpoints being sought but indicate how periphyton levels need to be managed to achieve those endpoints.

66.2 The Fish-IBI does not consider important aspects of fish community health and is therefore insensitive to the activities managed by PC1 (see paragraph 25.5). It was also not considered in the TAoP Whaitua process. Consequently, there are no objectives in the WIP that can be carried over to Table 9.2 of PC1 as numeric or letter (A, B, C or D) Fish-IBI TAS;

66.3 The Fish community health attribute was not considered directly in the WIPs and has simply been set at a level that reflects the ecological condition indicated by the Q/MCI TAS (see paragraph 49.3).

67 In PC1, the Q/MCI and average score per metric TAS are only described in letter grades and numerically , which do not meaningfully describe the level of ecosystem health these TAS aim to achieve. However, the Q/MCI state framework can be described in terms of 'ecological quality classes'[31,85,86] which describe the condition of the macroinvertebrate community in relation to what would be expected under reference (pristine) conditions[85,86]. Under the quality class system, the NPS-FM 2020 Q/MCI A band reflects 'Excellent' quality at a national scale; B reflects 'Good' quality, C reflects 'Fair' quality and D

reflects 'Poor' quality[23]. This framework allows for the ecosystem health outcome being sought in a particular part-FMU to be described on a simple Excellent-Good-Fair scale based the Q/MCI TAS sought at the TAS site, which is done in Table 2 below (see **Table 4** for the Q/MCI TAS).

68 In lakes, the aquatic life attributes that provide an indication of the level of ecosystem health being sought are phytoplankton and submerged plants (native and invasive). Of these, I consider submerged plants to be the better indicator, as the phytoplankton attribute provides no other measure of algal community other than abundance and is predominately used as indicator of trophic state (nutrient levels; i.e., water quality). In contrast, together the submerged plant attributes consider the abundance, diversity, distribution and natives of the plant community compared to what would be expected under natural conditions. To some extent it also implicitly includes phytoplankton, which at high concentrations can be detrimental to the submerged plant attributes abundance and naturalness[65]. As with Q/MCI, the submerged plant TAS are only described in letter grades and numerically. However, the submerged plant (native) A to D attribute states align with a four band Excellent to Poor scale developed by the NIWA for interpretation of LakeSPI scores. Thus, this attribute allows for the ecosystem health outcome being sought for a particular lake to be described in these terms (see **Table 2**).

69 In terms of the human contact value, the NPS-FM 2020 *E. coli* attribute narrative states an indication of what the outcomes of the TAS are in terms of *Campylobacter* infection (not illness) risk, while the Cyanobacteria (planktonic) attribute for lakes also provides an indication of the outcome sought regarding the risk of health effects from cyanobacteria exposure (see **Table 2**).

[23] The NPS-FM 2020 attribute state thresholds for MCI and QMCI arbitrarily increased the thresholds of quality class thresholds in Stark and Maxted[31] by 10 and 0.5 respectively. Thus, on a national scale, they may understate ecological quality. However, the Stark and Maxted[31] thresholds have been found to overstate ecological quality most rivers in the PC1 area[86]. Thus, for simplicity, the NPS-FM 2020 attribute state thresholds and the Stark and Maxted[31] quality class thresholds have been treated as consistent with each other in this statement of evidence.

Table 2: Description of the outcomes sought for the values of ecosystem health and human contact based on the Q/MCI, *E. coli* and Cyanobacteria TAS.

Whaitua	Part-FMU	Q/MCI TAS	Level of ecosystem health sought	*E. coli*/ Cyano. TAS	Level of risk sought for human contact
Te Awarua-o-Porirua Whaitua	Taupō	B	Good	B	*Campylobacter* infection risk < 0.1% at least 50% of the time. Average risk <2% (swimmable)
	Pouewe	A	Excellent		
	Wai-O-Hata	B	Good	C	Infection risk < 0.1% at least 50% of the time. Average risk <3% (swimmable)
	Takapū				
	Te Rio o Porirua and Rangituhi	C	Fair		
Whaitua Te Whanganui-a-Tara	Ōrongorongo, Te Awa Kairangi and Wainuiomata small forested and Te Awa Kairangi forested mainstems	A	Excellent	A	Infection risk < 0.1% at least 50% of the time. Average risk <1% (swimmable)
	Wainuiomata rural streams	B	Good		
	Te Awa Kairangi rural streams and rural mainstems			B	Infection risk < 0.1% at least 50% of the time. Average risk <2% (swimmable)
	Korokoro Stream	A	Excellent		
	Te Awa Kairangi lower mainstem	B	Good	C	Infection risk < 0.1% at least 50% of the time. Average risk <3% (swimmable)
	Te Awa Kairangi urban streams	C	Fair		
	Waiwhetū Stream				
	Wainuiomata urban streams				
	Kaiwharawhara Stream				
	Wellington urban				
	Parangārehu catchment streams and South-west coast rural streams			D	Infection risk > 5% 20-30% of the time. Average risk >3% (not swimmable)
	Lake Kōhangatera	B	Good	A	*Campylobacter* infection risk < 0.1% at least 50% of the time. Average risk <1% Risk exposure from cyanobacteria no different to that under natural conditions (swimmable)
	Lake Kōhangapiripiri				

INCONSISTENCIES BETWEEN THE TAS IN TABLES 8.4 AND 9.2 IN PC1

TOXICANTS IN URBAN PART-FMUS

70 Given the general level of ecosystem health being sought by the aquatic life TAS, it is my opinion that some of the toxicant attributes for rivers (i.e., ammoniacal-nitrogen, nitrate-nitrogen, dissolved copper and dissolved zinc) have been set at a level that is inconsistent with what could reasonably be expected necessary to achieve the aquatic life endpoints. Specifically, the following TAS require an improvement[24] from the baseline state to the A state:

70.1 Dissolved copper and ammoniacal-nitrogen in Waiwhetū Stream;

70.2 Ammoniacal nitrogen in Wainuiomata urban streams;

70.3 Dissolved zinc in Kaiwharawhara Stream;

70.4 Dissolved zinc, and potentially dissolved copper, in Wai-O-Hata (Duck Creek – the limited monitoring data suggests improvement not required (see **Table 4**), but this conflicts with modelled results).

71 The A states for these attributes all align with the ANZG 2018[11] 99% species protection DGVs (see paragraph 24). Under the water management framework in that document, this is the default level that should be set to protect high conservation or ecological value systems (i.e., "*effectively unmodified or other highly valued ecosystems, typically (but not always) occurring in national parks and conservation reserves, or in remote and inaccessible locations*"). None of the aforementioned streams meet this definition, and none of the Q/MCI TAS indicate that a return to natural state is the ecosystem health outcome sought for these part-FMUs.

72 Like all stormwater impacted urban streams, Kaiwharawhara Stream and Duck Creek meet the ANZG 2018[11] definition of 'Highly disturbed ecosystem' (i.e., a measurably degraded ecosystem of lower ecological value). Under the ANZG (2018) Water Management Framework, the most appropriate level to set the TAS listed in 70 would generally be the B state (95% species protection), as this is recommended for Highly disturbed ecosystems *except where it is not achievable*.

[24] Many other part-FMUs also have copper and zinc TAS set at A. However, they do not require an improvement from the baseline state and/or current state.

73 In my opinion there is also technical justification for further relaxing the dissolved copper and dissolved zinc TAS for Waiwhetū Stream from attribute state B to C. This is based on modelling presented in Greer[87], which suggests that achieving the B states for these attributes in this highly disturbed ecosystem would require a greater reduction in load than can be physically achieved through conventional treatment of existing impervious surfaces and roof replacement[88]. Thus, the B state is not achievable, and adopting the C state as the TAS is still consistent with the ANZG Water Management Framework[11]. Furthermore, it would still require a significant improvement in dissolved zinc concentrations (see **Table 4**) and loads (~20% to 40% based on modelling presented in Greer [87]) in this part-FMU, which should contribute to the required improvements in Q/MCI.

Note: *A B state TAS for copper and zinc would still require significant reduction in loads in Kaiwharawhara Stream and Duck Creek. However, I have not identified these reductions as scientifically unachievable, as they are not* <u>*physically impossible*</u>*. Nevertheless, I acknowledge there may be significant financial and operational challenges in achieving the amended B state TAS. While financial and operational constraints are outside the scope of my evidence, if they ultimately prove to be insurmountable (i.e., the mitigations required to achieve the TAS can simply not be implemented), I note that further amending these TAS to attribute state C would be consistent with the ANZG Water Management Framework*[11]*.*

DISSOLVED REACTIVE PHOSPHORUS IN THE ŌRONGORONGO, TE AWA KAIRANGI AND WAINUIOMATA SMALL FORESTED AND TE AWA KAIRANGI FORESTED MAINSTEMS PART - FMU

74 Table 8.4 of PC1 seeks a 25% (0.008 mg/L to 0.006 mg/L) reduction in median dissolved reactive phosphorus concentrations in the Whakatikei River at the Riverstone monitoring site (Ōrongorongo, Te Awa Kairangi and Wainuiomata small forested and Te Awa Kairangi forested mainstems part-FMU). The available science indicates that this reduction is unlikely to be physically possible and that there is little to no effects basis from which it can be justified.

75 As set out in paragraph 46.4.2, the WIP objectives for dissolved reactive phosphorus were adopted as TAS in Table 8.4 for those part-FMUs where they were more stringent than the periphyton growth nutrient outcomes selected[29] from Snelder and Kilroy[12] (see paragraphs 44 to 47). This was the case for the Whakatikei River, where the numeric dissolved reactive phosphorus TAS reflects the NPS-FM 2020 A attribute state. As

previously noted (see paragraph 25.12), there are significant technical issues with the NPS-FM 2020 dissolved reactive phosphorus attribute, and I believe this attribute should primarily be managed in relation to the PC1 periphyton biomass TAS.

76 While periphyton biomass is not directly measured in the Whakatikei River, the weighted composite cover generally is indicative of A state conditions, suggesting the periphyton biomass TAS is already met[25][89]. Furthermore, even if a reduction in algal growth were ultimately required, the available guidance[12] indicates that current dissolved reactive phosphorus concentrations are consistent with the achievement of the periphyton biomass TAS (i.e., any reduction in plant growth would likely need to be achieved through a mechanism other than phosphorus management). Consequently, there is no evidence that a reduction in phosphorus is required to manage periphyton growth in the Whakatikei River.

77 Regarding achievability, the modelling[81] behind the ANZG 2018[11] physical and chemical stressor default guideline values indicates that current dissolved reactive phosphorus concentrations in the Whakatikei River reflect what would be expected under reference conditions (i.e., natural state). Furthermore, the Our Land and Water Science Challenge Scenario Builder WebApp[26] suggests that the entirety of this already heavily forested (90%[1]) catchment would need to be converted to native vegetation to meet the PC1 TAS.

78 Given the absence of any evidence that the likely unachievable reductions in dissolved reactive phosphorus required in the Whakatikei River by Table 8.4 of PC1 are necessary to achieve the periphyton biomass TAS, I consider that amending the TAS to require only that dissolved reactive phosphorus be maintained (i.e., make them less stringent) is scientifically justified.

ECOSYSTEM METABOLISM IN ALL PART-FMUS

79 From a scientific perspective, there would appear to be limited value in including the ecosystem metabolism attribute in Tables 8.4 or 9.2 of PC1. Numeric thresholds have not and cannot be set for this attribute, the attribute is not currently monitored, and it is unclear when, if ever, it will be possible to use this attribute to assess the state and drivers of ecosystem health. Whether this is justification for removing a NPS-FM 2020 compulsory attribute from PC1 is outside the scope of my expertise.

[25] https://www.gw.govt.nz/annual-monitoring-reports/river-water-quality-and-ecology/
[26] https://www.freshwater-scenario-builder.co.nz/rivers

SUMMARY

80 The aforementioned changes to the TAS that could be justified from purely scientific perspective are provided in Table 3. These should not be considered recommendations, but an indication of where such changes would be supported by the best available science and national guidance.

Note: *Further potential changes to various TAS have been identified in my response to submissions in paragraph 100 in response to 203. These are not identified in Table 3. Instead, all scientifically justified changes to the TAS (including those in* ***Table 3****) are summarised at the end of this statement of evidence (****Table 19****).*

Table 3: The changes to the TAS in Tables 8.4 and 9.2 that could be justified from a scientific perspective.

Part-FMU	Site	Attribute	TAS	Technically justified change to TAS
Ōrongorongo, Te Awa Kairangi and Wainuiomata small forested and Te Awa Kairangi forested mainstems	Whakatikei R. @ Riverstone	DRP (median)	≤0.006	≤0.008
Waiwhetū Stream	Waiwhetū S. @ Whites Line East	Dissolved zinc	B	C
		Dissolved copper	A	C
		Ammonia (toxicity)	A	B
Wainuiomata urban streams	Black Ck @ Rowe Parade	Ammonia (toxicity)	A	B
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge	Dissolved zinc	A	B
Wai-O-Hata	Duck Ck @ Tradewinds Dr. Br.	Dissolved copper	A	B
		Dissolved zinc	A	B
All		Ecosystem metabolism	~~M~~	

CURRENT STATE OF WATER QUALITY AND ECOLOGY IN RELATION TO THE TAS IN PC1 AND NUMERIC DESCRIPTION OF THE NARRATIVE 'MAINTAIN' TAS IN TABLES

81 The NPS-FM 2020 baseline state means "*the state of the attribute on 7 September 2017*". Therefore, the baseline states in Tables 8.2, 8.4 and 9.2 may not necessarily provide a good indication of the scale of the improvement required to achieve the TAS. There may have been significant changes (improvement of degradation) in state between 7 September 2017 (baseline) and today (2025). To provide a clearer picture of which TAS require an improvement, I have calculated the current (on 30 June 2024) state for each attribute in Tables 8.2, 8.4 and 9.2 based on available data. These results are provided in Table 4 (rivers) and Table 5 (lakes) below, along with an assessment of which attributes need to improve to meet the TAS. While Tables 8.2, 8.4 and 9.2 do not include a numeric descriptor of the TAS that require maintenance (for the reasons described in paragraph 52), these are also provided for the panel and submitters in Table 4 and Table 5 below.

82 I understand some of the current state estimates in Table 4 have been included as amended baseline states in Tables 8.4 and 9.2 in Appendix 4 of Ms Mary O'Callahan's S42A Officer's Report[27].

[27] Plan Change 1 to the Natural Resources Plan for the Wellington Region Section 42A Hearing Report. Hearing Stream 2: Objectives. Prepared by Mary O'Callahan for Greater Wellington Regional Council (dated 28th February 2025)

Table 4: Current (as of 30 June 2024) state of river attributes in Tables 8.4 and 9.2 of PC1 compared to the TAS. Note with the exception of dissolved inorganic nitrogen and dissolved reactive phosphorus, achievement of the TAS is based off the letter grade only.

Whaitua			TWT											
Part-FMU			Te Awa Kairangi, Ōrongorongo and Wainuiomata											
			Forested mainstems						Te Awa Kairangi lower mainstem					
Site			Whakatikei R. @ Riverstone						Hutt R. @ Boulcott					
Parameter	Unit	Statistic	N	Current #	Current state	Target #	Target State	Target met	N	Current #	Current state	Target #	Target State	Target met
Periphyton biomass	mg chl-a/m^2	92nd %ile	0			≤50	A	?	17	52.1	B	≤120	B	✓
Ammonia (toxicity)	mg/L	Median	55	0.002	A	≤0.002	A	✓	56	0.002	A	≤0.002	A	✓
		Maximum		0.013		≤0.004				0.008		≤0.003		
Nitrate (toxicity)	mg/L	Median	55	0.13	A	≤0.14	A	✓	56	0.16	A	≤0.20	A	✓
		95th %ile		0.27		≤0.29				0.29		≤0.32		
Suspended fine sediment	Black disc (m)	Median	55	3.45	A	≥4.00	A	✓	56	2.83	B	≥2.95	A	×
E. coli	/100mL	Median	55	40	A	≤22	A	✓	56	130	D	≤58	C	×
		% >260/100 mL		5%		≤5%				30%		≤18%		
		% >540/100 mL		2%		≤3%				14%		≤8%		
		95th %ile		270		≤290				2140		≤1200		
Fish	Fish-IBI	Latest	0			≥34	A	?	0			≥34	A	?
Fish community health		Expert assessment	0				A	?	0				B	?
Macroinvertebrates	MCI	Median	5	131.1	A	≥130	A	✓	5	113.7	C	≥110	B	×
	QMCI	Median		6.9		≥7.0				5.1		≥5.5		
Macroinvertebrates	ASPM	Median	5	0.63	A	≥0.6	A	✓	5	0.52	B	≥0.42	B	✓
Deposited fine sediment	% cover	Median	43	4%	A	≤13%	A	✓	38	6%	A	≤5%	A	✓
Dissolved oxygen	mg/L	1-day minimum	0			≥7.5	A	?	0			≥7.5	A	?
		7-day mean				≥8.0						≥8.0		
Dissolved inorganic nitrogen	mg/L	Median	55	0.14		≤0.15		✓	56	0.17		≤0.20		✓
Dissolved reactive phosphorus	mg/L	Median	55	0.008	B	≤0.006	A	×	56	0.005	A	≤0.004	A	×
		95th %ile		0.011		≤0.011				0.009		≤0.008		
Dissolved Copper	mg/L	Median	0			≤1	A	?	56	0.3	A	≤0.3	A	✓
		95th %ile				≤1.4				0.7		≤0.6		
Dissolved Zinc	mg/L	Median	0			≤2.4	A	?	56	0.5	A	≤0.5	A	✓
		95th %ile				≤8				2.7		≤1.9		
Ecosystem metabolism	g O_2 m^{-2} d^{-1}		0					?	0					?

Whaitua			TWT																	
			Te Awa Kairangi, Ōrongorongo and Wainuiomata																	
Part-FMU			Te Awa Kairangi rural streams and…..						Te Awa Kairangi urban streams						Waiwhetū Stream					
Site			Mangaroa R. @ Te Marua						Hulls Ck adj. Reynolds Bach Dr.						Waiwhetū S. @ Whites Line East					
Parameter	Unit	Statistic	N	Current #	Current state	Target #	Target State	Target met	N	Current #	Current state	Target #	Target State	Target met	N	Current #	Current state	Target #	Target State	Target met
Periphyton biomass	mg chl-a/m^2	92nd %ile	21	187.31	C	≤120	B	×	0			≤200	C	?	0			≤200	C	?
Ammonia (toxicity)	mg/L	Median	58	0.008	A	≤0.002	A	✓	46	0.017	B	≤0.008	A	×	58	0.049	B	≤0.027	A	×
		Maximum		0.020		≤0.006				0.093		≤0.012				0.121		≤0.05		
Nitrate (toxicity)	mg/L	Median	56	0.35	A	≤0.43	A	✓	46	0.21	A	≤0.22	A	✓	58	0.48	A	≤0.48	A	✓
		95th %ile		0.53		≤0.61				0.50		≤0.44				0.66		≤0.89		
Suspended fine sediment	Black disc (m)	Median	58	1.45	D	≥2.22	C	×	46	1.16	A	≥1.20	A	✓	58	1.22	A	≥1.10	A	✓
E. coli	/100mL	Median	58	340	E	≤130	B	×	46	1100	E	≤130	C	×	57	1000	E	≤130	C	×
		% >260/100 mL		57%		≤30%				96%		≤34				89%		≤34%		
		% >540/100 mL		31%		≤10%				78%		≤20				67%		≤20%		
		95th %ile		2900		≤1000				16000		≤1200				16650		≤1200		
Fish	Fish-IBI	Latest	0			≥34	A	?	1	36	A	≥34	A	✓	0			≥34	A	?
Fish community health		Expert assessment	0				B	?	0				C	?	0				C	?
Macroinvertebrates	MCI	Median	5	116.5	B	≥118.3	B	✓	4	93.2	D	≥90	C	×	5	66.7	D	≥90	C	×
	QMCI	Median		5.8		≥5.7				3.3		≥4.5				4.0		≥4.5		
Macroinvertebrates	ASPM	Median	5	0.61	A	≥0.53	B	✓	3	0.31	C	≥0.3	C	✓	5	0.12	D	≥0.3	C	×
Deposited fine sediment	% cover	Median	42	2%	A	0%	A	✓	21	19%	B	≤11%	B	✓	31	65%	D	≤29%	C	×
Dissolved oxygen	mg/L	1-day minimum	0			≥7.5	A	?	0			≥7.5	A	?	0			≥7.5	A	?
		7-day mean				≥8.0						≥8.0						≥8.0		
Dissolved inorganic nitrogen	mg/L	Median	58	0.36		≤0.44		✓	46	0.23		≤0.24		✓	58	0.54		≤0.56		✓
Dissolved reactive phosphorus	mg/L	Median	58	0.010	C	≤0.010	B	×	46	0.018	C	≤0.018	C	×	58	0.027	D	≤0.018	C	×
		95th %ile		0.015		≤0.015				0.025		≤0.027				0.049		≤0.049		
Dissolved Copper	mg/L	Median	0			≤1	A	?	46	1.3	C	≤1.4	B	×	58	1.0	C	≤1	A	×
		95th %ile				≤1.4				4.2		≤1.8				4.3		≤1.4		
Dissolved Zinc	mg/L	Median	0			≤2.4	A	?	46	5.7	C	≤8	B	×	58	12.8	D	≤8	B	×
		95th %ile				≤8				22.8		≤15				47.5		≤15		
Ecosystem metabolism	g O_2 m^{-2} d^{-1}		0					?	0					?	0					?

Whaitua			TWT																	
			Te Awa Kairangi, Ōrongorongo and Wainuiomata												South-west coast, Mākara and Ōhariu					
Part-FMU			Wainuiomata urban streams						Wainuiomata rural streams						Parangārehu catchment streams and					
Site			Black Ck @ Rowe Parade						Wainuiomata River D/S of White Br.						Mākara S. @ Kennels					
Parameter	Unit	Statistic	N	Current #	Current state	Target #	Target State	Target met	N	Current #	Current state	Target #	Target State	Target met	N	Current #	Current state	Target #	Target State	Target met
Periphyton biomass	mg chl-a/m^2	92nd %ile	0			≤200	C	?	21	171.3	C	≤200	C	✓	0			≤200	C	?
Ammonia (toxicity)	mg/L	Median	47	0.047	B	≤0.025	A	×	57	0.010	A	≤0.004	A	✓	58	0.016	A	≤0.005	A	✓
		Maximum		0.091		≤0.05				0.018		≤0.016				0.040		≤0.019		
Nitrate (toxicity)	mg/L	Median	47	0.37	A	≤0.42	A	✓	57	0.21	A	≤0.16	A	✓	58	0.43	A	≤0.39	A	✓
		95th %ile		0.67		≤0.68				0.36		≤0.44				0.85		≤1.21		
Suspended fine sediment	Black disc (m)	Median	47	1.24	D	≥2.22	C	×	56	2.55	C	≥2.2	C	✓	57	1.42	D	≥2.22	C	×
E. coli	/100mL	Median	46	660	E	≤130	C	×	56	160	D	≤100	A	×	58	415	E	≤260	D	×
		% >260/100 mL		78%		≤34%				27%		≤18%				66%		≤50%		
		% >540/100 mL		59%		≤20%				16%		≤5%				41%		≤30%		
		95th %ile		15800		≤1200				2360		≤540				7920		≤6500		
Fish	Fish-IBI	Latest	1	30	B	≥34	A	×	0			≥34	A	?	1	46	A	≥34	A	✓
Fish community health		Expert assessment	0				C	?	0				B	?	0				C	?
Macroinvertebrates	MCI	Median	4	99.0	D	≥90	C	×	5	101.8	C	≥110	B	×	5	109.5	C	≥107.3	C	✓
	QMCI	Median		4.1		≥4.5				5.1		≥5.5				4.6		≥5.1		
Macroinvertebrates	ASPM	Median	3	0.40	B	≥0.30	C	✓	5	0.47	B	≥0.6	A	×	5	0.41	B	≥0.43	B	✓
Deposited fine sediment	% cover	Median	27	7%	A	≤11%	A	✓	41	2%	A	≤10%	A	✓	34	56%	D	≤27%	C	×
Dissolved oxygen	mg/L	1-day minimum	0			≥7.5	A	?	0			≥7.5	A	?	0			≥7.5	A	?
		7-day mean				≥8.0						≥8.0						≥8.0		
Dissolved inorganic nitrogen	mg/L	Median	47	0.44		≤0.50		✓	57	0.23		≤0.17		×	58	0.45		≤0.42		×
Dissolved reactive phosphorus	mg/L	Median	47	0.020	D	≤0.018	C	×	57	0.013	C	≤0.01	B	×	58	0.025	D	≤0.018	C	×
		95th %ile		0.034		≤0.035				0.017		≤0.023				0.053		≤0.054		
Dissolved Copper	mg/L	Median	47	0.9	C	≤1.0	C	✓	0			≤1	A	?	0			≤1	A	?
		95th %ile		2.4		≤2.0						≤1.4						≤1.4		
Dissolved Zinc	mg/L	Median	47	10.7	C	≤11.2	C	✓	0			≤2.4	A	?	0			≤2.4	A	?
		95th %ile		35.0		≤42						≤8						≤8		
Ecosystem metabolism	g O_2 m^{-2} d^{-1}		0					?	0					?	0					?

Whaitua			TWT																	
			Korokoro catchment						Wellington urban catchment											
Part-FMU			Korokoro Stream						Kaiwharawhara Stream						Wellington urban					
Site			Korokoro S. @ Cornish St. Br.						Kaiwharawhara S. @ Ngaio Gorge						Karori S. @ Mākara Peak					
Parameter	Unit	Statistic	N	Current #	Current state	Target #	Target State	Target met	N	Current #	Current state	Target #	Target State	Target met	N	Current #	Current state	Target #	Target State	Target met
Periphyton biomass	mg chl-a/m^2	92nd %ile	0			≤120	B	?	24	80.7	B	≤200	C	✓	0			≤200	C	?
Ammonia (toxicity)	mg/L	Median	11	0.002	A	≤0.03	A	✓	57	0.007	B	≤0.004	A	×	58	0.015	A	≤0.009	A	✓
		Maximum		0.007		≤0.05				0.064		≤0.030				0.049		≤0.024		
Nitrate (toxicity)	mg/L	Median	11	0.51	A	≤1	A	✓	57	0.96	A	≤1.13	B	✓	58	1.15	B	≤1.27	B	✓
		95th %ile		0.93		≤1.5				1.28		≤1.46				1.39		≤1.61		
Suspended fine sediment	Black disc (m)	Median	11	3.80	A	≥2.95	A	✓	55	3.19	A	≥3.20	A	✓	57	3.54	A	≥3.20	A	✓
E. coli	/100mL	Median	11	40	B	≤130	B	✓	57	1600	E	≤130	C	×	58	2400	E	≤130	C	×
		% >260/100 mL		18%		≤30%				91%		≤34%				98%		≤34%		
		% >540/100 mL		9%		≤10%				72%		≤20%				97%		≤20%		
		95th %ile		965		≤1000				11300		≤1200				9600		≤1200		
Fish	Fish-IBI	Latest	1	36	A	≥34	A	✓	1	36	A	≥34	A	✓	1	24	C	≥34	A	×
Fish community health		Expert assessment	0				A	?	0				C	?	0				C	?
Macroinvertebrates	MCI	Median	2	113.0	C	≥130	A	×	5	95.0	D	≥90	C	×	5	92.2	D	≥91.8	C	×
	QMCI	Median		5.1		≥6.5				3.5		≥4.5				3.3		≥4.5		
Macroinvertebrates	ASPM	Median	2	0.57	B	≥0.6	A	×	5	0.31	C	≥0.36	C	✓	5	0.30	C	≥0.3	C	✓
Deposited fine sediment	% cover	Median	10	6%	A	≤13%	A	✓	47	5%	A	≤8.6%	A	✓	49	5%	A	≤19%	B	✓
Dissolved oxygen	mg/L	1-day minimum	0			≥7.5	A	?	0			≥7.5	A	?	0			≥7.5	A	?
		7-day mean				≥8.0						≥8.0						≥8.0		
Dissolved inorganic nitrogen	mg/L	Median	11	0.51		≤0.26		×	57	1.00		≤1.14		✓	58	1.18		≤1.29		✓
Dissolved reactive phosphorus	mg/L	Median	11	0.015	C	≤0.006	A	×	57	0.036	D	≤0.018	C	×	58	0.035	D	≤0.035	D	×
		95th %ile		0.020		≤0.021				0.053		≤0.054				0.054		≤0.062		
Dissolved Copper	mg/L	Median	11	0.3	A	≤1	A	✓	57	1.3	C	≤1.3	B	×	58	1.3	D	≤1.3	C	✓
		95th %ile		0.5		≤1.4				3.3		≤1.8				4.6		≤4.3		
Dissolved Zinc	mg/L	Median	11	0.5	A	≤2.4	A	✓	57	4.9	B	≤2.4	A	×	58	17.6	C	≤16.2	C	×
		95th %ile		0.5		≤8				12.3		≤8				41.6		≤42		
Ecosystem metabolism	g O_2 m^{-2} d^{-1}		0					?	0					?	0					?

Whaitua			TAoP																	
Part-FMU			Taupō						Pouewe						Wai-O-Hata					
Site			Taupō S. @ Plimmerton Domain						Horokiri S. @ Snodgrass						Duck Ck @ Tradewinds Dr. Br.					
Parameter	Unit	Statistic	N	Current #	Current state	Target #	Target State	Target met	N	Current #	Current state	Target #	Target State	Target met	N	Current #	Current state	Target #	Target State	Target met
Periphyton biomass	mg chl-	92nd %ile	0					?	27	122.8	C	≤120	B	×	15	31.8	A	≤120	B	✓
Ammonia (toxicity)	mg/L	Median	47	0.028	B	≤0.03	A	×	55	0.006	A	≤0.002	A	✓	22	0.011	A	≤0.03	A	✓
		Maximum		0.065		≤0.05				0.014		≤0.013				0.019		≤0.05		
Nitrate (toxicity)	mg/L	Median	47	0.04	A	≤1	A	✓	55	0.44	A	≤0.64	A	✓	22	0.66	B	≤1	A	×
		95th %ile		0.46		≤1.5				0.89		≤1.07				1.63		≤1.5		
Suspended fine	Black	Median	46	1.43	A	≥0.9	A	✓	54	2.45	C	≥2.30	C	✓	22	1.99	A	≥0.93	A	✓
E. coli	/100mL	Median	47	260	D	≤130	B	×	55	260	D	≤130	B	×	22	230	D	≤130	C	×
Fish	Fish-IBI	% >260/100 mL	1	49%	A	≤30%		?	1	49%	A	≤30%		?	0	41%		≤20%		?
		% >540/100 mL		28%		≤10%				22%		≤10%				23%		≤34%		
		95th %ile		5240		≤1000				1400		≤1000				2580		≤1200		
		Latest		46						42										
Fish community health		Expert assessment	0				B	?	0				A	?	0					?
Macroinvertebrates	MCI	Median	4	75.9	D	≥100	B	×	5	106.9	C	≥130	A	×	2	104.0	D	≥100	B	×
Macroinvertebrates	QMCI	Median	3	3.5	D	≥5	B	×	5	5.0	B	≥6.5	B	✓	2	4.3	C	≥5	B	×
	ASPM	Median		0.17		≤0.4				0.57		≥0.5				0.34		≥0.4		
Deposited fine	% cover	Median	29					?	45	8%	A	≤10%	A	✓	17	6%	A			?
Dissolved oxygen	mg/L	1-day minimum	0					?	0					?	0					?
		7-day mean																		
Dissolved inorganic nitrogen	mg/L	Median	47	0.08		≤1.03 I		✓	55	0.45		≤0.64		×	22	0.67		M		?
Dissolved reactive	mg/L	Median	47	0.018	D			?	55	0.013	C	≤0.011	C	×	22	0.021	D			?
Dissolved Copper	mg/L	95th %ile	47	0.033	B		B	✓	0	0.020		≤0.026	A	?	22	0.027	A		A	✓
		Median		0.6		≤1.4						≤1				0.6		≤1		
Dissolved Zinc	mg/L	95th %ile	47	1.6	A	≤1.8	A	✓	0			≤1.4	A	?	22	1.2	C	≤1.4	A	×
Ecosystem metabolism		Median	0	1.6		≤2.4		?	0			≤2.4		?	0	2.5		≤2.4		?
		95th %ile		4.4		≤8						≤8				16.8		≤8		
		g O_2 m^{-2} d^{-1}																		

Whaitua			TAoP											
Part-FMU			Takapū						Te Rio o Porirua and Rangituhi					
Site			Pāuatahanui S. @ Elmwood Br.						Porirua S. @ Milk Depot					
Parameter	Unit	Statistic	N	Current #	Current state	Target #	Target State	Target met	N	Current #	Current state	Target #	Target State	Target met
Periphyton biomass	mg chl-a/m^2	92nd %ile	0			≤120	B	?	21	45.6	A	≤120	B	✓
Ammonia (toxicity)	mg/L	Median	56	0.009	A	≤0.005	A	✓	58	0.018	B	≤0.006	A	×
		Maximum		0.021		≤0.017				0.051		≤0.031		
Nitrate (toxicity)	mg/L	Median	56	0.31	A	≤0.32	A	✓	58	0.86	A	≤0.90	A	✓
		95th %ile		0.83		≤0.75				1.36		≤1.5		
Suspended fine sediment	Black disc	Median	56	2.19	D	≥2.22	C	×	58	2.16	A	≥2.4	A	✓
E. coli	/100mL	Median	56	390	E	≤130	C	×	58	1400	E	≤130	C	×
		% >260/100 mL		75%		≤20%				98%		≤20%		
		% >540/100 mL		38%		≤18%				83%		≤34%		
		95th %ile		2580		≤1200				20200		≤1200		
Fish	Fish-IBI	Latest	1	42	A			?	0					?
Fish community health		Expert assessment	0				B	?	0		C			?
Macroinvertebrates	MCI	Median	5	98.8	D	≥105	B	×	5	96.5	C	≥90	C	✓
	QMCI	Median		4.3		≥5.25				4.5		≥4.5		
Macroinvertebrates	ASPM	Median	5	0.33	C	≥0.4	B	×	5	0.36	C	≥0.3	C	✓
Deposited fine sediment	% cover	Median	37	67%	D	≤27%	C	×	40	3%	C	≤20%	C	✓
Dissolved oxygen	mg/L	1-day minimum	0					?	0					?
		7-day mean												
Dissolved inorganic nitrogen	mg/L	Median	56	0.31		≤0.33		✓	58	0.89		≤0.92		✓
Dissolved reactive phosphorus	mg/L	Median	56	0.013	C	≤0.014	C	✓	58	0.024	D	≤0.018	D	×
		95th %ile		0.019		≤0.022				0.036		≤0.034		
Dissolved Copper	mg/L	Median	0			≤1	A	?	58	1.1	C	≤1.1	C	✓
		95th %ile				≤1.4				2.6		≤2.6		
Dissolved Zinc	mg/L	Median	0			≤2.4	A	?	58	7.1	C	≤7.5	C	✓
		95th %ile				≤8				31.6		≤42		
Ecosystem metabolism	g O_2 m^{-2} d^{-1}		0					?	0					?

Table 5: Current (as of June 30, 2024) state of lake attributes in Table 8.2 of PC1 compared to the TAS. Note achievement of the TAS is based on letter grades.

Lake			Lake Kōhangatera						Lake Kōhangapiripiri					
Parameter	**Unit**	**Statistic**	**N**	**Current #**	**Current state**	**Target #**	**Target State**	**Target met**	**N**	**Current #**	**Current state**	**Target #**	**Target State**	**Target met**
Phytoplankton	mg chl-a/m³	Median	12	1.5	D	≤2	A	×	11	1.5	D	≤1.5	A	×
		Maximum		84		≤10				84		≤6		
Total nitrogen	mg/m³	Median	12	620	C	≤480	B	×	11	620	C	≤500	B	×
Total phosphorus	mg/m³	Median	12	42	C	≤20	B	×	11	42	C	≤20	B	×
Ammonia (toxicity)	mg/L	Median	12	0.003	A	≤0.005	A	✓	11	0.005	A	≤0.003	A	✓
		95th %ile		0.016		≤0.024				0.029		≤0.005		
E. coli	/100mL	Median	12	25	A	≤125	A	✓	11	19	A	≤23	A	✓
		%>260/100mL		8%		≤17%				0%		0		
		%>540/100mL		0%		0%				0%		0%		
		95th %ile		380		≤350				211.5		≤186		
Cyanobacteria (planktonic)	Total biovolume	80th %ile	9	0.04	A	≤0.248	A	✓	10	0.04	A	≤0.008	A	✓
Submerged plants (natives)	Native Condition Index	Latest	1	81%	A	≥81%	A	✓	1	81%	A	≥75%	A	✓
Submerged plants (invasive species)	Invasive Impact Index (% of max)	Latest	1	16%	B	≤16%	B	✓	1	16%	B	≤25%	B	✓
Lake-bottom dissolved oxygen	mg/L	Annual minimum	0			≥7.5	A	?	0			≥7.5	A	?

83 The number of TAS that are currently met and not met is summarised Table 6. For context, the same assessment is also provided for the baseline states in Tables 8.2, 8.4 and 9.2. Currently, 39% of the TAS are known to be met, 29% are known to not be met, while the remaining 32% are unknown. Fewer TAS are currently not met compared to what the baseline states suggest (80 versus 82), despite a significant increase in the number of TAS that can now be benchmarked (187 compared to 151)

Table 6: Summary of the number of TAS met and not met at baseline and current state.

Whaitua/ Waterbody	Baseline state			Current state		
	Yes	No	Unknown	Yes	No	Unknown
TAoP Rivers	21 (26%)	22 (28%)	37 (46%)	28 (35%)	21 (26%)	31 (39%)
TWT Rivers	38 (22%)	54 (31%)	84 (48%)	69 (39%)	53 (30%)	54 (31%)
TWT Lakes	10 (56%)	6 (33%)	2 (11%)	10 (56%)	6 (33%)	2 (11%)
Total	69 (25%)	82 (30%)	123 (45%)	107 (39%)	80 (29%)	87 (32%)

ASSESSMENT OF THE LIKELIHOOD OF THE PC1 TAS BEING MET UNDER THE REGULATORY PROVISIONS

84 To date the biophysical effects of the proposed provisions have not been explicitly modelled, although I understand that this is in process. Consequently, the CMP and BSP scenario testing outputs (see paragraphs 31 to 37) still represent the best available information that can be used to assess the extent to which the proposed provisions will contribute to achievement of the TAS. To inform the S32 analysis for PC1, I used the BSP and CMP scenario results to assess how effectively the proposed regulatory provisions of PC1 will achieve the notified TAS for TWT and TAoP Whaitua (these reports can be found at the links below[28])[70,73]. To provide the panel with a broad indication of the potential effectiveness of the PC1 provisions, the methodology and results of these assessments are summarised in paragraphs 85 to 95.

[28] https://www.gw.govt.nz/assets/Documents/2023/10/Greer-M.J.C.-2023b.-Assessment-of-alignment-between-the-regulatory-provisions-and-target-attribute-states-in-proposed-Plan-Change-1-to-the-Natural-Resources-Plan-Te-Awarua-o-Porirua-Whaitua.pdf; and https://www.gw.govt.nz/assets/Documents/2023/10/Greer-2023a-Assessment-of-alignment-between-the-regulatory-provisions-and-target-attribute-states-in-proposed-Plan-Change-1-to-the-Natural-Resources-Plan-Whaitua-Te-Whanganui-a-Tara-1.pdf

85 The assessment process by which the effectiveness of the PC1 provisions were assessed in Greer[70,73] was as follows:

85.1 Water quality attributes were grouped as per with Table 7:

Table 7: How water quality attributes were grouped in the assessments by Greer[70,73]

Attribute Group	Attributes
Sediment	• Suspended fine sediment
Faecal indicator bacteria	• *E. coli*
Nitrogen	• Nitrate-nitrogen • Ammoniacal-nitrogen • Dissolved inorganic nitrogen (nutrient outcome)
Phosphorus	• Dissolved reactive phosphorus (nutrient outcome).
Metals	• Dissolved copper • Dissolved zinc

85.2 For each activity managed by PC1 an assessment was made of where the relevant proposed provisions sit in relation to the assumptions of the CMP/BSP scenarios. This was based on:

85.2.1. Where the proposed provisions require regulated parties to undertake specific actions, how similar those actions are to those assumed under the CMP/BSP scenarios; or

85.2.2. Where the proposed provisions require regulated parties to achieve a certain outcome how similar those outcomes are to those assessed under the CMP/BSP scenarios.

85.3 The scenario assignment process was based on (my) expert opinion and involved:

85.3.1. Identifying the relevant scenario assumptions for each activity;

85.3.2. Considering the actual and potential actions and outcomes required for each activity by the proposed provisions;

85.3.3. Identifying the BSP/CMP scenario whose assumptions most closely matched the requirements of the proposed provisions for each activity using the template set out below in Table 8;

Table 8: Example of the scenario alignment outputs for individual activities (in this case retirement). Please note this is just one of many tables contained in Greer[70,73]. It is included simply to detail the methodology undertaken, rather than draw attention to the environmental effects of any one specific provisions or land-use activity.

BAU	Improved	Water Sensitive
No retirement.	Retirement of LUC class 7e and 8e land with grassland land cover. Assumed this land reverts to native cover (3,733 ha)	As for Improved but with additional retirement of LUC class 6e land with grassland land cover (27,985 ha).

↑

Provisions
WH.R27(b) and Schedule 36 (B) & (E) require retirement of all highest erosion risk land on farms >20 ha by 2040 (50% by 2033) (3,734 ha).

85.3.4. Identifying which activities, and therefore, BSP/CMP scenario scenarios, are most relevant to each of the attribute groups in Table 7;

85.3.5. Providing a narrative description of how the proposed provisions and the assumptions of the assigned scenario align for each activity and attribute group based on the scenario testing outputs, monitoring results and the wider literature; and

85.3.6. Describing the key differences between the proposed provisions and the assigned scenario for each activity and attribute group.

86 These activity-based assessments were then used to assign a CMP/BSP scenario to each of the attribute groups set out above in Table 7. The results of this exercise are set out in Table 9.

Table 9: Summary of where the proposed PC1 provisions (as notified) on each attribute group sit in relation to the CMP and BSP scenarios (adapted from Greer[70,73]).

Whaitua	Attribute group	Most applicable BSP/CMP scenario
TAoP	Sediment	Improved
	Faecal indicator bacteria	
	Nitrogen	
	Phosphorus	
	Metals	Water Sensitive
TWT	Sediment (rural and mixed-rural part-FMUs)	Improved
	Sediment (urban part-FMUs)	Water Sensitive
	Faecal indicator bacteria (rural and mixed-rural part-FMUs)	Improved
	Faecal indicator bacteria (urban part-FMUs)	Water Sensitive
	Nitrogen (rural and mixed-rural part-FMUs)	Improved
	Nitrogen (urban part-FMUs)	Water Sensitive
	Phosphorus (rural and mixed-rural part-FMUs)	Improved
	Phosphorus (urban part-FMUs)	Water Sensitive
	Metals	

87 For each attribute group consideration was then given to whether the achievement of TAS for the water quality attributes listed in Table 7 was predicted under the assigned scenario during the BSP and CMP scenario testing processes. If not, consideration was given to the likely 'gap' between the outcome of the provisions and the TAS.

88 For each ecological TAS a narrative assessment was then made of:

88.1 The most applicable CMP/BSP scenario (based on expert opinion and the results of the scenario assignment process described in paragraph 85.3 above); and

88.2 The likely outcome of the proposed provisions based on the BSP/CMP scenario testing results for the most applicable scenario.

89 The TAS that were assessed as unlikely to be met by the PC1 provisions alone are listed in Table 10. Results suggest that the proposed regulatory provisions of PC1 require outcomes and actions that are likely to achieve most of the TAoP (~90%) and TWT (~85%) TAS. However, there are still several that are considered unlikely to be met through the proposed provisions alone.

Note: *While the assessment described above relies heavily on the results of scenario testing conducted for the TAoP CMP and TWT BSP, it was not an output of that project. No* *specific modelling was undertaken, nor do the results reflect an outcome of an expert panel assessment. Rather it should be treated as the peer reviewed opinion of one expert (myself).*

Table 10: Description of the TAS that Greer[70,73]) assessed as being unlikely to be met by the proposed PC1 regulatory provisions alone.

Whaitua	Part-FMU	Attribute
TAoP	Pouewe	Periphyton biomass
		E. coli
	Taupō	Nitrate
		E. coli
	Takapū	*E. coli*
	Wai-O-Hata	*E. coli*
	Te Rio o Porirua and Rangituhi	*E. coli*
TWT	Ōrongorongo, Te Awa Kairangi and Wainuiomata small forested and Te Awa Kairangi forested mainstems	Fish community health
		Dissolved reactive phosphorus
	Te Awa Kairangi lower mainstem	Fish community health
		Periphyton biomass
		Suspended fine sediment
		Macroinvertebrates
	Te Awa Kairangi rural streams and rural mainstems	Periphyton biomass
		E. coli
		Macroinvertebrates
		Fish-IBI
	Te Awa Kairangi urban streams	Fish-IBI
	Waiwhetū Stream	Dissolved reactive phosphorus
	Wainuiomata urban streams	Ammonia
		E. coli
	Wainuiomata rural streams	Periphyton biomass
		Suspended fine sediment
		Macroinvertebrates
		Dissolved reactive phosphorus
	Parangārehu catchment streams and South-west coast rural streams	*E. coli*
		Suspended fine sediment
		Dissolved reactive phosphorus
	Korokoro Stream	Periphyton biomass
	Kaiwharawhara Stream	Macroinvertebrates
		Dissolved reactive phosphorus
	Wellington urban	*E. coli*

E. COLI

90 Of particular note is the degree to which the *E. coli* TAS are not expected to be achieved under the provisions, especially in part-FMUs with rural land-use. This stems from many of the TAS requiring a multiple attribute state improvement, which goes beyond the minimum requirements of the NPS-FM 2020.

91 Of all the part-FMUs where a multiple attribute state improvement in *E. coli* is required; only the TAS for Te Awa Kairangi urban streams, Waiwhetū Stream, Kaiwharawhara Stream have been assessed as being achieved once all of the PC1 provisions have been implemented (assuming implementation is financially and physically feasible). To provide context on the extent of the improvement being sought by the *E. coli* TAS, Table 11 below indicates the potential load reductions required to achieve these TAS compared to the minimum improvement required by the NPS-FM 2020 (assumed to be one attribute state). These load reductions were calculated primarily to inform the economic assessment presented in the evidence of Mr David Walker[29], with the methodology documented in Greer [87].

Note: *There are significant limitations to the modelling approach discussed above, and results should be treated as indicative only[30]. They are by no means a definitive assessment of the load reductions required to achieve the TAS.*

[29] Evidence of David Adrian Walker on Behalf of Greater Wellington Regional Council (dated 28th February 2025)

[30] The limitations and uncertainties associated with the modelling approach is described in full in Greer[87].

Table 11: Estimated load reductions required to achieve the *E. coli* TAS for rivers compared to the reductions required to achieve the minimum improvement required by the NPS-FM 2020 (one attribute state). Calculated using the methodologies documented in Greer[87]. Parenthesised values in the load reduction columns represent the range of results from produced by the four modelling approaches employed for the TWT Whaitua (the top value is the average result from these four approaches).

Whaitua	Part-FMU	TAS site	Baseline state	Achieve PC1 TAS		Minimum required improvement	
				State	Load reduction	State	Load reduction
TAoP	Takapū	Pāuatahanui S. @ Elmwood Br.	E	C	59%	D	15%
	Pouewe	Horokiri S. @ Snodgrass	E	B	67%	D	48%
	Taupō	Taupō S. @ Plimmerton Domain	E	B	99%	D	49%
	Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot	E	C	92%	D	60%
	Wai-O-Hata	Duck Ck @ Tradewinds Dr. Br.	E	C	83%	D	54%
TWT	Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge	E	C	89% (84%-94%)	D	79% (64%-93%)
	Wellington urban	Karori S. @ Mākara Peak	E	C	96% (93%-99%)	D	92% (85%-95%)
	Waiwhetū Stream	Waiwhetū S. @ Whites Line E.	E	C	90% (82%-98%)	D	80% (61%-98%)
	Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.	E	C	91% (86%-95%)	D	85% (73%-98%)
	Wainuiomata urban streams	Black Ck @ Rowe Parade end	E	C	91% (84%-99%)	D	80% (62%-99%)
	Te Awa Kairangi rural streams and rural mainstems	Mangaroa R. @ Te Marua	D	B	61% (38%-83%)	C	53% (38%-67%)

92 These results show that in most part-FMUs where a multiple attribute state improvement is required, the TAS necessitate large reductions in load, with several part-FMUs requiring reductions over 90%. Theoretically, this may be possible through infrastructure upgrades in purely urban areas. However, it will also likely require significant destocking in those part-FMUs with rural land-use, which is not required by the notified PC1 regulatory provisions. This is partly due to the inclusion of the 95th percentile assessment statistic in the NPS-FM 2020 *E. coli* attribute state.

93 All PC1 *E. coli* TAS requiring an improvement from the E to C state necessitate significant reductions in 95th percentile concentrations; reductions that would not be needed if the TAS were set at the D state. Achieving such reductions is challenging because the 95th percentile assessment statistic is more sensitive to high concentrations recorded during rainfall than the other assessment statistics included in the NPS-FM 2020 *E. coli* attribute. When the data requirements for the *E. coli* attribute are met (i.e., the state is calculated from 60 samples), the 95th percentile is determined by the third and fourth highest concentrations in the dataset. Consequently, if a site experiences more than 12 rainy days per year, there is a high probability that the *E. coli* 95th percentile will be influenced by data collected during rainfall. As a result, at sites where stormflow *E. coli* concentrations occasionally exceed 1,200 cfu, achieving an improvement from the E to C state will require wet-weather concentration reductions that are often difficult to achieve through mitigation.

94 While stock exclusion has been shown to be effective at reducing *E. coli* concentrations in pastoral rivers during baseflows (i.e., when *E. coli* primarily enters the stream from animals defecating in close proximity to it)[90], there is evidence that it is less effective (62% in Sunohara *et al*.[91]) during rainfall when:

94.1 *E. coli* enters from the pasture via run-off[90];and

94.2 Faecal material previously deposited on the bed (and the associated *E. coli*) is remobilised[92].

95 Thus, while mitigations like stock exclusion may significantly reduce *E. coli* concentrations in pastoral rivers during baseflows, it is uncertain how they will contribute to achieving a TAS that requires substantial reductions in storm-flow concentrations to achieve a specific 95th percentile concentration. Ultimately this signals that the achievement of many of the

PC1 TAS will require some level of de-stocking beyond that required under Schedule 27 of PC1 (retirement of highest erosion risk land to reduce sediment losses).

96 It is not within the scope of my evidence to comment on what level of aspiration is appropriate in community based TAS.

DISSOLVED REACTIVE PHOSPHORUS

97 The dissolved reactive phosphorus TAS have been identified as not being achieved by the regulatory provisions of PC1 (see **Table 10**):

97.1 Waiwhetū Stream; and

97.2 Wainuiomata rural streams;

97.3 Parangārehu catchment streams and South-west coast rural streams; and

97.4 Kaiwharawhara Stream.

98 As set out in paragraph 46.4.2, the WIP objectives for dissolved reactive phosphorus were adopted as TAS in Table 8.4 for those part-FMUs where they were more stringent than the periphyton growth nutrient outcomes selected[29] from Snelder and Kilroy[12] (see paragraphs 44 to 47). This was the case for the all of the part-FMUs listed above. As previously noted (see paragraph 25.12) in my opinion this attribute should primarily be managed in relation to the PC1 periphyton biomass TAS.

99 If dissolved reactive phosphorus was managed for periphyton growth, the nutrient outcome process described paragraphs 44 to 47 would have generated the TAS set out in Table 12 below[31]

[31] These values are consistent with the suggested amendments to the periphyton biomass TAS in Table 21.

Table 12: Dissolved reactive phosphorus concentration that are consistent with the achievement of the periphyton biomass TAS in the part-FMUs where the current dissolved reactive phosphorus TAS have been identified as not being achieved by the regulatory provisions of PC1 (from Snelder & Kilroy[12]).

Part-FMU	Site	Statistic	TAS	Concentration consistent with relevant periphyton TAS
Waiwhetū Stream	Waiwhetū S. @ Whites Line E.	Median	≤0.018	≤0.024
		95th percentile	≤0.042	≤0.042
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge	Median	≤0.018	≤0.025
		95th percentile	≤0.054	≤0.064
Wainuiomata rural streams	Wainuiomata rural streams	Median	≤0.01	≤0.012
		95th percentile	≤0.017	≤0.017
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels	Median	≤0.018	≤0.025
		95th percentile	≤0.054	≤0.064

RESPONSES TO SPECIFIC MATTERS RAISED IN SUBMISSIONS

SUBMISSIONS ON MISSING BASELINE STATES IN TABLES 8.2, 8.4 AND 9.2 OF PC1

100 In its submission, Wairarapa Federated Farmers (**WFF**) state "*there is currently a lack of quality data to establish baseline positions for all TAS*" and that there are "*insufficient data on baseline states for some attributes and that further monitoring and modelling is required to develop attribute state frameworks*". Based on this, WFF have requested an amendment to Tables 8.2, 8.4 and 9.2 to "*delete sites/attributes where baseline state is based on limited* [data] *or modelled estimates*" and/or "*amend baseline state for the monitored sites to use the latest Council data*". Similarly, in its submission Wellington Water Ltd (**WWL**) notes that "*further information is required on the baseline state*" and that some attributes should be "*withdrawn until such detail can be added*".

101 The NPS-FM 2020 defines the baseline state as "*as the best state out of the following:*

101.1 *the state of the attribute on the date it is first identified by a regional council under clause 3.10(1)(b) or (c)*

101.2 *the state of the attribute on the date on which a regional council set a freshwater objective for the attribute under the National Policy Statement for Freshwater Management 2014 (as amended in 2017)*

101.3 *the state of the attribute on 7 September 2017*"

102 For the compulsory attributes in the NPS-FM 2020, this definition limits the baseline state to the state of the attribute on 7 September 2017, as those attributes:

102.1 Were not developed by the Council under clause 3.10(1)(b) or (c) of the NPS-FM 2020; and

102.2 Did not have freshwater objectives set under the NPS-FM 2014 (as amended in 2017).

103 Consequently, an indication of "*insufficient data*", or a footnote referencing "*based on limited data*" in Tables 8.4 and 9.2 is not generally a reflection of current data quality or quantity, rather it reflects data limitations that existed September 2017 but may no longer exist. Thus, I do not agree with the submitter that the inclusion of these baseline state notes/ footnotes is a sufficient source of uncertainty to justify the deletion of the corresponding TAS (although see paragraph 105 for discussion on attributes where data limitations remain).

104 It is not possible to simply generate new data for the baseline period to populate all the missing or footnoted (i.e., data limited) baseline states in Tables 8.2, 8.4 and 9.2. However, to provide submitters with an indication of the extent of the improvements required by the various TAS, I have calculated the current state (as of 30 June 2024) for each attribute in Tables 8.2, 8.4 and 9.2 for which data are available. I have also included the number of measurements upon which these current state estimates are based to give an indicator of robustness. These results are provided in Table 4 and Table 5, along with an assessment of which attributes require improvement to meet the TAS. It is my understanding that in her S42A Officer's Report Ms O'Callahan has recommended that this Table, with the addition of the PC1 baseline states, be included in a new schedule in PC1.

105 As can be seen from Table 4 (the column labelled "N" indicates the number of available data points) there are still a number of attributes and sites where measured or robust modelled state data remains sparse. Specifically:

105.1 Dissolved oxygen, Fish community health and ecosystem metabolism at all sites;

105.2 Periphyton biomass at some sites;

105.3 Fish-IBI at most sites;

105.4 All attributes in the Korokoro and Wai-O-Hata part-FMUs; and

105.5 Lake-bottom dissolved oxygen in the Lake Kōhangatera and Lake Kōhangapiripiri part-FMUs

106 I agree with the WFF and WWL submissions that there is a high level of uncertainty around the improvements required by the TAS for these attributes/part-FMUs and the actions required to improve them. Whether this uncertainty justifies removing them despite the NPS-FM 2020 requirement that a "*local authority must not delay making decisions solely because of uncertainty about the quality or quantity of the information available*" is a policy matter that is outside the scope of my evidence. However, I do consider that there is little scientific justification for setting an A state TAS for lake-bottom dissolved oxygen in the Lake Kōhangatera and Lake Kōhangapiripiri part-FMUs in the absence of baseline or current state data.

107 As stated in paragraph 26.5 the lake bottom dissolved oxygen attribute is not designed to prevent against direct adverse effects on aquatic life. Instead, it is designed to control the nutrient release that can occur from bed sediments in anoxic conditions. Thus, the attribute is linked to the Total nitrogen and Total phosphorus TAS. The actions required to achieve those TAS in Lake Kōhangatera and Lake Kōhangapiripiri are unclear, and it is not known to what extent dissolved oxygen conditions contribute to the nutrient concentrations in these lakes. On that basis, I see no scientific justification for setting a TAS that may require an improvement in this attribute, and a simple 'Maintain' type TAS would be more appropriate from a scientific perspective.

108 As more lake monitoring and modelling data become available the extent to which oxygen conditions drive nutrients concentration Lake Kōhangatera and Lake Kōhangapiripiri should become clearer. This may justify interventions through action planning to improve oxygen conditions in the lake. However, I understand the nutrient TAS alone should provide sufficient justification for this.

SUBMISSIONS REQUESTING MORE STRINGENT NITRATE TAS FOR KAIWHARAWHARA AND WELLINGTON URBAN PART-FMUS IN TABLE 8.4 OF PC1

109 Environmental Defence Society Inc. (**EDS**) have requested that the TAS for nitrate-nitrogen in the Kaiwharawhara Stream and Wellington Urban part-FMUs be changed from the B state to the A state. In my opinion, this change is not justified from a toxicity risk perspective for the exactly the same reasons that the current A state TAS for dissolved copper, dissolved zinc and ammoniacal nitrogen in urban streams are not justified (i.e., they are not required to achieve the Q/MCI TAS; see paragraph 71). Nevertheless, I acknowledge that adopting the submitters request for the Kaiwharawhara Stream would not change the management required to achieve the TAS. Current state nitrate concentrations at the specified monitoring site are within A band (**Table 4**), and there has been improving trends at the site over the last 15 years[25].

110 The same does not apply to the Wellington urban part-FMU, which remains in the B band for nitrate-nitrogen despite improving trends[25]. In that catchment, the mechanisms by which the improvements requested by EDS can be achieved are unclear. The sources of nutrients in New Zealand urban landscapes are poorly understood[93], and in the aforementioned part-FMU likely comes from a combination of wastewater contamination, stormwater discharges, and landfill leachate from closed sites. Without understanding the relative impacts of these activities, it is not possible to identify what mitigations are required to achieve the nutrient reductions that would be required. However, the Our Land and Water Science Challenge Scenario Builder WebApp suggests that mitigations would have to reduce urban nitrogen losses by ~20%[26]. For context, if all of the nitrogen load was sourced from stormwater discharges this would require approximately 50% of the existing urban area to be treated by devices like wetlands or rain gardens.

111 I understand that the submitters request for an A state TAS for nitrate-nitrogen in the Wellington urban part-FMU may stem more from concerns about potential conflicts between the nitrate and periphyton TAS for this part-FMU than from concerns about toxicity effects. I agree with the submitter that dissolved inorganic nitrogen concentrations should not exceed 1 mg/L in this FMU (discussed further paragraph 115), and that amending the numeric target attribute state for median (only) nitrate-nitrogen concentrations to 1.0 mg/L would align with this. However, the 95^{th} percentile nitrate concentration in this part-FMU is currently in the B band, and setting the TAS at A would necessitate an improvement in this statistic which would have no meaningful impact on

nitrate toxicity effects or periphyton growth (which is better predicted by median concentrations).

SUBMISSIONS REQUESTING DIFFERENT NUTRIENT OUTCOMES FOR DISSOLVED INORGANIC NITROGEN IN TABLES 8.4 AND 9.2 OF PC1

112 In their submissions EDS, the Vic Uni Canoe Club and the Wellington Fish and Game Regional Council (**Fish and Game**) have requested the dissolved inorganic nitrogen nutrient outcomes for various part-FMUs be amended to 0.3 mg/L, 0.5 mg/L or 1.0 mg/L. In my opinion, such a change is not scientifically justified.

113 The dissolved inorganic nitrogen nutrient outcomes in Tables 8.4 and 9.2 were set in accordance with the requirements of the NPS-FM 2020 and the associated national guidance (see paragraphs 25.11 and 44 to 47), and are consistent with the periphyton TAS when shading is also implemented. In contrast, there does not appear to be any scientific basis for some of the submitter requested amendments, as the 0.3 mg/L threshold is contrary to the relevant available thresholds in the literature[12,32,51,94]. While Fish and Game's submission indicates that they are from Canning *et al*.[95], 0.3 mg/L is not cited in that paper.

114 Changing the dissolved inorganic nitrogen nutrient outcomes is not necessary, in my opinion, to achieve the periphyton TAS. Furthermore, the current nutrient outcomes are also consistent (at 50% under-protection risk) with achieving the periphyton TAS requested by EDS and the Vic Uni Canoe (those at 'C' amended to be 'B')[12] Thus, there is no technical justification for adopting most of the thresholds proposed in these submissions regardless of where the final periphyton TAS end up.

115 The only exception is for the Wellington Urban part-FMU. I agree with EDS, the Vic Uni Canoe Club and Fish and Game that the dissolved inorganic nitrogen nutrient outcome should not be set above 1.0 mg/L where an improvement in periphyton biomass is required. This may be the case for the Wellington Urban part-FMU where current state is unknown[32]. The dissolved inorganic nitrogen nutrient outcomes in Table 8.4 and 9.2 were drawn from Snelder and Kilroy[12], which is clear that 1.0 mg/L of dissolved inorganic nitrogen represents the saturating concentration (where growth is not limited by

[32] Current periphyton cover monitoring (maximum weighted composite cover = 31%)[25] cover suggests the risk of the TAS being exceeded is low. However, this cannot be confirmed without biomass data as the relationship between cover and biomass is weak in the Wellington Region[96]

availability of nutrients) and nutrient outcomes should not be set above this level where an improvement in periphyton is required. Consequently, to be consistent with the guidance upon which it is based, the dissolved inorganic nitrogen nutrient outcome for the Wellington urban part-FMU would need to be made more strict by reducing it from 1.29 mg/L to 1 mg/L, which, in-turn necessitates that the numeric median nitrate concentration TAS also be reduced to 1 mg/L (see paragraph 110).

116 In most part-FMUs the current dissolved inorganic nitrogen nutrient outcomes, which also represent baseline state, are actually more stringent than the requested thresholds by submitters. Indeed, if adopted, the EDS requested dissolved inorganic nitrogen nutrient outcomes would require significant reductions in concentrations only in the following part-FMUs (see Table 13 below):

116.1 Te Rio o Porirua and Rangituhi;

116.2 Te Awa Kairangi rural streams and rural mainstems;

116.3 Kaiwharawhara Stream; and

116.4 Wellington urban.

117 However, in most of those part-FMUs listed above the required reductions in dissolved inorganic nitrogen concentrations would require significant interventions to achieve them including significant stormwater treatment in existing urban areas, retirement of rural land, and significant upgrades to the wastewater networks (discussed further in paragraphs 0 to 122 below). I cannot comment on whether the level of mitigation on its own means the amended dissolved inorganic nutrient outcomes requested by EDS, the Vic Uni Canoe Club and Fish and Game for these part-FMUs should not be included in Tables 8.4 and 9.2 (that is a policy matter). However, it is my opinion that such mitigations are not necessary to achieve the relevant periphyton TAS except in the Wellington Urban part-FMU (for the reasons described in paragraphs 113 to 115).

Table 13: Comparison of existing baseline and target dissolved inorganic nitrogen concentrations in different part-FMUs compared to the values requested in submissions. The abbreviation 'NO' stands for nutrient outcome.

Part-FMU	Site	Baseline state dissolved inorganic nitrogen and existing NO	Requested dissolved inorganic nitrogen NO	Percent reduction from baseline state and existing NO
Taupō	Taupō S. @ Plimmerton Domain	0.41	1.0	0%
Pouewe	Horokiri S. @ Snodgrass	0.64	0.6	6%
Wai-O-Hata	Duck Ck @ Tradewinds Dr. Br.	0.48	1.0	0%
Takapū	Pāuatahanui S. @ Elmwood Br.	0.33	0.6	0%
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot	0.92	0.6	35%
Ōrongorongo, Te Awa Kairangi and Wainuiomata small forested and Te Awa Kairangi forested mainstems	Whakatikei R. @ Riverstone	0.15	0.3	0%
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott	0.2	0.3	0%
Te Awa Kairangi rural streams and rural mainstems	Mangaroa R. @ Te Marua	0.44	0.3	32%
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.	0.24	0.6	0%
Waiwhetū Stream	Waiwhetū S. @ Whites Line East	0.56	1.0	0%
Wainuiomata urban streams	Black Ck @ Rowe Parade	0.5	0.6	0%
Wainuiomata rural streams	Wainuiomata River D/S of White Br.	0.17	0.3	0%
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels	0.42	0.6	0%
Korokoro Stream	Korokoro S. @ Cornish St. Br.	0.26	0.6	0%
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge	1.14	0.6	47%
Wellington urban	Karori S. @ Mākara Peak	1.29	0.6	53%

118 For the Te Rio o Porirua and Rangituhi part-FMU the Our Land and Water Science Challenge Scenario Builder WebApp[26] suggests that a 30% reduction in nitrogen losses are required to achieve the submitters dissolved inorganic nitrogen targets. The CMP outputs[75] suggest such improvements are unlikely even with:

118.1 Retirement of all high and highest erosion risk land;

118.2 Five metres of riparian planting undertaken on all REC order 2 or greater streams with catchment slope less than 15 degrees;

118.3 All wastewater-stormwater cross connections being repaired;

118.4 Wastewater overflows reduced from 12 per year on average to two;

118.5 In greenfield and infill development, the treatment of:

118.5.1. 50% of paved surface in new greenfield dwellings and 25% of infill dwellings with permeable paving;

118.5.2. 90% of roads with bioretention; and

118.5.3. 100% of paved and rooved surfaces with wetlands.

118.6 In existing urban areas, the treatment of:

118.6.1. 100% runoff from major roads with wetlands

118.6.2. 100% runoff from paved industrial areas with media filters

118.6.3. 100% runoff from paved commercial areas with bioretention.

119 Exactly what additional actions would be needed to achieve the submitter's requested nutrient outcomes is unclear, but it likely would involve additional retirement of farmland.

120 In the Te Awa Kairangi rural streams and rural mainstems part-FMU, the Our Land and Water Scenario Builder WebApp[26] suggests that the proposed dissolved inorganic nitrogen target would require a 15% reduction in N loss. It also suggests that this could be achieved through the implementation of the erosion risk treatment plan (**ERTP**) requirements of Schedule 36 of PC1 (i.e., retirement of highest erosion risk land), provided the stock exclusion and the general Farm Environment Plan (FEP) provisions generate a ~10% reduction in the remaining farmland.

121 The mechanisms by which dissolved inorganic nitrogen concentration could be reduced in the urban part FMUs listed above (Kaiwharawhara Stream and Wellington urban) to the levels requested by submitters are unclear. But will likely need to involve a combination of stormwater treatment, reducing wastewater leaks and overflows and, potentially, pump and treatment of leachate from closed landfill sites. Based on the Our Land and Water Scenario Builder WebApp[26] results for these part-FMUs such mitigations would have to reduce urban nitrogen losses by approximately

121.1 ~50% in the Kaiwharawhara Stream part-FMU; and

121.2 ~60% in the Wellington urban part-FMU.

122 To give an idea of the scale of the mitigations required to achieve this, if 50% of urban nutrient losses come from stormwater and 50% come from wastewater (which is not the case), then achieving the proposed dissolved inorganic nitrogen targets would require stormwater from 100% of the impervious surfaces in both part-FMUs to be treated with devices like wetland or rain gardens, and wastewater contamination to be reduced by 60% and 80% in the Kaiwharawhara Stream and Wellington urban part-FMUs, respectively. I understand that even if it is physically possible to implement these mitigations at such a large scale, it would be extremely expensive (see Mr David Walker's Statement of Primary Evidence for costs associated with these sorts of mitigations).

SUBMISSIONS REQUESTING DIFFERENT NUTRIENT OUTCOMES FOR DISSOLVED REACTIVE PHOSPHORUS IN TABLES 8.4 AND 9.2 OF PC1

123 In its submission Fish and Game note that "*median Dissolved Reactive Phosphorus* [sic] *concentrations should be set at around 0.01 – 0.02 mg/L*", citing Canning *et al*.[95] as the source of these figures. In my opinion, this amendment is generally redundant and not scientifically justified.

124 The dissolved reactive phosphorus nutrient outcomes in Tables 8.4 and 9.2 were set in accordance with the requirements of the NPS-FM 2020 and the associated national guidance (see paragraphs 25.11 and 44 to 47). Consequently, they are consistent with the periphyton TAS when shading is also implemented. In contrast, the thresholds requested by Fish and Game are based on correlations between nutrient concentrations and Q/MCI and the macroinvertebrate average score per metric attributes. In my opinion there are a number of issues with this approach. Specifically:

124.1 As stated in the note to paragraph 25.11, periphyton growth is the primary mechanism through which phosphorus directly and/or indirectly affects the Q/MCI and macroinvertebrate average score per metric attributes. Thus, achieving the TAS for those attributes through phosphorus management is best achieved by setting and achieving dissolved reactive phosphorus targets that are consistent with periphyton biomass TAS that are in turn consistent with the macroinvertebrate TAS;

124.2 The dissolved reactive phosphorus thresholds in Canning *et al*.[95] are set at a level that is consistent with the National Bottom Lines (C state) for Q/MCI and the macroinvertebrate average score per metric attributes. Consequently, even if they were environmentally relevant, which I do not consider they are, they are not consistent with those TAS set at the A or B (see **Table 2**); and

124.3 Most importantly, Fish and Game's requested amendment to the dissolved reactive phosphorus nutrient outcomes in Tables 8.4 and 9.2 is almost completely redundant. With the exception of the Wellington urban part-FMU (discussed further in paragraph 125), all of the existing dissolved reactive phosphorus nutrient targets are either consistent with, or more stringent than the 0.1 mg/L to 0.2 mg/L range requested by Fish and Game.

125 Nevertheless, Fish and Game's requested amendment to the dissolved reactive phosphorus nutrient outcomes in Tables 8.4 and 9.2 has highlighted that the median target for the Wellington Urban part-FMU is potentially too lenient. Snelder and Kilroy[12] (the source of the nutrient outcomes) state that 0.025 mg/L is the saturating concentration (where growth is not limited by availability of nutrients) for dissolved reactive phosphorus and nutrient outcomes should not be set to be less stringent than this where an improvement in periphyton is required, which may be the case in the currently unmonitored Wellington Urban part-FMU[32]. Consequently, to be consistent with the guidance upon which it is based the dissolved reactive phosphorus nutrient outcome for this part-FMU would need to be made stricter by reducing it from 0.35 mg/L to 0.25 mg/L.

126 Achieving an amended dissolved reactive phosphorus nutrient outcome of of 0.025 mg/L (a 30% improvement form current state – see Table 4) in the Wellington urban part-FMU will likely require stormwater treatment and reducing wastewater leaks/overflows. Based on the Our Land and Water Scenario Builder WebApp results[26] for this part-FMU such mitigations would have to reduce urban phosphorus losses by approximately 50%

upstream of the Karori Stream monitoring site. To give an idea of the scale of the mitigations required to achieve this, if 50% of urban nutrient losses come from stormwater and 50% come from wastewater (which is probably not the case), then achieving a median dissolved reactive phosphorus concentration of 0.025 mg/L would require stormwater from 83% to 100% of impervious surfaces in this part-FMU to be treated with devices like wetland or rain gardens, and wastewater contamination to be reduced by 50%.

SUBMISSIONS REQUESTING MORE STRINGENT PERIPHYTON BIOMASS TAS FOR THE WAIWHETŪ STREAM PART-FMU IN TABLE 8.4 OF PC1

127 In their submissions EDS and the Vic Uni Canoe request that the TAS for periphyton biomass in the Waiwhetū Stream part-FMU be amended to the B state (from the C state). In my opinion, this amendment should be made, as the current C TAS theoretically allows for a degradation from current state.

128 The Waiwhetū Stream at the TAS site is a macrophyte dominated system. Between 2018 and 2021, no periphyton was recorded at the site[97], and the Council no longer monitors it for this reason. Thus, the level at which the periphyton biomass TAS is set is redundant. However, it was included because the river does not meet the technical definition of 'naturally soft-bottomed' in the NPS-FM 2020. Nevertheless, there is no need or mechanism to improve this attribute, which is almost certainly in the A state. Adopting the amendment requested by EDS and Vic Uni Canoe Club would result in a TAS that better reflects the current state of periphyton without necessitating any real change in how plant growth is managed in PC1 (i.e., the nutrient outcomes set for dissolved inorganic nitrogen and dissolved reactive phosphorus in Table 8.4).

SUBMISSIONS REQUESTING MORE STRINGENT PERIPHYTON BIOMASS TAS FOR OTHER PART-FMUS IN TABLES 8.4 AND 9.2 OF PC1

129 In their submissions EDS and Vic Uni Canoe have requested that the periphyton biomass TAS that are currently set at attribute state C, instead be set at attribute state B (≤120 mg chl-a/m^2). This applies to the following part-FMUs

129.1 Te Awa Kairangi urban streams;

129.2 Wainuiomata urban streams;

129.3 Wainuiomata rural streams;

129.4 Parangārehu catchment streams and South-west coast rural streams;

129.5 Kaiwharawhara Stream; and

129.6 Wellington urban.

130 In terms of ecological effects, such a change would shift the TAS from protecting trout habitat/angling values and ensuring that there are only "*periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or moderate alteration of the natural flow regime or habitat*" to also protecting aesthetic/recreational values and ensuring there are only *occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat*"[5].

131 Matheson *et al*.[89] found that C/D attribute state (the national bottom line (NBL)) for periphyton results in a high level of correspondence with equivalent macroinvertebrate indices. However, the periphyton and macroinvertebrate community health attributes in the NPS-FM 2020 do not align well at higher attribute states (i.e., A and B). Thus, the current 'C' periphyton TAS in the following part-FMUs are set at a level that is consistent with the aquatic life endpoints sought by the corresponding Q/MCI TAS (C):

131.1 Te Awa Kairangi urban streams

131.2 Wainuiomata urban streams

131.3 Parangārehu catchment streams and South-west coast rural streams

131.4 Kaiwharawhara Stream; and

131.5 Wellington urban.

132 In contrast, the periphyton TAS in the Wainuiomata rural streams part-FMU may not be sufficiently stringent to achieve the corresponding macroinvertebrate community health TAS, which are both set at B state. Consequently, it is my opinion that amending this TAS to the B state would be consistent with the ecosystem health endpoints sought for this part-FMU. Such an amendment would not necessitate a consequential change to the dissolved inorganic nitrogen and dissolved reactive phosphorus nutrient outcomes that have been set for this part-FMU which are already consistent with a B state TAS for periphyton (50% under-protection risk with shading[12]).

***Note:** While the available evidence suggests making the periphyton TAS more stringent should result in better macroinvertebrate community health than at the current C state TAS, there is no certainty that making the periphyton TAS more stringent to the B state will align with the corresponding B state Q/MCI TAS in this part-FMU (i.e. it could result in better or worse Q/MCI than the TAS).*

SUBMISSIONS REQUESTING MORE STRINGENT MACROINVERTEBRATE TAS IN TABLES 8.4 AND 9.2 OF PC1

133 EDS have requested more stringent TAS be set for Q/MCI in Table 8.4 and 9.2, although they have not specified the exact level at which these targets should be set.

134 Theoretically, the ecosystem health benefits of setting higher Q/MCI targets are clear. For example, changing the TAS for Q/MCI from the C to B would shift the target level of ecosystem health from fair to good[31,85,86], and would require stressors like pollution and land-use to be reduced to a level where they have a mild rather than moderate impact on macroinvertebrate community health. Further reducing the TAS to A would necessitate an excellent level of health reflective of pristine conditions with almost no impact from stressors like pollution and land-use.

135 Achieving a B in the Parangārehu catchment streams and South-west coast rural streams part-FMU is not impossible given the land-use in the area (more information is provided below in paragraph 141)[73]. However, it is unlikely that increasing the stringency of the Q/MCI TAS from the C state to the B state in the following part-FMUs will result in achievable targets in the following part-FMUs:

135.1 Te Rio o Porirua and Rangituhi;

135.2 Te Awa Kairangi urban streams;

135.3 Waiwhetū Stream;

135.4 Wainuiomata urban streams;

135.5 Kaiwharawhara Stream; and

135.6 Wellington urban.

136 Ecological communities in all of these streams are significantly impacted by urban development, including having high dissolved metal concentrations, flashy flows, and

habitat modification (bed and bank armouring). Achieving a Q/MCI target attribute state of B in these rivers will require a fundamental shift in the land-cover of their catchments and morphology of their beds[74]. For context, nationally there is only one urban water quality monitoring site where MCI scores are currently in in the B band [93]. Importantly, the current Q/MCI TAS for these part-FMUs already requires them to improve to be within the top 20% of monitored urban rivers [93].

137 Achieving a TAS of A in those urban part-FMUs (Taupō and Wai-O-Hata) where it is currently set at B would also be extremely difficult, given the existing TAS requires them to improve to be within the top 2% of monitored urban rivers[93]. It is simply not possible to achieve such natural macroinvertebrate communities in already developed urban landscapes. Thus, setting an A TAS for the Taupō and Wai-O-Hata part-FMUs, would likely require the retirement of residential land to native bush as, to my knowledge, not a single urban water quality site in New Zealand has an MCI statistic/metric in the A band[93].

138 Even in the rural and mixed land-use part FMUs where the TAS currently sits in the C or B band, achieving the A band will require significant land-use change to replicate natural state conditions. While the level of effort required to achieve this in TAoP has not been robustly assessed, the TWT expert panel[74] considered that stock exclusion with ten metre forested riparian buffers on all second order and greater streams on land less 15 degrees, and retirement of all high and highest erosion risk land would be required in the following part-FMUS:

138.1 Te Awa Kairangi rural streams and rural mainstems; and

138.2 Wainuiomata rural streams.

139 They also noted that those actions were unlikely to achieve an A state in the Te Awa Kairangi lower mainstem even with significant stormwater treatment in urban feeder catchments.

140 In short, changing the Q/MCI TAS in most part FMUs would result in targets being impracticable with current land-use. Such a change would likely necessitate reversion to native bush in both rural and urban part-FMUs. Whether this justifies not adopting the requested changes is a policy matter that is outside the scope of my evidence.

141 The only exception is the Parangārehu catchment streams and South-west coast rural streams part-FMU where EDS have requested the Q/MCI TAS be amended from the C state

to (presumably) at least B state. Theoretically, such an improvement is possible in this catchment. However, it would be contrary to the outcome sought for ecosystem health in the TWT WIP (see **Table 2**). Furthermore, the BSP expert panel only considered such an improvement (a full attribute state) likely under a scenario where all rivers were fenced with ten metre riparian buffers, and all high and highest erosion risk land was retired. Thus, EDSs requested amendment could necessitate far more intensive mitigation and land-use controls than what is required by the provisions of PC1[73]. Whether these issues justify not adopting EDSs requested amendment is a policy matter and outside the scope of my evidence.

SUBMISSIONS ON THE ACHIEVABILITY OF THE *E. COLI* AND PERIPHYTON TAS IN TABLES 8.4 AND 9.2 OF PC1

142 In its submission Winstone Aggregates raise concern over whether the TAS in Tables 8.4 and 9.2 are too ambitious in the timeframe proposed (2040). Specifically, they identified the periphyton TAS that require an improvement from the D to the B states, and the *E. coli* TAS that require an improvement from the C to the A (TWT) or E/D to the B state (TAoP) as being an issue.

143 Three part-FMUs have a periphyton biomass TAS that requires an improvement from the D state to the B state,

143.1 Pouewe

143.2 Te Awa Kairangi lower mainstem

143.3 Te Awa Kairangi rural streams and rural mainstems

144 Increasing the stringency of the TAS in these part-FMUs from the B state to the C state would have the opposite effects to what is described in paragraph 130. Specifically, while trout/angling values would remain protected, aesthetic and recreational values would not be, and there would be periodic rather than occasional blooms, reflecting moderate, rather than low, nutrient enrichment and/or alteration of the natural flow regime or habitat. Furthermore, based on Matheson *et al*.[89] the periphyton TAS would then be inconsistent with achieving an Q/MCI TAS that is more stringent than the NBL, and therefore, the desired ecosystem health outcomes for these part FMUs (Excellent or Good; see **Table 2**).

145 The best available information suggests achieving the B band in these part-FMUs is achievable. The baseline states for all of these part-FMUs are based on incomplete data, as

the Council's periphyton monitoring programme was in its infancy in 2017. Currently the Te Awa Kairangi lower mainstem is in the A state for periphyton biomass, while the Pouewe and Te Awa Kairangi rural streams and rural mainstems part-FMUs are in the C state (see Table 4). Thus, the difference between the baseline and target states are not a fair representation of the improvement required.

146 In terms of the level of effort needed to achieve the periphyton TAS being sought by submissions, an initial assessment of the nutrient criteria in Snelder and Kilroy[12] indicates that nutrient management is not required to achieve the current TAS in any of the relevant part-FMUs, and that shading alone is likely (>50% probability) to achieve the B attribute state in the Pouewe and Te Awa Kairangi rural streams and rural mainstems part-FMUs (Table 14), and that no action is required in the Te Awa Kairangi lower mainstem part-FMU (where shading is not possible) which already meets the relevant TAS. Thus, I do not agree with the submitter that these TAS will necessitate "*significant land-use change*".

Table 14: The probability of achieving the periphyton B attribute state through shading (where possible) and the existing nutrient outcomes in part-FMUs where the baseline state is D and the TAS is B (based on the nutrient outcomes at different under-protection risk thresholds in Snelder and Kilroy[12].

<table>
<tr><th>Part-FMU</th><th>Probability of achieving the B attribute state with shading and existing nutrient outcomes based on Snelder and Kilroy[12]</th></tr>
<tr><td>Pouewe</td><td rowspan="3">50-70%</td></tr>
<tr><td>Te Awa Kairangi rural streams and rural mainstems</td></tr>
<tr><td>Te Awa Kairangi lower mainstem</td></tr>
</table>

147 In contrast, there is evidence to support the submitters position that the *E. coli* TAS they have identified would require "*significant land-use change*" in the following part-FMUs [74,75] (note there are no TAS which require an improvement from the C to A state as suggested by the submitter):

147.1 Taupō (E to B)

147.2 Pouewe (E to B)

148 As set out in Table 11, the *E. coli* TAS for these part-FMUs could require a 99% and 67% reduction in *E. coli* load, respectively. The available science from the Whaitua processes (see paragraphs 31 to 37 and 87 to 95) indicates that such large reductions in load in these

part-FMUs would require at least the near complete removal of urban (wastewater and stormwater) *E. coli* sources, the retirement of all high and highest erosion risk land identified in Map 90 and 93 of PC1, and full stock exclusion with five metre riparian buffers on all order 2 or greater streams with an average catchment slope of less than 15 degrees. Furthermore, even those interventions were not modelled to achieve the Taupō part-FMU TAS.

149 In short, there is evidence to support Winstone Aggregates submission that the *E. coli* TAS for the Taupō and Pouewe part-FMUs will require significant land-use change. However, I cannot comment on whether this justifies adopting their requested amendments as that is a policy matter, outside the scope of my evidence.

SUBMISSIONS REQUESTING THAT COLOUR BE ACCOUNTED FOR IN THE VISUAL CLARITY TAS FOR THE TE AWA KAIRANGI RURAL STREAMS AND RURAL MAINSTEMS PART-FMU IN TABLE 8.4 OF PC1

150 In its submission, the Wellington Branch of New Zealand Farm Forestry Association (**NZFFA**) correctly identify that the suspended fine sediment TAS for the Te Awa Kairangi rural streams and rural mainstems part-FMU does not account for the naturally occurring processes of high coloured dissolved organic matter in the Mangaroa River.

151 In response to this submission point Dr Amanda Valois has calculated the impact of coloured dissolved organic matter on visual clarity in the Mangaroa River and developed a colour corrected national bottom line in her Statement of Primary Evidence[22]. In his Statement of Primary Evidence[20] Mr Blyth has then recalculated the sediment load reductions required in this catchment to achieve this threshold. In my opinion adopting these proposed TAS and load reductions is justified and consistent with clause 3.32 of the NPS-FM 2020 (naturally occurring processes).

SUBMISSIONS SUGGESTING THAT NATURAL SEDIMENT CONDITIONS ARE DRIVING NON-ACHIEVEMENT WITH THE VISUAL CLARITY TAS FOR THE TAKAPŪ PART-FMU IN TABLE 9.2 OF PC1

152 In its submission, WFF requests that an additional clause be added to Policy WH.P4, directing "*sediment source studies to establish fit for purpose information on relative sources and spatial-temporal patterns including consideration of natural factors impacting clarity (eg,* [] *Pauhatanui* [sic]*/soft-bottom substrate)*". I do not consider such an amendment to be scientifically justified.

153 The Pāuatahanui Stream does not meet the definition of a naturally soft-bottomed river under the NPS-FM 2020[33], and in my opinion, its soft-bottom condition is likely a symptom of the same factors driving visual clarity in this stream; elevated sediment input. While there is evidence that visual clarity NBLs cannot be met in some rivers even with a return to indigenous land cover[98], that is not the case for the Pāuatahanui Stream, where current visual clarity is only 3 cm (1.3%) below achieving level required to achieve the NBL and the PC1 TAS for the Takapū part-FMU

SUBMISSIONS SUGGESTING THAT COLOUR IS ACCOUNTED FOR IN THE VISUAL CLARITY TAS FOR TE AWA KAIRANGI URBAN STREAMS PART-FMU

154 In its submission, the NZFFA suggests that coloured dissolved organic matter has been accounted for when setting the visual clarity TAS for the Te Awa Kairangi urban streams part-FMU, stating: "*Hull's Creek achieves an A rating with only 1.2m visual clarity, but Mangaroa (1.5m) and Black Creek (1.3m) score a D grade*". However, this is not the case.

155 As stated in paragraph 25.3, the NPS-FM 2020 sets different numeric attribute states for visual clarity based on four sediment classes. Hull's Creek belongs to sediment class 2, which has significantly less stringent attribute state thresholds than those set for sediment class 3, to which the Mangaroa River and Black Creek belong (NBL = 0.61 metres vs. 2.22 metres). For this reason, the Te Awa Kairangi urban streams part-FMU is assigned a baseline state of A in Table 8.4 of PC1, despite having a median visual clarity lower than that recorded for the Te Awa Kairangi rural streams and rural mainstems, and Wainuiomata urban streams part-FMUs.

SUBMISSIONS REQUESTING THE DELETION OF THE DISSOLVED COPPER AND ZINC TAS IN TABLES 8.4 AND 9.2 OF PC1

156 I understand WWL are seeking the removal of the dissolved copper and zinc TAS from Tables 8.4 and 9.2 (based on their request that these tables be "withdrawn"). In my opinion, deleting all of the dissolved copper and zinc TAS would jeopardise the achievement of the ecological endpoints sought for urban streams (see paragraph 61 to 67 and

[33] River Environment Classification classes WD_Low_Al, WD_Low_VA, WD_Lake_Any. WD_Low_SS and WW_Low_Al

157 Table 2)

158 Streams that run through urban areas are subjected to a number of stressors, and typically exhibit degraded faunal communities, a state referred to as 'urban stream syndrome'. Large contaminant loads are an almost universal symptom of urban stream syndrome[99]. Surface run-off from roads and roofs 'picks up' sediment and metals, such as copper and zinc, which are then transported into stream networks via storm water infrastructure[100,101]. At high concentrations, the metals commonly found in storm water runoff are toxic to aquatic fauna. The input of these contaminants from storm water can reduce the abundance of stream fauna, and alter community structure[102].

159 As a key driver of degraded ecosystem health in urban streams, it is necessary to manage dissolved copper and zinc concentrations to achieve the aquatic life TAS in part-FMUs with current or planned urban development. However, as set out in paragraph 67 to 70, some of the copper and zinc TAS cannot be considered reasonable from a technical perspective as they go beyond what is needed to achieve desired ecological end points. These are listed in Table 3.

SUBMISSIONS REQUESTING THE DELETION OF THE PART-FMU DEFAULT TAS IN TABLES 8.4 AND 9.2 OF PC1

160 In its submission, WFF requested the deletion of the narrative part-FMU default TAS in Tables 8.4 and 9.2. These "M's" and "I's" were added to Table 8.4 and 9.2 to highlight that specific numeric targets for the TAS sites do not apply universally throughout the part-FMU and at other locations it is the direction of change signalled in the relevant WIP (maintain or improve) that is relevant. Whether the part-FMU default TAS are the best way to signal how the site specific TAS should be interpreted is a policy matter that is outside the scope of my evidence. However, as long as it is clear that the numeric TAS only apply at the site, then there is no scientific justification to retain the part-FMU default TAS.

SUBMISSIONS ON THE FISH COMMUNITY HEALTH ATTRIBUTE IN TABLES 8.4 AND 9.2 OF PC1

161 In its submission EDS requested that PC1 be amended to "*clearly define what fish community health as determined by experts actually means*". In my opinion, this attribute is defined as much as it possibly can be in PC1. Specifically, the various components of the attribute are all clearly defined in Tables 8.4 and 9.2 (abundance, structure and composition) and are currently measurable (diversity is captured by the Fish-IBI). Thus, any direction of change in the attribute can be assessed and reported on by a qualified and

experienced ecologist. However, it is simply not possible to set numeric standards for these components of Fish community health as applicable guideline values do not exist.

162 Clause 3.10(2) of the NPS-FM 2020 specifies that "*any attribute identified by a regional council under subclause (1)(b) or (c) must be specific and, where practicable, be able to be assessed in numeric terms*". Clause 3.11(5)(c) then states that for such attributes, TAS must "*be set in any way appropriate to the attribute*". Given the absence of numeric thresholds for fish community health it is my opinion that the Fish community health attribute is consistent with these clauses and should not be amended to be more specific.

163 However, I do note that from a scientific perspective, there appears to be limited value in including the Fish community health attribute in Tables 8.4 or 9.2 of PC1. Numeric thresholds have not been, and cannot currently be, set for this attribute, and it remains unclear when, if ever, it will be possible to use the attribute to assess the state and drivers of ecosystem health. I understand its inclusion in PC1 is primarily to capture the less robust objectives in the TAoP WIP (see paragraphs 25.6 and 49.3) Whether this is justification for removing this attribute from PC1 is a policy matter outside the scope of my evidence.

SUBMISSIONS REQUESTING ADDITIONAL PROTECTIONS FOR RIVERS CONTAINING GIANT KŌKOPU, SHORTJAW KŌKOPU AND LAMPREY

164 In her submission, Ms. Lynn Cadenhead suggests that "[a]*ny waterways that contain giant kōkopu, shortjaw kōkopu, or lampreys should have the highest level of protection as these species are particularly vulnerable to an increase in sediment, temperature, or other pollutants*". However, there is no evidential basis for this assertion. Specifically:

164.1 Giant kōkopu (*Galaxias argenteus*) and shortjaw kōkopu (*G. postvectis*) have been shown to be no more sensitive to temperature than other native fishes[103], while, to my knowledge, the thermal tolerance of lamprey (*Geotria australis*) has not been studied;

164.2 Lamprey actually prefer high-sediment environments, and I am unable to find any evidence suggesting that giant kōkopu and shortjaw kōkopu are more sensitive to sediment than other species. Indeed, in my experience, giant kōkopu thrive in sediment-laden 'drains'[104]; and

164.3 To my knowledge, the sensitivity of giant kōkopu and shortjaw kōkopu to toxicants remains untested.

Note: *Most of the rivers where these fishes have been found in the Wellington region are listed in Schedule F1 of the Operative NRP.*

SUBMISSIONS REQUESTING THE INCLUSION OF A NATURAL CHARACTER INDEX ATTRIBUTE IN TABLES 8.4 AND 9.2 OF PC1

165 EDS and the Royal Forest and Bird Protection Society NZ (F&B) have requested that Tables 8.4 and 9.2 be amended to include target attribute states for habitat and natural form and character using the Habitat Quality / Natural Character Index.

166 The NPS-FM 2020 identifies habitat as one of the five biophysical components of aquatic ecosystem health. Accordingly, the NPS-FM 2020 notes that it is necessary to manage habitat (Appendix 1A(1) and (3)) and treat it as a value (3.9(1)). Through the development process of PC1 significant consideration was given to whether this meant that a specific habitat attribute was required to give effect to this part of the NPS-FM 2020 (see Section 5 of Greer *et al*.[29]). The decision not to include a habitat attribute such as the Habitat Quality / Natural Character Index was based on:

166.1 The extent to which the existing compulsory attributes already manage habitat;

166.2 The availability of multi-metric habitat attributes that targets could be set for; and

166.3 The availability of individual habitat attributes that targets could be set for.

167 Ultimately, it was decided that setting specific TAS for habitat in PC1 was not necessary as meeting the targets for existing compulsory attributes will:

167.1 Manage some specific components of habitat; and

167.2 Require habitat generally to be managed to achieve ecological outcomes (how the existing compulsory attributes relate to the management of habitat are set out below in Table 15).

Table 15: Description of how the existing NPS-FM 2020 attributes relate to habitat.

Attribute	How it provides for habitat
Deposited sediment	Deposited sediment cover is a key component of aquatic habitat quality. Setting TAS for this attribute ensures that deposited cover does not degrade habitat quality and that the bed is composed of substrates that provide a diversity of habitats (including those in the hyporheic zone)
Fish	The health and functioning of fish communities is heavily impacted by the diversity, quality, and quantity of habitat available. Thus, meeting the fish TAS will require that habitat is managed.
Macroinvertebrates	EPT taxa have a significant influence over all macroinvertebrate indices for which TAS must be set. This is by historical design as they are the most sensitive taxa to organic pollution (which the MCI was developed for). However, these taxa also favour undisturbed, structurally complex habitat such as gravely-cobbly riffles clear of filamentous algae/macrophytes. As such, achieving the macroinvertebrate TAS will require some protection or enhancement of benthic habitat
Periphyton	Nuisance blooms of periphyton smother benthic habitat used by invertebrates and fish. As such, managing periphyton to the biomass TAS will influence benthic habitat quality and quantity.

168 With regards to the Habitat Quality / Natural Character Index it was determined not to be suitable for use in PC1 at that time as:

168.1 It generally captures the effects of one or two activities (urban channel modification and flood protection) and therefore is not a useful measure of the impacts of the land-uses and discharges managed by PC1.

168.2 It only considers geomorphology. Thus, does not capture key components of aquatic habitat, such as cover.

168.3 Attribute state thresholds have not been developed that can be easily adopted in PC1.

168.4 It may not be possible to measure for all sites, especially those with a canopy or where there is a dearth of historical aerial photographs.

169 Nevertheless, in my opinion, this tool provides a robust method for measuring the habitat impacts of human activities on the beds and banks of managed rivers. I also understand it may already be in use by the Council's flood protection department for this purpose[34].

[34] https://www.gw.govt.nz/assets/Documents/2022/03/Code-of-Practice-for-River-Management-Activities.pdf

Thus, if a robust attribute state framework were developed and targets were applied at a measurable scale (i.e., to individual managed rivers), the only reason not to include the Habitat Quality / Natural Character Index in Tables 8.4 and 9.2 would be that it is impacted by activities on the beds of rivers that are not managed by PC1. Whether that alone should preclude its inclusion in these tables is a policy matter outside the scope of my evidence.

SUBMISSIONS REQUESTING THE INCLUSION OF THE PERIPHYTON COVER AND TOXICANT OBJECTIVES FROM TABLE 3.4 OF THE OPERATIVE NRP IN TABLES 8.4 AND 9.2 OF PC1

170 EDS and F&B have requested that the periphyton cover, mahinga kai, and toxicant attributes from Table 3.4 of O19 of the NRP be added to Tables 8.4 and 9.2 of PC1. I am not a cultural expert and cannot comment on the relevance of the mahinga kai species attribute. However, I do not consider that the periphyton cover or toxicant attributes from O19 of the NRP should be included in Tables 8.4 and 9.2 as:

170.1 The resulting periphyton cover TAS would be in direct conflict with the existing periphyton biomass TAS. The periphyton cover objective for significant (High macroinvertebrate community health in Schedule F1) and Class 1 rivers in Table 3.4 of Objective O19 of the operative NRP is set at a level that is consistent with the NPS-FM periphyton biomass A attribute state, while for all other rivers it is set to be consistent with the B attribute. Thus, carrying this objective over into Tables 8.4 and 9.2 would result in conflicting periphyton cover and biomass TAS for the following part-FMUs:

170.1.1. Taupō;

170.1.2. Ōrongorongo, Te Awa Kairangi and Wainuiomata small forested and Te Awa Kairangi forested mainstems;

170.1.3. Te Awa Kairangi rural streams and rural mainstems;

170.1.4. Te Awa Kairangi urban streams;

170.1.5. Waiwhetū Stream;

170.1.6. Wainuiomata urban streams;

170.1.7. Wainuiomata rural streams;

170.1.8. Parangārehu catchment streams and South-west coast rural streams;

170.1.9. Kaiwharawhara Stream; and

170.1.10. Wellington urban.

170.2 The resulting toxicants TAS would be in direct conflict with the ammoniacal-nitrogen, nitrate-nitrogen, dissolved copper and dissolved zinc TAS. The toxicant objective for significant (High macroinvertebrate community health) and Class 1 rivers in Objective O19 is consistent with the A state for the ammoniacal-nitrogen, nitrate-nitrogen, dissolved copper and dissolved zinc attributes (99% species protection), while for all other rivers it is set to be consistent with the B state (95% species protection). Thus, carrying this objective over into Tables 8.4 and 9.2 would result in conflicting TAS for the following part-FMUs:

170.2.1. Taupō (ammoniacal-nitrogen, nitrate-nitrogen and zinc);

170.2.2. Pouewe (ammoniacal-nitrogen, nitrate-nitrogen, copper and zinc);

170.2.3. Wai-O-Hata (ammoniacal-nitrogen, nitrate-nitrogen, copper and zinc);

170.2.4. Takapū (ammoniacal-nitrogen, nitrate-nitrogen, copper and zinc);

170.2.5. Te Rio o Porirua and Rangituhi (ammoniacal-nitrogen, nitrate-nitrogen, copper and zinc);

170.2.6. Ōrongorongo, Te Awa Kairangi and Wainuiomata small forested and Te Awa Kairangi forested mainstems (ammoniacal-nitrogen, nitrate-nitrogen, copper and zinc);

170.2.7. Te Awa Kairangi lower mainstem (ammoniacal-nitrogen, nitrate-nitrogen, copper and zinc);

170.2.8. Te Awa Kairangi urban streams (ammoniacal-nitrogen and nitrate-nitrogen);

170.2.9. Waiwhetū Stream (ammoniacal-nitrogen, nitrate-nitrogen and copper; based on notified TAS not potential updates discussed in paragraph 70 to 73);

170.2.10. Wainuiomata urban streams (ammoniacal-nitrogen, nitrate-nitrogen, copper and zinc);

170.2.11. Wainuiomata rural streams (ammoniacal-nitrogen, nitrate-nitrogen, copper and zinc);

170.2.12. Parangārehu catchment streams and South-west coast rural streams (ammoniacal-nitrogen, nitrate-nitrogen, copper and zinc);

170.2.13. Korokoro Stream (ammoniacal-nitrogen, nitrate-nitrogen, copper and zinc);

170.2.14. Kaiwharawhara Stream (ammoniacal-nitrogen and zinc); and

170.2.15. Wellington urban (ammoniacal-nitrogen, copper and zinc).

SUBMISSIONS REQUESTING THE INCLUSION OF THE NUISANCE MACROPHYTE OBJECTIVE FROM TABLE 3.4 OF THE OPERATIVE NRP IN TABLES 8.4 AND 9.2 OF PC1

171 EDS and F&B have also requested that the nuisance macrophyte cover objective from O19 be added to Tables 8.4 and 9.2 of PC1. From a technical perspective, including the NRP O19 nuisance macrophyte cover objective in Tables 8.4 and 9.2 would ensure this important component of stream health continues to be directly recognised in the NRP. Nuisance macrophyte growths negatively impact the values in the NPS-FM 2020 in the following ways:

171.1 Ecosystem health:

171.1.1. Reducing nighttime oxygen concentration and causing daily swings in pH[105,106] (water quality);

171.1.2. Reducing habitat diversity and quality, by creating a dense homogenous pool-run habitat with limited open water habitats or riffles;

171.1.3. Raising water levels and reducing water velocities (water quantity);

171.1.4. Reducing habitat diversity and quality, by creating a homogenous forest with limited open water habitats (habitat);

171.1.5. Altering primary production, decomposition, nutrient cycling in rivers (ecological processes);

171.1.6. Necessitating mechanical excavation or herbicide application to limit their impact on flood risk, both of which can have significant adverse ecological and water quality effects; and

171.1.7. Significantly impacting fish and macroinvertebrate communities due to all of the factors listed above (aquatic life).

171.2 Human contact:

171.2.1. Impacting how recreational users perceive rivers;

171.2.2. Posing a risk to recreational users by obscuring hazards or altering their perception of depth/velocity; and

171.2.3. Limiting the value of a river for boating, not only due to user perception, but also by impeding visibility and navigability.

171.3 Natural form and character:

171.3.1. Generally dominated by invasive rather than native species impacting the relative dominance of indigenous flora and fauna[107]; and

171.3.2. Reducing hydraulic capacity and bed sheer stress thereby impacting the natural movement of water and sediment.

171.4 Fishing – Impacting the acceptability of a river to anglers[89]

171.5 Commercial and industrial use – Increasing flow resistance within a waterway to the point that hydraulic capacity is reduced. Elevated water tables in adjacent areas can then saturate productive pasture, reducing yields and increasing flood risk.

172 Thus, setting a TAS for these macrophytes is scientifically consistent with managing the compulsory values in the NPS-FM 2020. However, it is unclear how adding macrophyte TAS to Table 8.4 and 9.2 will materially change how this attribute is managed under the PC1, as:

172.1 The existing aquatic vegetation and sediment removal rules in the operative NRP (R135, R136 and Schedule W) already encourage local authorities to take actions to reduce the growth of these plants in the rivers they manage by providing a restricted discretionary global consenting pathway if they do;

172.2 The current provisions of PC1 currently do not include any additional actions to manage plant growth beyond the Freshwater Action Plan provisions (Policies WH.P3, WH.P3, P.P2, P.P3 and Schedule 27). The ability of many macrophyte species to obtain nutrients from sediment as well as water means they can grow even when dissolved nutrient concentration are low[107,108], and nutrient controls are not generally considered an effective means of managing these plants. Consequently, the management of discharges and land-use through PC1, even if more stringent limits are added, may well have limited impact on macrophyte growth.

172.3 In contrast, Freshwater Action Plans will need to focus on controlling these growths where they contribute to the existing TAS in Table 8.4 and 9.2 not being achieved, regardless of whether a specific macrophyte TAS are included in the tables. For example, should monitoring indicate that prolific macrophyte growths in the Waiwhetū Stream are resulting in dissolved oxygen concentrations that are not meeting the TAS, then the relevant Freshwater Action Plans will need to contain actions, like riparian planting[107,109] and pest species control[107], that will reduce plant growth and consequently, its impact on oxygen[109];

172.4 While alternative thresholds do not exist, the submitters proposed TAS (50% cross sectional area (CAV)) is provisional and only reflects the level where there is "*potential for adverse effects on other stream biota*"[107]. There is no evidence that achieving this threshold is necessary to meet the other TAS or support the identified values in different part-FMUs. Thus, including this TAS in Table 8.4 and 9.2 could result in a perverse outcome where macrophytes are managed to achieve a macrophyte TAS, rather than being managed to achieve the TAS from compulsory attributes and support the values of different part-FMUs.

172.5 To summarise, while adding a nuisance macrophyte objective from Table 3.4 of the Objective O19 of NRP to Tables 8.4 and 9.3 of PC1 is scientifically consistent with managing the compulsory values in the NPS-FM 2020, it is not necessary to achieve the ecosystem health outcomes sought by the existing TAS and may actually be a hinderance in that regard.

SUBMISSIONS REQUESTING THE INCLUSION OF THE RIVER CLASSES FROM TABLE 3.4 OF THE OPERATIVE NRP IN TABLES 8.4 AND 9.2 OF PC1

173 In its submission EDS have requested that the river classes from Table 3.4 of Objective O19 of the operative NRP be included in Tables 8.4 and 9.2. In my opinion, adding these river classes to Tables 8.4 and 9.2 would serve no purpose. The river classes were used in Objective O19 as the objectives in that Table apply to all rivers. Thus, a framework was needed to ensure that the natural variability between rivers was captured and that thresholds applied differentially to not be overly strict or lenient in any one river. This is not required for Tables 8.4 and 9.2. where TAS are set at the site scale, and the variability between sites captured by bespoke TAS.

SUBMISSIONS REQUESTING THE INCLUSION OF THE SEDIMENT, MAHINGA KAI SPECIES, FISH, AND MACROALGAE OBJECTIVES FROM TABLE 3.5 OF THE OPERATIVE NRP IN TABLES 8.2 OF PC1

174 In their submissions EDS and F&B have requested that the sediment, mahinga kai species, fish, and macroalgae objectives from Table 3.5 of O19 of the NRP be added to Tables 8.2 of PC1. I am not a cultural expert and cannot comment on the relevance of the mahinga kai species attribute. However, neither TAoP nor TWT WIPs set objectives for the other attributes (unlike for fish in rivers). Hence, TAS have not been set in PC1. I also understand that there are currently no robust measurement methodologies and/or meaningful effects based thresholds for these attributes[35], and that the macroalgae objective in Table 3.5 does not actually apply to the Parangārahu Lakes (Kōhangatera and Kōhangapiripiri). As a result, in my opinion there is little benefit in adding these attributes to Table 8.2.

SUBMISSIONS ON THE DIFFERENCES BETWEEN RIVERS LISTED IN TABLE 8.3 OF PC1 AND SCHEDULE H1 OF THE OPERATIVE NRP

175 In their submissions, WWL and Civil Contractors NZ suggest that Table 8.3 should be combined with Schedule H1 of the operative NRP (Significant Contact Recreation Freshwater Bodies). The planning benefits of such a change are outside my area of expertise. However, I note that Table 8.3 of PC1 is fully aligned with Schedule H1 of the operative NRP. Table 8.3 simply defines the monitored sites on the rivers listed in

[35] Secchi disk desk can theoretically provide an indication of the impact of suspended sediment on visual clarity. However, in most lakes visual clarity is impacted by a range of factors, including sediment, phytoplankton and humic acids[65], and it is not possible to partition the impact of each of these from Secchi disk depth. Furthermore, existing guideline values for Secchi disk depth are set in relation to phytoplankton not sediment[56].

Schedule H1.Importantly, Table 8.3 does not introduce any rivers that are not already in Schedule H1, and Schedule H1 does not include any rivers from the TAoP and TWT Whaitua that are absent from Table 8.3 (see **Table 16**).

Table 16: The probability of achieving the periphyton B attribute state through shading (where possible) and the existing nutrient outcomes in part-FMUs where the baseline state is D and the TAS is B (based on the nutrient outcomes at different under-protection risk thresholds in Snelder and Kilroy[12].

Schedule H1 freshwater bodies in TWT and TAoP Whaitua	Table 8.3 sites
Te Awa Kairangi/Hutt River	Te Awa Kairangi/Hutt River @ Birchville
	Te Awa Kairangi/Hutt River @ Maoribank Corner
	Te Awa Kairangi/Hutt River @ Poets Parks
	Te Awa Kairangi/Hutt River @ Upstream Silverstream Bridge
	Te Awa Kairangi/Hutt River @ Taita Rock
	Te Awa Kairangi/Hutt River @ Melling Bridge
Pākuratahi River	Pākuratahi River @ Hutt Forks
	Pākuratahi River @ Kaitoke Campground
Akatarawa River	Akatarawa River @ Hutt Confluence
Wainuiomata River	Wainuiomata River @ Richard Prouse Park

SUBMISSIONS ON THE BASELINE STATES FOR PRIMARY CONTACT RIVERS IN TABLE 8.3 OF PC1

176 In its submission WFF have requested that "*a clause directing collection of robust data for* [primary contact] *sites with insufficient information be added*" to Objective WH.O8. Such a clause is not necessary. All sites in Table 8.3 are currently monitored, and the missing baseline states for Pākuratahi River @ Kaitoke Campground and Hutt River @ Taita Rock is simply a reflection of data availability in September 2017 (see paragraph 81). The current state (as at October 2023) of these sites is provided in Conwell[110] (see link below[36]) and is:

176.1 Pākuratahi River @ Kaitoke Campground = Poor; and

176.2 Te Awa Kairangi/Hutt River @ Taita Rock = Good.

[36] https://www.gw.govt.nz/assets/Documents/2023/10/Conwell-C-2023.-Baseline-and-current-e.coli-states-for-primary-contact-sites-across-the-Wellington-region.pdf

SUBMISSIONS SEEKING A LONGER TIMEFRAME FOR MEETING PRIMARY CONTACT OBJECTIVES FOR RIVERS IN TABLE 8.3 OF PC1

177 In its submission WWL comments they consider 2040 is insufficient time to achieve the required outcomes for primary contact sites in Table 8.3 and that they render prioritisation of sub-catchments meaningless. I do not agree with this position.

178 Specifically; only three primary contact sites listed in Table 8.3 require an improvement:

178.1 Pākuratahi River @ Kaitoke Campground;

178.2 Wainuiomata River @Richard Prouse Park; and

178.3 Te Awa Kairangi/Hutt River @ Melling Bridge.

179 Of these only the Te Awa Kairangi/Hutt River @ Melling Bridge is impacted by the wastewater or stormwater network. Thus, this is the only site that needs to be prioritised by the network operators. The Pākuratahi River @ Kaitoke Campground has an upstream catchment almost entirely in native bush. If there is a human source of *E. coli* at this site it presumably originates in the Council operated Kaitoke Regional Park Camp site. Similarly, the only wastewater network source Wainuiomata River @Richard Prouse Park is the pipe running between the water treatment plant and Richard Prouse Park. Even if that pipe is leaking into the Wainuiomata River, the *E. coli* concentrations in the discharge should not be sufficiently high to contribute to the TAS not being met (measured concentrations range from 0-250 cfu/100 mL – see link below[37]).

180 Nevertheless, it is not currently possible to quantify the *E. coli* load reductions or specific actions required to achieve the TAS for the Te Awa Kairangi/Hutt River @ Melling Bridge site. All that is known from the current data is that 95th percentile concentrations must reduce by ~ 23% to achieve that TAS. Thus, I cannot comment on the validity of WWL's assertion that that the TAS cannot be achieved by 2040.

[37] https://www.wellingtonwater.co.nz/assets/Resources/Drinking-Water/Wainuiomata-Water-Treatment-Plant-technical-information.pdf

SUBMISSIONS REQUESTING THE INCLUSION OF A 'SWIMMABLE DAYS' METRIC FOR PRIMARY CONTACT RIVERS IN TABLE 8.3 OF PC1

181 In his submission Mr Pat van Berkel has requested that the *E. coli* TAS Table 8.3 of PC1 (primary contact rivers) be expressed in a 'swimmable days' metric instead of the numeric targets. In my opinion, there is no scientific reason to make this amendment.

182 The NPS-FM 2020 Table 22 *E. coli* attribute included in Table 8.3 is based solely on the risk of *Campylobacter* infection for 95% of the time. While this metric varies greatly between the states, the number of swimmable days, as defined in the *Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas*[26] does not. This is a result of the national bottom line reflecting the point at which a site is considered unsuitable for swimming, and the same assessment statistic (95th percentile) applying to all attribute states. This is demonstrated below in Table 17.

Table 17: Number of swimmable days under different NPS-FM 2020 Table 22 *E. coli* attribute states

Attribute state	NPS-FM narrative	Number of swimmable (*E. coli* < 540/100mL) days (based on NRP bathing season)
Excellent	Estimated risk of Campylobacter infection has a < 0.1% occurrence, 95% of the time.	229
Good	Estimated risk of Campylobacter infection has a 0.1 – 1.0% occurrence, 95% of the time.	229
Fair	Estimated risk of Campylobacter infection has a 1 – 5% occurrence, 95% of the time.	229
Poor	Estimated risk of Campylobacter infection has > 5% occurrence, at least 5% of the time.	<229

SUBMISSIONS REQUESTING THE INCLUSION OF A BENTHIC CYANOBACTERIA ATTRIBUTE FOR PRIMARY CONTACT RIVERS IN TABLE 8.3 OF PC1

183 In his submission Mr Pat van Berkel (S282) has requested that "*a measure of benthic cyanobacteria or cyanobacteria blooms*" be added to Table 8.3 of PC1 as "*this is a key*

measure for Te Awa Kairangi as the toxic algae in this river has killed over 12 dogs in the last 20 years. It can seriously affect children and adults".

184 Benthic cyanobacteria grow attached to the substrate of rivers and streams. In New Zealand rivers the dominant bloom-forming benthic cyanobacteria genus is *Microcoleus*[111,112]. *Microcoleus* blooms are primarily associated with river or stream environments where they form leathery dark brown or black mats, but they can also establish in lakes and ponds[113]. *Microcoleus* can produce four lethal neurotoxins, known collectively as anatoxins, which cause convulsions, coma, rigors, cyanosis, limb twitching, hyper salivation and/or death. The presence of anatoxins in *Microcoleus* mats is widespread. However, the concentration of all four variants is highly spatially and temporally variable[114,115,116].

185 Neither the TAoP nor TWT WIPs set a cyanobacteria objective. Hence why TAS have not been set for this attribute in PC1, except through the narrative approach in Objective WH.08(b). Furthermore, the human health risks associated with benthic cyanobacteria are significantly less well known than the risks associated with their planktonic counterparts (see paragraph 25.4). The existing MfE/MoH[117] guidelines are the only existing numeric thresholds against which the potential health risks associated with benthic cyanobacteria can be assessed.

186 The MfE/MoH[117] guidelines recommend coverage thresholds for potentially toxigenic cyanobacteria as part of three-tier surveillance, alert and action sequence for managing the public health risk associated with benthic cyanobacteria. However, these thresholds are based on preliminary observations and still require significant refinement. Furthermore, the drivers and the complex interactions that govern benthic cyanobacteria growth are poorly understood, meaning there is uncertainty around what interventions could actually be employed to manage cyanobacteria cover[118]. In the absence of defensible effects-thresholds and proven interventions that could be set/employed to manage the potential health risks associated with benthic cyanobacteria, it is my opinion it would not be appropriate to include this attribute in Table 8.3.

SUBMISSIONS ON THE CONSISTENCY BETWEEN HOW THE TAS IN TABLES 8.2, 8.4 AND 9.2 OF PC1 WERE SET AND THE REQUIREMENTS OF CLAUSE 3.11 (8) NPS-FM

187 In its submission PF Olsen Ltd (**PF Olsen**) raises concerns that some of the TAS in Table 8.4, 8.4 and 9.2 are inconsistent with Clause 3.11 (8) NPS-FM.

188 When setting target attribute states, every regional council must:

(a) have regard to the following:

(i) the environmental outcomes and target attribute states of any receiving environments

(ii) the connections between water bodies

(iii) the connection of water bodies to receiving environments; and

(b) take into account results or information from freshwater accounting systems

189 Regarding whether TAS have been set in accordance with 3.11(8)(a) that is outside the scope of my expertise. I cannot comment on the thought processes of the Whaitua Committees and the extent to which they had regard to (i), (ii) and (iii). Nevertheless, I can confirm that while there is generally a strong level of alignment between the river TAS/load limits and the coastal objectives. However:

189.1 As identified in Dr Megan Melidonis[38]'Statement of Primary Evidence, the extent to which the Table 8.5 sediment load reduction targets for the Mākara Stream will achieve the sedimentation rate targets for the Mākara Estuary is unclear.

189.2 Achieving the Table 9.1 sedimentation rate targets for Te Awarua-o-Porirua Harbour will require greater sediment load reductions than the visual clarity TAS set for rivers in Table 9.2 of PC1. Hence, the disparity in the sediment load reductions required by Tables 9.3 (coast) and 9.4 (rivers)

189.3 The lack of knowledge regarding nutrient inputs and cycling in the Parangārehu Lakes, and the fact that the monitoring site for this part-FMU is not within the catchment means it is highly uncertain whether the river dissolved inorganic nitrogen and dissolved reactive phosphorus nutrient outcomes are consistent with the achievement of the lake TAS.

190 Furthermore, the TAS cannot have been set in accordance 3.11(8)(b), as the Council is yet to develop and implement a functioning freshwater accounting system.

[38] Evidence of Megan Clair Melidonis on Behalf of Greater Wellington Regional Council (dated 28th February 2025)

SUBMISSIONS ON THE INCONSISTENT USE OF TOTAL AND DISSOLVED COPPER AND ZINC SCHEDULE 28 AND TABLES 8.4 AND 9.2 OF PC1

191 In its submission Stormwater360 raises concerns regarding inconsistencies between the attribute type (dissolved vs. total) of copper and zinc references in Tables 8.4/9.2 and Schedule 28 of PC1. Specifically, the copper and zinc TAS in Tables 8.4 and 9.2 apply to the dissolved form of these metals, while the target load reductions in Schedule 28 of PC1 applies to the total metal loads from the site (i.e., dissolved and particulate metals).

192 Dissolved rather than total copper/zinc is used in the TAS tables as that is the form:

192.1 In which these metals are toxic in the water column; and

192.2 That have applicable guideline values for the onset of adverse effects.

193 In contrast, load reduction targets are set for total metals (in P.P4 and Schedule 28) as:

193.1 The percentage of metals in solution (dissolved) and bound to sediment (particulate) in rivers is dependent on a range of factors, including pH, temperature and major ion concentration[119]. Thus, it is the total metals in the discharge that dictates ecological risk associated with a discharge, not just the dissolved fraction. For example, the discharge of predominately particulate metals from a basic source to an acidic receiving environment could result in far higher instream dissolved metal concentrations than what would be expected based on the dissolved metal concentration and volume of the discharge.

193.2 Metal losses (from land) are currently quantified as total rather than dissolved in the models available.

194 For the reasons described above it is not possible to align the stream attribute for metals with the manner in which discharge loads are managed. To be meaningful, load reductions can really only be described in terms of total metals, while the TAS for rivers need to be presented in terms of dissolved concentrations. That does not, however, mean that the two are inconsistent with each other, and total metals are being managed in new developments specifically to minimise their impact on dissolved metal concentrations in freshwater receiving environments. To make that clear to plan users the following change to Schedule 28 (or something similar) would be justified from a technical perspective

To minimise the negative effect of stormwater discharge from new and redeveloped impervious surface on the achievement of the target attribute states for dissolved copper and zinc (Table 8.4 and Table 9.2) and the coastal objectives for copper and zinc in sediment (Table 8.1 and Table 9.1), all new and redeveloped impervious surfaces are to be treated to meet an equivalent target load reduction for copper and zinc to those set out for a raingarden/bioretention device, as per Table 1.

SUBMISSIONS ON THE MEANING OF 'COMMENSURATE' REDUCTION IN PC1

195 In its submission WWL have raised concerns regarding the uncertainty around what 'commensurate' means when used in terms similar to:

"*reduction XX commensurate with what is required in the receiving environment to meet the target attribute state*"

196 These terms appear in the rules and schedules related to wastewater and stormwater networks. It is my understanding that these terms are meant to signal that every emitter must reduce their loads by the same proportion needed across the entire catchment to achieve the TAS. I.e., if a 40% reduction in ammoniacal-nitrogen load is needed to achieve the 20% reduction in median concentration required by the TAS, then each consent holder who discharges that containment should reduce their losses by 40%. It is not meant to signal that the amount each consent holder needs to reduce is determined by the degree to which they contribute to current loads (i.e., a higher emitter does not need to reduce their loads by a greater percentage than a low emitter).

197 It is my understanding that PC1 essentially requires the regulated party to calculate the extent to which loads must be reduced to meet the TAS, then apply that reduction to their own discharges. However, this is not clear, and I agree it could be explicitly stated in Schedule 31 and 32.

198 For context, an indication of the extent of the reductions being sought by the dissolved copper, dissolved zinc and *E. coli* TAS are provided in Table 18 below. These load reductions were calculated to inform the economic assessment presented in Mr Walker's Statement of Primary Evidence, the methodology of which is documented in Greer[87].

Table 18. Indication of the extent of the load reductions required to achieve the dissolved copper, dissolved zinc and *E. coli* TAS that seek an improvement in these attributes. See Greer[87] for methodology.

Whaitua	Part-FMU	Attribute	Load reduction
TWT	Kaiwharawhara Stream	Copper	53% (38% - 68%)
		Zinc	76% (62% - 89%)
		E. coli	89% (84% - 94%)
	Wellington urban	Copper	4% (0% - 9%)
		Zinc	8% (7% - 10%)
		E. coli	96% (93% - 99%)
	Waiwhetū Stream	Copper	80% (67% - 93%)
		Zinc	76% (71% - 80%)
		E. coli	90% (82% - 98%)
	Te Awa Kairangi urban streams	Copper	69% (53% - 84%)
		Zinc	40% (35% - 45%)
		E. coli	91% (86% - 95%)
	Wainuiomata urban streams	*E. coli*	91% (84% - 99%)
	Wainuiomata rural streams	*E. coli*	18% (6% - 30%)
	Te Awa Kairangi rural streams and rural mainstems	*E. coli*	61% (38% - 83%)
	Te Awa Kairangi lower mainstem	*E. coli*	17% (0% - 33%)
	Parangārehu catchment streams and South-west coast rural streams	*E. coli*	N/A (No wastewater infrastructure above TAS site)
	Korokoro Stream	*E. coli*	N/A (Insufficient *E. coli* and flow data to determine required load reductions)
TAoP	Pouewe	*E. coli*	67%
	Takapū	*E. coli*	59%
	Taupō	*E. coli*	99%
	Te Rio o Porirua and Rangituhi	*E. coli*	92%
	Wai-O-Hata	Copper	99%
		Zinc	30%
		E. coli	83%

199 In terms of achievability, the cost of achieving these reductions through stormwater and wastewater management are presented in Mr Walker's Statement of Primary Evidence.

SUBMISSIONS RELATED TO *E. COLI* IN THE MĀKARA-OHARIU STREAM CATCHMENT

200 In its submission Mākara and Ohariu large farms[39] note that "*the source of high e-coli levels in the Mākara Stream is unknown* [but] *need*[s] *to be known for each catchment in order for them to be addressed*". I do not agree with this statement. While the potential benefits of exploring the sources of *E. coli* in this catchment are documented[77], it is not needed to identify the specific activities and sub-catchments that need to be regulated to achieve the TAS.

201 Approximately 80% of the Mākara-Ohariu catchment is in pastoral land-cover and a very large reduction in *E. coli* load is required to achieve the TAS for this catchment (>70 % based on the Our Land and Water Science Challenge Scenario Builder WebApp[26]). Thus, there is little doubt that:

201.1 Livestock contribute a significant, albeit undefined, proportion of the *E. coli* in the Mākara-Ohariu catchment and

201.2 Large *E. coli* reductions from livestock will be necessary throughout **the entire catchment** to achieve the *E. coli* TAS.

Note: *In their submission Mākara and Ohariu large farms focus heavily on the fact there is just one monitoring site in the Mākara-Ohariu catchment and they consider that this means improvements are being required in sub-catchments where there is no demonstrable E. coli problem. I do not agree. The TAS site is downstream of the confluence of the Mākara and Ohariu streams and is influenced by 92% of the Mākara-Ohariu catchment. Thus, effectively all sub-catchments contribute to the E. coli at the TAS site and need to be managed given the very large load reductions required to achieve the TAS.*

202 Furthermore, while Mākara and Ohariu large farms submission that "*there are several potential sources (livestock, septic tanks, waterfowl)*" is correct, it is also my understanding that of these, only livestock can be managed through PC1. Specifically, I understand that a regional plan cannot manage the location and number of waterfowl in an area and that

[39] Supported by Ms Diane Strugnell further submissions.

septic tank discharges are already controlled through the operative provisions of the NRP (Rules R62 and R63).

SUBMISSIONS RELATED TO SEDIMENT IN THE MĀKARA-OHARIU CATCHMENT

203 In its submission, Mākara and Ohariu large farms note that PC1 "*focuses on hill country erosion as a source of sediment* [in the Mākara-Ohariu catchment] *and not streambank erosion resulting from high flow events*". I understand that this interpretation is not correct and that together Policy WH.P26 Rule WH.R28, Rule WH.R29 and Schedule 27 of PC1 require significant increases in stock exclusion in the wider Mākara-Ohariu catchment for the purposes of reducing sediment loads.

Note: *In their submissions Mākara and Ohariu large farms and Mr John Easther focus heavily on the fact there is just one monitoring site in the Mākara-Ohariu catchment and they consider that this means improvements are being required in sub-catchments where there is no demonstrable sediment problem. I do not agree. The TAS site is downstream of the confluence of the Mākara and Ohariu streams and is influenced by 92% of the Mākara-Ohariu catchment. Thus, effectively all sub-catchments contribute to the sediment load at the TAS site and need to be managed given the large load reductions (38%) required to achieve the TAS.*

CONCLUSIONS

SUMMARY OF RESPONSES TO SUBMISSIONS

204 I do not agree with the submissions that an indication of "*insufficient data*" instead of a baseline state, or a footnote referencing "*based on limited data*" in Tables 8.4 and 9.2 is a sufficient source of uncertainty to justify the deletion of the corresponding TAS. In general, those notes are not a reflection of current data quality or quantity, rather they reflect data limitations that existed September 2017 but may no longer exist. However, data remains sparse for:

204.1 Dissolved oxygen, Fish community health and ecosystem metabolism at all sites;

204.2 Periphyton biomass at some sites;

204.3 Fish-IBI at most sites;

204.4 All attributes in the Korokoro and Wai-O-Hata part-FMUs.

I agree with the submissions that there is a high level of uncertainty around the improvements required by the TAS for these attributes/part-FMUs and the actions required to improve them. Whether this uncertainty justifies removing is a policy matter that is outside the scope of my evidence.

205 However, regarding the lake bottom dissolved oxygen attribute in Table 8.2 of PC1, I acknowledge that the lack of baseline data means the TAS may have been set at an unnecessarily stringent level. Without baseline data, it is unclear what, if any, improvement is required to achieve the A-state TAS set for Lakes Kōhangatera and Kōhangapiripiri. Given that this attribute is intended to control nutrient release from bed sediments rather than prevent direct adverse effects on aquatic life, there is no scientific justification for setting a TAS that may require improvement without clear evidence that oxygen conditions contribute to the current exceedance of the Total nitrogen and Total Phosphorus TAS. In my opinion, a simple narrative TAS would suffice.

206 In my opinion, submissions to amend the nitrate-nitrogen TAS for the Kaiwharawhara Stream and Wellington Urban part-FMUs from the B-state to the A-state are not justified. However, I agree that the median target for the Wellington Urban part-FMUs should be amended (to 1.0 mg/L) to be consistent with the recommended change to the dissolved inorganic nitrogen nutrient outcome for this part-FMU.

207 In my opinion, submissions seeking amendments to the dissolved inorganic nitrogen and dissolved reactive phosphorus nutrient outcomes in Table 8.4 and 9.2 are not scientifically justified. The only exception being for the Wellington urban part-FMU. To be consistent with the guidance on which it is based the dissolved inorganic nitrogen and dissolved reactive phosphorus nutrient outcomes for this part-FMU would need to be amended to 1.0 mg/L and 0.025 mg/L respectively.

208 I agree with submissions that TAS for periphyton biomass in the Waiwhetū Stream part-FMU should be amended to the B state (from the C state), as the current C TAS theoretically allows for a degradation from current state.

209 The current 'C' periphyton TAS in the following part-FMUs are set at a level that is consistent with the aquatic life endpoints sought by the corresponding macroinvertebrate community health TAS, and I disagree with submissions that they be amended to the B state:

209.1 Te Awa Kairangi urban streams

209.2 Wainuiomata urban streams

209.3 Parangārehu catchment streams and South-west coast rural streams

209.4 Kaiwharawhara Stream; and

209.5 Wellington urban.

210 However, amending the periphyton TAS for the Wainuiomata rural streams to the B state would be consistent with the ecosystem health endpoints sought for this part-FMU. Such an amendment would not necessitate a consequential change to the dissolved inorganic nitrogen and dissolved reactive phosphorus nutrient outcomes that have been set for this part-FMU.

211 Regarding submissions for more stringent Q/MCI TAS I considered that this would result in targets being generally unachievable with current land-use.

212 I do not agree with submissions that the periphyton TAS requiring a D to B state improvement will necessitate "significant land-use change". However, I do agree with submissions that the *E. coli* TAS requiring an E to B state improvement will necessitate "significant land-use change".

213 The suspended fine sediment TAS for the Te Awa Kairangi rural streams and rural mainstems part-FMU does not account for the naturally occurring processes of high coloured dissolved organic matter in the Mangaroa River. Consequently, alternative TAS and sediment load reductions for this part-FMU have been developed.

214 There is no scientific evidence to support submissions claiming that a naturally soft-bottomed Pāuatahanui Stream is responsible for the non-achievement of the visual clarity TAS for the Takapū part-FMU.

215 Submissions claiming that coloured dissolved organic matter was considered when setting the visual clarity TAS for the Te Awa Kairangi urban streams part-FMU are incorrect. This part-FMU has been assigned a baseline state of A in Table 8.4 of PC1 despite having poorer visual clarity than part-FMUs assigned to the D-state, due to the suspended sediment class it belongs to; not because the impacts of coloured dissolved organic matter were accounted for.

216 In my opinion, submissions to delete the copper and zinc TAS would jeopardise the achievement of the ecological endpoints sought for urban streams.

217 As long as it is clear that the numeric TAS only apply at the site, then I agree with submissions that there is no scientific justification to retain the part-FMU default TAS.

218 I do not agree with EDS's submission seeking to further describe the fish community health attribute in Tables 8.4 and 9.2; the attribute is defined as much as it is possible in PC1. Indeed, from a scientific perspective there is limited value in including this attribute at all in Tables 8.4 and 9.2.

219 There is no evidential basis to support submissions that the TAS in Table 8.4 and 9.2 of PC1 should be amended to provide additional protection to submission, giant kōkopu, shortjawed kōkopu or lamprey.

220 I do not see any scientific issues with including the Habitat Quality / Natural Character Index Tables 8.4 and 9.2 provided a robust attribute state framework was developed, and the targets are applied at a measurable scale. However, I note that this metric is predominately impacted by works in the beds and riparian zones of rivers which are not managed by PC1. Whether that alone should preclude its inclusion in these tables is a policy matter outside the scope of my evidence

221 I do not consider that the periphyton cover or toxicant attributes from O19 of the NRP should be included in Tables 8.4 and 9.2 as they would be in direct conflict with the existing TAS in these tables.

222 While EDS's and F&B's request to include the nuisance macrophyte objective from Table 3.4 of the Objective O19 of NRP to Tables 8.4 and 9.3 of PC1 is scientifically consistent with managing the compulsory values in the NPS-FM 2020, I do not consider it necessary to achieve the ecosystem health outcomes sought by the existing TAS and may actually be a hinderance in that regard.

223 In my opinion, there is no scientific justification for adding the river classes from Table 3.4 of Objective O19 of the operative NRP to Tables 8.4 and 9.2 as requested in submissions.

224 Submissions that the TAS have not been set in accordance with 3.11(8) of the NPS-FM are correct. From a purely scientific view, the lack of knowledge regarding nutrient inputs and cycling in the Parangārehu Lakes, and the fact that the monitoring site for this part-FMU is not within the catchment means it is highly uncertain how the action required to achieve the river periphyton, dissolved inorganic nitrogen and dissolved reactive phosphorus TAS will contribute to the achievement of the lake TAS (3.11(8)(a)). Similarly, there is

poor/uncertain alignment between the visual clarity TAS in rivers and the sedimentation rate coastal objectives. Furthermore, the TAS cannot have been set in accordance 3.11(8)(b), as GWRC is yet to develop and implement a functioning a freshwater accounting system.

225 Regarding submissions suggesting that Table 8.3 should be combined with Schedule H1 of the operative NRP (Significant Contact Recreation Freshwater Bodies), I note that the two are perfectly aligned. Table 8.3 does not introduce any rivers that are not already in Schedule H1, and Schedule H1 does not include any rivers from the TAoP and TWT Whaitua that are absent from Table 8.3.

226 Submissions requesting a clause directing collection of robust data for primary contact sites with insufficient information be added to Objective WH.O8 are not justified. All primary contact sites are currently monitored and have been for some time.

227 There is no scientific justification for submissions requesting that that the *E. coli* TAS Table 8.3 of PC1 (primary contact rivers) be expressed in a 'swimmable days' metric.

228 In my opinion submissions requesting the inclusion of a measure of benthic cyanobacteria or cyanobacteria blooms in Table 8.3 are not scientifically justified.

229 To make it clear to plan users the following change to Schedule 28 (or something similar) could be made to respond to submission querying the inconsistencies between the dissolved metals referenced in Table 8.4 and 9.2 and the total metal loads referenced in Schedule 28.

To minimise the negative effect of stormwater discharge from new and redeveloped impervious surface on the achievement of the target attribute states for dissolved copper and zinc (Table 8.4 and Table 9.2) and the coastal objectives for copper and zinc in sediment (Table 8.1 and Table 9.1), all new and redeveloped impervious surfaces are to be treated to meet an equivalent target load reduction for copper and zinc to those set out for a raingarden/bioretention device, as per Table 1.

230 Submissions have raised concerns regarding the uncertainty around what 'commensurate reduction' in contaminant loads means in PC1. It is my understanding that these terms are meant to signal that every emitter must reduce their loads by the same proportion needed across the entire catchment to achieve the TAS. I.e., if a 40% reduction in ammonia load is

needed to achieve the 20% reduction in median concentration required by the TAS, then each consent holder who discharges ammonia needs to reduce their load by 40%.

231 I do not agree with submissions that "*the source of high e-coli levels in the Mākara Stream is unknown* [but] *need*[s] *to be known for each catchment in order for them to be addressed*". The extent of pastoral land-cover in the Mākara-Ohariu catchment combined with the location of the TAS site in this catchment and the magnitude of the *E. coli* load reductions required means it is almost certain that large *E. coli* reductions from farming will be necessary throughout **the entire catchment** to achieve the *E. coli* TAS.

232 I understand that submissions stating that PC1 "*focuses on hill country erosion as a source of sediment* [in the Mākara-Ohariu catchment] *and not streambank erosion resulting from high flow events*" are not correct and that together Policy WH.P26 Rule WH.R28, Rule WH.R29 and Schedule 27 of PC1 require significant increases in stock exclusion in the wider Mākara-Ohariu catchment for the purposes of reducing sediment loads.

SUMMARY OF SCIENTIFICALLY JUSTIFIED CHANGES TO TABLES 8.4, 8.5, 9.2 AND 9.4

233 The changes to Tables 8.4 and 9.2 that could be justified scientifically are summarised in Table 19 below, while the scientifically justified changes to Table 8.3 are set out in Table 20. They are not a recommendation to change the TAS and do not account for achievability. They simply denote where submitters or I have identified inconsistencies between the TAS and the requirements of the NPS-FM 2020, established national guidance and each other.

234 The changes to Tables 8.5 and 9.4 that could be justified scientifically are summarised in Table 21 below. They are not a recommendation to change the load reductions and do not account for achievability. They simply denote where Dr Valois and Mr Blyth have identified changes that, in my opinion, would make them more robust by accounting for new data and/or naturally occurring processes. I also note that Mr Blyth has recommended the deletion of the baseline sediment load estimates in Tables 8.5 and 9.4, and I agree with this recommendation for the reasons set out in paragraph 40 to 51 of his Statement of Primary Evidence[20].

Table 19: Amendments to Table 8.4 and 9.2 TAS that could be justified from a scientific perspective (note these are not recommendations).

Part-FMU	Waiwhetū Stream	Wellington urban catchment		Te Awa Kairangi, Ōrongorongo and Wainuiomata				Wai-O-Hata
	Waiwhetū Stream	Kaiwharawhara Stream	Wellington urban	Small forested and forested mainstems	Te Awa Kairangi rural streams and rural mainstems	Wainuiomata rural streams	Wainuiomata urban streams	
Site	Waiwhetū S. @ Whites Line East	Kaiwharawhara S. @ Ngaio Gorge	Karori S. @ Mākara Peak	Whakatikei R. @ Riverstone	Mangaroa R. @ Te Marua	Wainuiomata River D/S of White Br.	Black Ck @ Rowe Parade	Duck Ck @ Tradewinds Dr. Br.
Periphyton biomass	B[1]	-	-	-	-	B[1]	-	-
Ammonia (toxicity)	B	-	-	-	-	-	B	-
Nitrate (toxicity): Median	-	-	≤1.00[1]	-	-	-	-	-
Dissolved inorganic nitrogen	-	-	≤1.00[1]	-	-	-	-	-
Dissolved reactive phosphorus	-	-	≤0.025[1]	≤0.008[1]	-	-	-	-
Suspended fine sediment	-	-	-	-	D[1]	-	-	-
Suspended fine sediment: Median	-	-	-	-	1.67	-	-	-
Dissolved Copper	C	-	-	-	-	-	-	B
Dissolved Zinc	C	B	-	-	-	-	-	B
All part-FMUs								
Fish community health	Remove TAS until further research on these attributes becomes available							
Ecosystem metabolism								

[1] Submitter suggested amendment

Table 20: Amendments to Table 8.3 TAS that could be justified from a scientific perspective (note these are not recommendations).

Part-FMU	Lake Kōhangatera	Lake Kōhangapiripiri
Lake-bottom dissolved oxygen	M	M

Table 21: The changes to TAS in Tables 8.5 and 9.4 that could be justified from a scientific perspective.

Part-FMU	Target attribute state site	% reduction in mean annual sediment load	
		Current	Alternative
Table 8.5			
Te Awa Kairangi rural streams and rural mainstems	Mangaroa R. @ Te Marua R. @ Te Marua	-51%	-17%
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott	-24%	-25%
Wainuiomata urban streams	Black Ck @ Rowe Parade	-50%	-50%
Wainuiomata rural streams	Wainuiomata River D/S of White Br.	-7%	-8%
Parangārehu catchment streams and south-west coast rural streams	Mākara S. @ Kennels	-34%	-38%
Table 9.4			
Takapū	Pāuatahanui S. @ Elmwood Br.	-24%	-26%

SUMMARY OF THE TAS IN TABLE 8.4 AND 9.2 THAT WILL BE DIFFICULT TO MEET WITHOUT SIGNIFICANT MITIGATION AND/OR LAND-USE CHANGE THAT GOES BEYOND WHAT IS REQUIRED BY PC1.

235 The achievement of many of the TAS in 8.2, 8.4, and 9.4 of PC1 will require significant mitigation and/or land-use change that goes beyond what is required by PC1. Whether this justifies amending these TAS is a policy matter that sits outside the scope of my evidence. However, for clarity the TAS I have identified as being 'difficult' to achieve are listed below in Table 22.

236 For *E. coli*, dissolved copper and dissolved zinc in part-FMUs impacted by urban land-cover this assessment is based on the modelling presented in Greer[87]. Specifically, those TAS that require mitigations over >50% of the stormwater or wastewater network have been identified as difficult to meet[40]. For all other attributes TAS have been identified as being

[40] 50% has been chosen subjectively as it reflects the point where most of the network is impacted.

difficult to achieve if they have been assessed as being unlikely to be met by the proposed PC1 provisions [70,73] (see paragraphs 84 to 96).

Notes: *For the purposes of compiling Table 22 I have assumed that the Council will achieve the periphyton biomass TAS through shading where it is required and possible. Hence many of the references to periphyton biomass in Table 10 are not included in Table 22.*

The suspended fine sediment TAS for the Te Awa Kairangi lower mainstem has not been identified as being 'difficult' to achieve in Table 22 based on Mr Blyth's Statement of Primary Evidence which suggests that a 6% reduction in sediment load is currently required to achieve this TAS. 40% of this reduction will need to come from the Mangaroa River catchment to achieve the suspended fine sediment TAS for the Te Awa Kairangi rural streams and rural mainstems part-FMU. Thus, for the other 85% of the Hutt River Catchment the required sediment load reduction is less than 3.6%.

237 *That some of the Q/MCI TAS in PC1 have been identified in Table 19 should not be considered justification to amend them. This attribute it included in Appendix 2B of the NPS-FM (i.e., it does not have to be achieved through limits). Thus, I understand it is acceptable for the regulatory provisions to not result in the achievement of the target states for this attribute without additional non-regulatory action planning.*

Table 22: Description of the TAS in tables 8.4 and 9.3 of PC1 (as notified) that I consider will be difficult to meet without significant mitigation and/or land-use change that goes beyond what is required by the regulatory provisions of PC1. Note the potential changes in Table 19 are not considered here. This table differs from Table 10 in that it considers current state (i.e., where a TAS is currently met it is considered to be achievable even if it was assessed as not being so in Greer[70,73]).

Whaitua	Part-FMU	Attribute
TAoP	Pouewe	*E. coli*
TAoP	Taupō	*E. coli*
TAoP	Takapū	*E. coli*
TAoP	Wai-O-Hata	*E. coli*
TAoP	Wai-O-Hata	Dissolved copper
TAoP	Wai-O-Hata	Dissolved zinc
TAoP	Te Rio o Porirua and Rangituhi	*E. coli*
TWT	Ōrongorongo, Te Awa Kairangi and Wainuiomata small forested and Te Awa Kairangi forested mainstems	Fish community health
TWT	Ōrongorongo, Te Awa Kairangi and Wainuiomata small forested and Te Awa Kairangi forested mainstems	Dissolved reactive phosphorus
TWT	Te Awa Kairangi lower mainstem	Q/MCI
TWT	Te Awa Kairangi lower mainstem	Fish community health
TWT	Te Awa Kairangi rural streams and rural mainstems	*E. coli*
TWT	Te Awa Kairangi urban streams	*E. coli*
TWT	Te Awa Kairangi urban streams	Dissolved copper
TWT	Te Awa Kairangi urban streams	Dissolved zinc
TWT	Waiwhetū Stream	*E. coli*
TWT	Waiwhetū Stream	Dissolved copper
TWT	Waiwhetū Stream	Dissolved zinc
TWT	Waiwhetū Stream	Dissolved reactive phosphorus
TWT	Wainuiomata urban streams	Ammonia
TWT	Wainuiomata urban streams	*E. coli*
TWT	Wainuiomata rural streams	Q/MCI
TWT	Wainuiomata rural streams	Dissolved reactive phosphorus
TWT	Parangārehu catchment streams and South-west coast rural streams	*E. coli*
TWT	Parangārehu catchment streams and South-west coast rural streams	Suspended fine sediment
TWT	Parangārehu catchment streams and South-west coast rural streams	Dissolved reactive phosphorus
TWT	Kaiwharawhara Stream	*E. coli*
TWT	Kaiwharawhara Stream	Dissolved copper
TWT	Kaiwharawhara Stream	Dissolved zinc
TWT	Kaiwharawhara Stream	Q/MCI
TWT	Kaiwharawhara Stream	Dissolved reactive phosphorus
TWT	Wellington urban	*E. coli*

DATE: 28 FEBRUARY 2025

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