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

Report No. 2023-007

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Glossary

Term	Meaning
2A type attributes	Attributes that are treated in the same way as the compulsory attributes in Appendix 2A of the NPS-FM 2020 in PC1
2B type attributes	Attributes that are treated in the same way as the compulsory attributes in Appendix 2B of the NPS-FM 2020 in PC1
Action planning	Developing and implementing an action plan in accordance with the NPS-FM 2020
BSP	Biophysical Science Programme (for Whaitua Te Whanganui-a-Tara)
CFU	Colony Forming Unit
CLM	Contaminant Load Model
CLUES	Catchment Land Use for Environmental Sustainability
CMP	Collaborative Modelling Programme
Cu	Copper
DFS	Deposited fine sediment
DIN	Dissolved inorganic nitrogen
DRP	Dissolved reactive Phosphorus
Earthworks	means the alteration or disturbance of land, including by moving, removing, placing, blading, cutting, contouring, filling or excavation of earth (or any matter constituting the land including soil, clay, sand and rock) (PC1 definition).
E. coli	*Escherichia coli*
EQR	Ecological Quality Rating (for macroalgae)
ERTP	Erosion risk treatment plan – A plan prepared in compliance with Schedule 36 (PC1 definition)
FEP	Farm Environment Plan prepared in accordance with Schedule Z of the operative NRP and Schedule 36 of PC1
GW	Greater Wellington
High erosion risk land	Land with high erosion risk in Te Awarua-o-Porirua Whaitua shown on Map 90 or in Whaitua Te Whanganui-a-Tara shown on Map 93 (based on PC1 definition)
Highest erosion risk land	Land with highest erosion risk in Te Awarua-o-Porirua Whaitua shown on Map 90, 91 and 92 or in Whaitua Te Whanganui-a-Tara shown on Map 93, 94 and 94 (based on PC1 definition)
Livestock	Farm animals
Low slope land	means land identified as low slope land in https://www.mfe.govt.nz/fresh-water/freshwater-acts-and-regulations/stock-exclusion (Stock Exclusion Regulations definition).
LUC	Land Use Capability (class)
MLG	Modelling Lead Group
NH_4-N	Ammoniacal – nitrogen
NRP	Natural Resources Plan for the Wellington Region
NPS-FM	National Policy Statement for Freshwater Management
NO_3-N	Nitrate – nitrogen
Part-FMU	Part Freshwater Management Unit
PC1	Proposed Plan Change 1 to the NRP
The proposed provisions	The regulatory provisions of PC1
REC	River Environment Classification
SFS	Suspended Fine Sediment (as measured by visual clarity)
Soil conservation treatment	Includes: • Revegetation of highest or high erosion risk land; • Planting of poplar or willow poles on grazing land; • Construction of sediment detention structures; and • Wetland construction and restoration. (based on PC1 definition (Schedule 36 – Table D1))
Stock Exclusion Regulations	Resource Management (Stock Exclusion) Regulations 2020
TAoP	Te Awarua-o-Porirua
TAS	Target attribute state
TN	Total nitrogen
TP	Total phosphorus
TSS	Total suspended solids
Whaitua	Whaitua is the Māori word for catchment or space. The Wellington Region is divided into five whaitua, which will eventually each have a Whaitua Committee responsible for them
WTWT	Whaitua Te Whanganui-a-Tara
Zn	Zinc

Executive summary

Proposed Plan Change 1 (PC1) to the Natural Resources Plan (NRP) for the Wellington Region will implement the National Policy Statement for Freshwater Management (NPS-FM) 2020 for Te Awarua-o-Porirua (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 will:

- Define Target Attribute States (TASs) for the compulsory attributes in Appendix 2 of the NPS-FM 2020;
- Set equivalent coastal water quality and ecology objectives ('coastal objectives'); and
- Establish provisions that will contribute to those TASs and coastal objectives being met.

This process is especially important for those compulsory attributes in Appendix 2A of the NPS-FM 2020; as these require limits (input controls, output controls, or land use controls) be set as rules in regional plans to contribute to the achievement of their target states.

In this report, the extent to which the proposed regulatory provisions of PC1 will achieve the TASs and coastal objectives for TAoP Whaitua is assessed using the scenario testing outputs of the Collaborative Modelling Project (CMP), which informed their selection by the TAoP Whaitua Committee. The scenarios tested through the CMP were:

- Business as usual (BAU) – Represented the regulatory and management approach at the time;
- Improved – Included a range of actions with the potential to minimise the impact of urban and rural land uses such as stormwater treatment, wastewater network upgrades, riparian planting, space planting and retirement; and
- Water Sensitive – Included much the same actions as Improved, but with an increase in their extent and efficacy.

Results suggest that the proposed regulatory provisions of PC1 require outcomes and actions that are likely to achieve most (~90%) of the TAoP TASs and coastal objectives. However, there are several that are unlikely to be met through the proposed provisions alone (see Table I).

In most cases, the 'gap' between the outcome of the proposed provisions and the TAS/coastal objective can be filled through non-regulatory actions like those assumed under the middle of the road CMP (Improved) scenario (e.g., planting five metre riparian buffers on all second order streams on low slope pastoral land)/ Nonetheless, a small number of TAS and coastal objectives may not be met unless unless action planning includes even greater non-regulatory actions, such as as the retirement of all high erosion risk land (as defined in PC1) or even mitigations that go beyond the assumptions of the most aspirational (Water Sensitive) CMP scenario (Table I).

Table I: Description of the TASs and coastal objectives that will not be met through the proposed provisions alone. The non-regulatory actions that could potentially fill these 'gaps' are also identified from the CMP scenario assumptions.

<table>
<tr><th>Part-FMU</th><th>Attribute</th><th>Possible non-regulatory actions to fill the 'gap' between the proposed provisions and TAS/objective based on the CMP scenario assumptions</th></tr>
<tr><td>Pouewe</td><td>Periphyton biomass</td><td>Planting of riparian buffers on all second order and above streams on low slope pastoral land.</td></tr>
<tr><td rowspan="2">Taupō</td><td>Nitrate</td><td rowspan="3">• Planting of riparian buffers on all second order and above streams on low slope pastoral land; and
• Retirement of all high erosion risk land.</td></tr>
<tr><td rowspan="4">E. coli</td></tr>
<tr><td>Pouewe</td></tr>
<tr><td>Takapū</td></tr>
<tr><td>Wai-o-hata</td><td rowspan="3">• Everything above; and
• Additional mitigations not considered in CMP scenarios or land-use change.</td></tr>
<tr><td>Te Rio o Porirua and Rangituhi</td></tr>
<tr><td>Onepoto Arm</td><td rowspan="2">Enterococci</td></tr>
<tr><td>Pāuatahanui Inlet</td></tr>
</table>

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1.1 Background

Plan Change 1 (PC1) to the Natural Resources Plan (NRP) for the Wellington Region will implement the National Policy Statement for Freshwater Management (NPS-FM) 2020 for Te Awarua-o-Porirua (TAoP) Whaitua and Whaitua Te Whanganui-a-Tara (WTWT). 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 will:

- Define target attribute states ('TASs') for the compulsory attributes in Appendix 2 of the NPS-FM 2020;
- Set equivalent coastal water quality and ecology objectives ('coastal objectives'); and
- Establish provisions that will contribute to the achievement of those TASs and coastal objectives.

This process is especially important for those compulsory attributes in Appendix 2A of the NPS-FM 2020; as these require limits (input controls, output controls, or land use controls) be set as rules in regional plans to contribute to the achievement of their target states.(as opposed to those in Appendix 2B, which can be achieved through action planning[1] alone).

The proposed TASs and coastal objectives for TAoP Whaitua are set out in Table 1 and Table 2. These are based on those published by TAoP Whaitua Committee ('the Committee) in their Whaitua Implementation Programme (WIP). However, minor refinements have been made based on the recommendations of a technical advisory panel (Greer *et al.*, 2023). For each river attribute the tables include a baseline and target state for each part Freshwater Management Unit (part-FMU) (Table 2). The differences between those states provide an indication of the magnitude of the improvement required by the TASs and have been used to define default TASs that prescribe the direction of change required for each attribute across each part-FMU[2] (Table 2).

The development of Table 1 and Table 2, and how they should be interpreted, is documented in Greer *et al.* (2023). However, most of the relevant detail can also be found in the glossary of this report and the footnotes to the tables. The attribute state frameworks behind the river TASs in Table 2 are provided in Appendix A.

[1] I.e., developing and implementing an action plan in accordance with the NPS-FM 2020.

[2] Where baseline state is unknown, this direction of change is based on the difference in the assumed baseline in the WIP and the TAS.

1.2 Target Attribute States and coastal objectives

Table 1: Coastal objectives for the TAoP Whaitua. Note that the sediment and metal load reduction targets are not objectives in themselves, rather they are the proxies for the sedimentation rate and sediment metal objectives used in this assessment.

			Onepoto Arm		Pāuatahanui Inlet		Coast
Parameter	**Unit**	**Statistic**	**Intertidal**	**Subtidal**	**Intertidal**	**Subtidal**	
Enterococci	**cfu/100 mL**	95th %ile	≤500		≤200		≤200
Macroalgae	**EQR**	Latest score	Maintain or improve				Maintain or improve
Copper in sediment	**mg/kg**	Mean of latest round of replicate samples					
Zinc in sediment	**mg/kg**						
Muddiness	**% >50% mud**	Latest score					
	% of sample						
Sedimentation rate	**mm/year**	5-year mean	1		2		
Sediment load reduction	***% Δ in annual average loads (from the baseline period)***		*40%*				
Copper load reduction			*15% to be achieved through regulation*[1]				
Zinc load reduction			*40%*				

[1] In total a 40% reduction in copper load is required, with 25% to be achieved through action planning. For the purposes of this report, the copper load reduction target is considered to be a 15% reduction as that is the desired outcome of the proposed provisions.

Table 2: Rivers TASs for TAoP Whaitua

				Taupō					Pouewe					Wai-o-hata					Takapū				
				Taupō S. @ Plimmerton Domain				Part-FMU default TAS[1]	Horokiri S. @ Snodgrass				Part-FMU default TAS[1]	Duck Ck @ Tradewinds Dr. Br.				Part-FMU default TAS[1]	Pāuatahanui S. @ Elmwood Br.				Part-FMU default TAS[1]
				Baseline		TAS[1]			Baseline		TAS[1]			Baseline		TAS[1]			Baseline		TAS[1]		
Parameter	Unit	Statistic	Timeframe	Numeric	State	Numeric	State		Numeric	State	Numeric	State		Numeric	State	Numeric	State		Numeric	State	Numeric	State	
Periphyton biomass	mg chl-a/m²	92nd %ile	By 2040	N/A[2]				M	436[3]	D	≤120	B	I	Insufficient data		≤120	B	I	Insufficient data		≤120	B	I
Ammonia (toxicity)	mg/L	Median		0.011	B[4]	≤0.03	A	I	0.002	A	M	A	M	0.013	A[4]	M	A	M	0.005	A	M	A	M
		95th %ile		0.051		≤0.05			0.013					0.044					0.018				
Nitrate (toxicity)	mg/L	Median		0.4	B[4]	≤1	A		0.6	A		A		0.5	B[4]	≤1	A	I	0.3	A		A	
		95th %ile		2.1		≤1.5			1.1					1.6		≤1.5			0.8				
Suspended fine sediment	Black disc (m)	Median		1.2	A[4]	≥0.93	A	M	2.3	C		C		1.2	A[4]	≥0.93	A	M	1.8	D	≥2.22	C	
E. coli	/100mL	Median		735	E[4]	≤130	B	I	370	E	≤130	B	I	703	E[4]	≤130	C	I	275	E	≤130	C	I
		%>260/100mL		96		≤30			63		≤30			92		≤20			55		≤20		
		%>540/100mL		62		≤10			32		≤10			59		≤34			18		≤34		
		95th %ile		5,299		≤1,000			4,950		≤1,000			4,783		≤1,200			6,050		≤1,200		
Fish	Fish-IBI	Latest		Insufficient data		M		M	Insufficient data		M		M	Insufficient data		M		M	Insufficient data		M		M
Fish community health (abundance, structure and composition)		Expert assessment[5]				N/A[5]	B	I			N/A[5]	A	I			N/A[5]	B	I			N/A[5]	B	I
Macroinvertebrates (1 of 2)	MCI	Median				≥100	B		115.0	B	≥130	A				≥100	B		101.2	D	≥105	B	
	QMCI	Median				≥5			6.0		≥6.5					≥5			3.8		≥5.25		
Macroinvertebrates (2 of 2)	ASPM	Median				≥0.4	B		0.5	B	M	B				≥0.4	B		0.4	C	≥0.40	C	M
Deposited fine sediment[3]	%cover	Median		N/A[6]					10	A		A							60	D	≤27	C	I
Dissolved oxygen	mg/L	1-day minimum		Insufficient data		M		M	Insufficient data		M		M			M		M	Insufficient data		M		M
		7-day mean minimum																					
Dissolved inorganic nitrogen[7]	mg/L	Median		0.41[4]		≤1.03		I	0.64					0.48[4]					0.33				
Dissolved reactive phosphorus[7]	mg/L	Median		0.017[4]		M		M	0.011					0.018[4]		M			0.014		M		
		95th%ile		0.047[4]					0.026					0.05[4]					0.022				
Dissolved copper	µg/L	Median		0.61	D[4]	≤1	B	I	0.03	A[4]	M	A		0.47	C[4]	≤1	A	I	0.06	A[4]	M	A	
		95th %ile		4.69		≤1.8			0.12					2.93		≤1.4			0.27				
Dissolved zinc	µg/L	Median		3.91	C[4]	≤2.4	A		0.07	A[4]		A		1.96	B[4]	≤2.4	A		0.11	A[4]		A	
		95th %ile		32.25		≤8			0.23					13.04		≤8			0.48				
Ecosystem metabolism	g O_2 m^{-2} d^{-1}	N/A[8]		M																			

				Te Rio o Porirua and Rangituhi					Island rivers TAS[1]
				Porirua S. @ Milk Depot				Part-FMU default TAS[1]	
				Baseline		TAS[1]			
Parameter	**Unit**	**Statistic**	**Timeframe**	**Numeric**	**State**	**Numeric**	**State**		
Periphyton biomass	**mg chl-a/m²**	92nd %ile	By 2040	Insufficient data		≤120	B	I	M
Ammonia (toxicity)	**mg/L**	Median		0.006	A	M	A	M	
		95th %ile		0.034					
Nitrate (toxicity)	**mg/L**	Median		0.9	B	≤0.9	A	I	
		95th %ile		1.6		≤1.5			
Suspended fine sediment	**Black disc (m)**	Median		1.7	A	M	A	M	
E. coli	**/100mL**	Median		1400	E	≤130	C	I	
		%>260/100mL		95		≤20			
		%>540/100mL		83		≤34			
		95th %ile		6950		≤1200			
Fish	**Fish-IBI**	Latest		Insufficient data		M		M	
Fish community health (abundance, structure and composition)		Expert assessment[5]				N/A[5]	C	I	
Macroinvertebrates (1 of 2)	**MCI**	Median		87.0	D	≥90	C		
	QMCI	Median		4.3		≥4.5			
Macroinvertebrates (2 of 2)	**ASPM**	Median		0.3	D	≥0.3	C		
Deposited fine sediment[3]	**%cover**	Median		20	C	M	C		M
Dissolved oxygen	**mg/L**	1-day minimum		Insufficient data		M			
		7-day mean minimum							
Dissolved inorganic nitrogen[7]	**mg/L**	Median		0.92					
Dissolved reactive phosphorus[7]	**mg/L**	Median		0.018					
		95th%ile		0.034					
Dissolved copper	**µg/L**	Median		1.1	C	M	C		
		95th %ile		2.6					
Dissolved zinc	**µg/L**	Median		7.5	D	≤7.5	C	I	
		95th %ile		58		≤42			
Ecosystem metabolism	**g O_2 m^{-2} d^{-1}**	N/A[8]		M[8]					

[1] 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.

[2] All rivers in part-FMU naturally soft bottomed and unlikely to support periphyton growth (River Environment Classification group = WW/L/SS).

[3] Baseline state based on limited data.

[4] Baseline state based on eWater Source model results. Further monitoring needed to confirm whether the attribute meets the TAS.

[5] 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.

[6] All rivers in part-FMU naturally soft bottomed (River Environment Classification group = WW/L/SS).

[7] Median concentration targets reflect the nutrient outcomes required by Clause 3.13 of the NPS-FM 2020

[8] Further monitoring needed to define baseline state and develop attribute state framework.

1.3 Introduction to the TAoP Collaborative Modelling Project

1.3.1 Collaborative Modelling Project framework

The decisions made 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 (MLG) whose purpose was to develop a broad multidisciplinary modelling framework (Figure 1) that:

- Covered the effect of urban and rural land and water resource use on water quantity and quality, in freshwater, harbour and coastal waters; and
- Encompassed environmental, social, cultural and economic aspects.

Ultimately a set of multiple interacting and stand-alone models were required to deliver this coverage. The purpose of those models was to test the effects of the following scenarios on various biophysical attributes (the full assumptions of each scenario are provided in Appendix B):

- Business as usual (BAU) – Represented the regulatory and management approach at the time;
- Improved – Included a range of actions with the potential to minimise the impact of urban and rural land uses, such as stormwater treatment, wastewater network upgrades, riparian planting, space planting and retirement; and
- Water Sensitive – Included much the same actions as Improved, but with an increase in their extent and efficacy.

1.3.2 Scenario testing

1.3.2.1 Purpose

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:

- Make informed decisions regarding TASs and coastal objectives; and
- Understand the actions required to achieve those TASs and objectives, and their 'cost and benefit'.

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 TASs, coastal objectives and recommendations in the WIP could be tailored to reflect the values of the community.

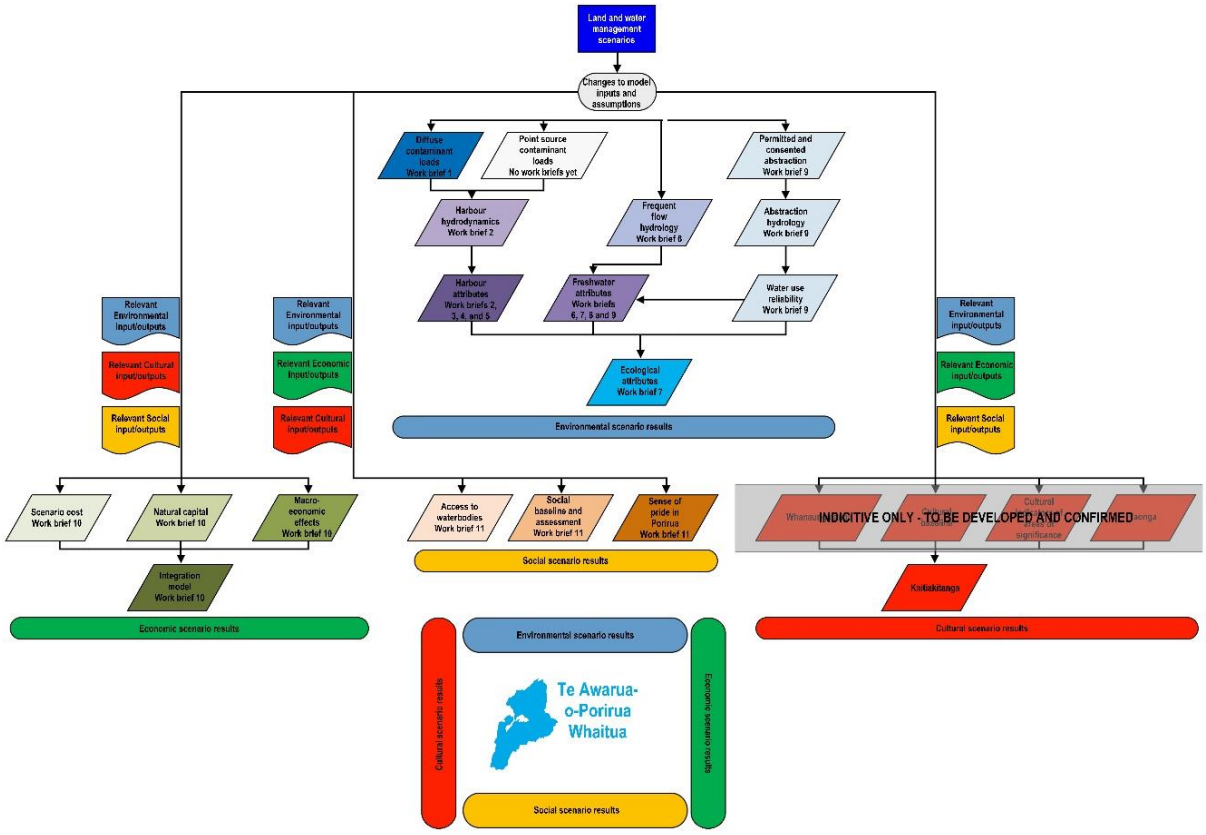


Figure 1: Diagram of the TAoP CMP framework provided to the Committee

1.3.2.2 Relevant models and outputs

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 (Easton *et al.*, 2019a). That model utilised environmental data from a range of sources, including Whaitua specific contaminant yields generated by the following models:

- The Catchment Land Use for Environmental Stability (CLUES) model (Semadenis-Davies and Kachhara, 2017); and
- The urban Contaminant Load Model (CLM) (Moores *et al.*, 2017).

The Source modelling results are documented in Easton *et al.*, (2019b) and were summarised by GW officers for the Committee in:

- A spreadsheet[3];
- A memorandum drafted in April 2018 (Miller and King, 2018a); and

[3] https://www.gw.govt.nz/assets/Documents/2022/05/RESULTS-TAoPW-Information-for-Objective-Setting-freshwater-scenario-modelling-19-April-2018-1.pdf

- A presentation[4] during a Committee meeting on the 19th of April 2018.

The state of sediment quality, deposition and texture, and water quality in Te Awarua-Porirua Harbour under the CMP scenarios were modelled by DHI (DHI Water and Environment Limited) using a suite of hydrodynamic, wave, sediment transport and contaminant dispersion models. The Source modelling was a major input to those models; providing the estimated contaminant loads and flows to the harbour under the different CMP scenarios. The results of the harbour modelling are presented in Oldman (2019) and were further summarised by GW in:

- A spreadsheet[5];
- A memorandum drafted in April 2018 (Miller and King, 2018b); and
- A summary technical report (Miller and King, 2018c).

Note: The CMP Improved scenario was not tested by Oldman (2019).

The impacts of the CMP scenarios on freshwater and coastal 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 freshwater and coastal modelling were considered. The results of the freshwater and harbour expert assessments were provided to the Committee as spreadsheets[6,7] and were summarised by GW officers in presentations[8,9], reports and memoranda (Miller and King, 2018b, 2018d, 2018c).

1.4 Report objectives

The purpose of this report is to assess the extent to which the proposed regulatory provisions of PC1[10] ('the proposed provisions') will achieve the TASs and coastal objectives for TAoP Whaitua in PC1 (Table 1 and Table 2) using the CMP outputs described above in Section 1.3.2.2. This is necessary as the impacts of the proposed provisions were not explicitly tested through the CMP.

[4] https://www.gw.govt.nz/assets/Documents/2022/05/Scenario-modelling-of-state-of-fresh-water-in-Te-Awarua-o-Porirua.pdf
[5] https://www.gw.govt.nz/assets/Documents/2022/05/Harbour-Summary-Table-current-state-and-scenario-projections-31-05-18.pdf
[6] https://www.gw.govt.nz/assets/Documents/2022/05/Ecological-assessment-summary-sheets.pdf
[7] https://www.gw.govt.nz/assets/Documents/2022/05/Harbour-Summary-Table-current-state-and-scenario-projections-31-05-18.pdf
[8] https://www.gw.govt.nz/assets/Documents/2022/05/PRESENTATION-Scenario-assessment-of-ecological-attributes-in-Te-Awarua-o-Porirua-10May18.pdf
[9] https://www.gw.govt.nz/assets/Documents/2022/05/Ecological-Attributes-for-Te-Awarua-o-Porirua-Harbour-2.pdf
[10] https://www.gw.govt.nz/your-region/plans-policies-and-bylaws/updating-our-regional-policy-statement-and-natural-resources-plan/natural-resources-plan-2023-changes/

1.5 Scope and limitations of this assessment

- This assessment does not cover the full range of topics that GW will need to produce expert evidence on during the PC1 Freshwater Planning Process. Rather it is intended to inform the PC1 S32 report, and, in tandem with Greer *et al.*, (2023), transparently document the technical work that has been completed since the TAoP WIP was published. Consequently, detailed introductions to the freshwater and coastal environments in TAoP Whaitua, the NPS-FM 2020 and the NRP are not provided.
- Torlesse (Torlesse Environmental Limited) was not involved in the TAoP CMP process. Thus, is unable to confirm the extent to which its outputs contributed to the Committee decisions on the TASs and coastal objectives in the WIP. Consequently, that a TAS or coastal objective is assessed as being unachievable is not justification for changing it, as 'achievability' may, or may not, have factored into their selection.
- While this assessment relies heavily on the results of scenario testing conducted for the CMP, it is not an output of the project. Rather it should be treated as the peer reviewed opinion of one expert.
- A comparable report has been prepared for WTWT by Greer (2023). The similarities between the scenarios tested for that Whaitua and TAoP means that large parts of that report are replicated here.

2 Methods

2.1 Scale of assessment

The impact of the proposed provisions on each of the attributes listed in Table 1 and Table 2 (except ecosystem metabolism) was assessed for each of the spatial areas (except the 'Coast' (Table 1)) set out in the headers of those tables (hereafter collectively referred to as 'part-FMUs'). This resulted in 89 TASs and coastal objectives being assessed across the 7 part-FMUs listed below and mapped in Figure 2:

- Rivers:
    - Taupō;
    - Pouewe;
    - Wai-o-hata
    - Takapū; and
    - Te Rio o Porirua and Rangituhi.
- Coastal:
    - Te Awarua-o-Porirua Harbour – Onepoto Arm; and
    - Te Awarua-o-Porirua Harbour – Pāuatahanui Inlet.

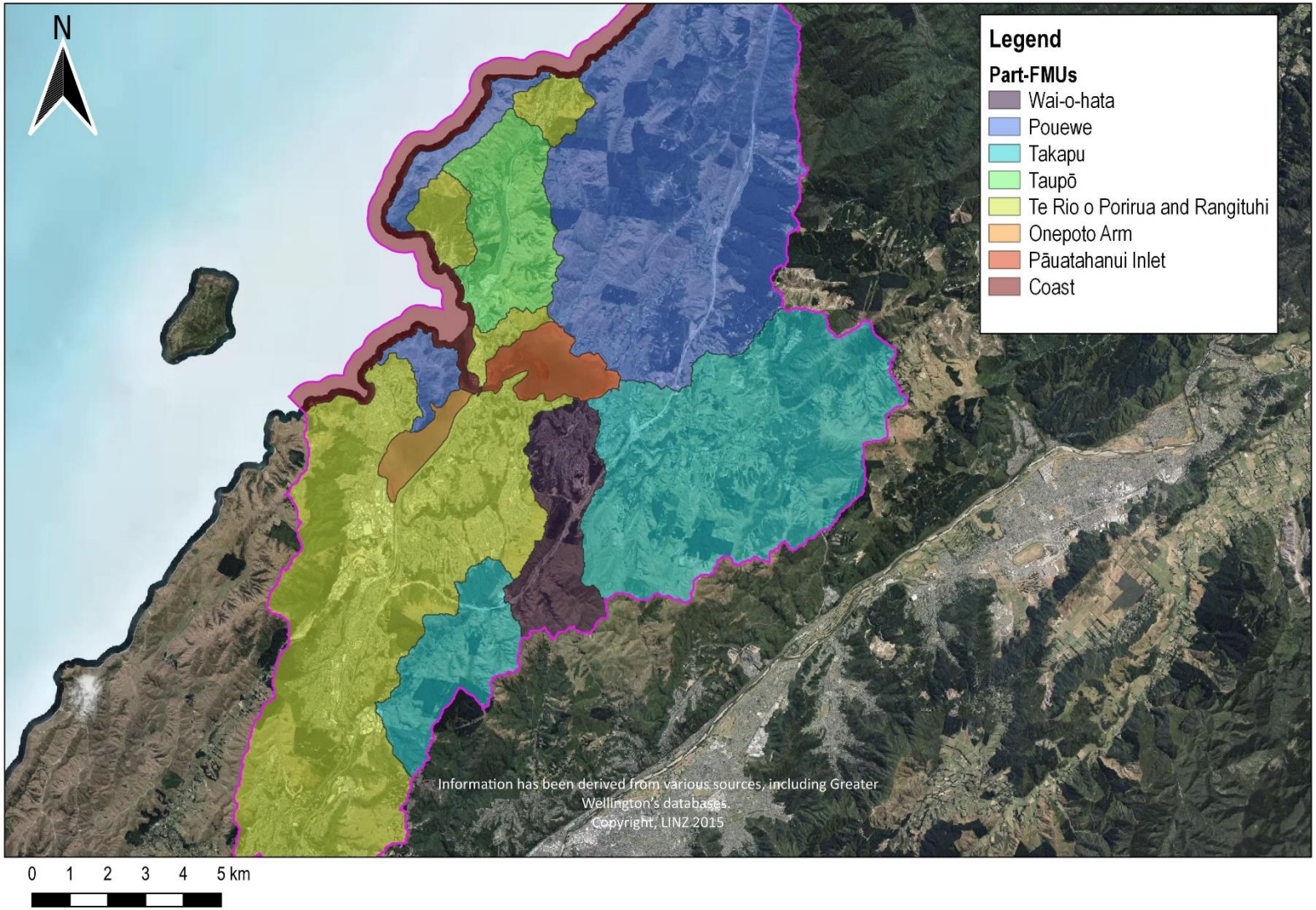


Figure 2: Map of TAoP part-FMUs

2.2 Assessment method for 2A type attributes

The NPS-FM 2020 requires that the proposed provisions contribute to the achievement of the target states for attributes in Appendix 2A of that document and the nutrient outcomes required by clause 3.13. Consequently, these attributes require a more detailed assessment methodology than the other attributes in Table 1 and Table 2. The proposed provisions are also directly linked to the TASs or coastal objectives for the following attributes:

- Dissolved copper (Cu) TASs;
- Dissolved zinc (Zn) TASs;
- Cu load reduction targets for Te Awarua-o-Porirua Harbour;
- Zn load reduction targets for Te Awarua-o-Porirua Harbour;
- Sediment load reduction targets for Te Awarua-o-Porirua Harbour; and
- Enterococci coastal objectives for Te Awarua-o-Porirua Harbour.

Thus, for this assessment they are treated the same way as the NPS-FM 2020 Appendix 2A compulsory attributes (hereafter collectively referred to as '2A type attributes'). A full list of the 2A type attributes assessed in this report is provided in Table 3.

Table 3: 2A type attributes and attribute groups.

Attribute Group	Attributes
Sediment	• Rivers – Suspended fine sediment (SFS) • Harbour – Sediment load reduction target[1]
Faecal indicator bacteria	• Rivers – *E. coli* • Harbour – Enterococci
Nitrogen	• Rivers – Nitrate (NO_3-N) • Rivers – Ammonia (NH_4-N) • Rivers – Dissolved inorganic nitrogen (DIN) (nutrient outcome)
Phosphorus	• Rivers – Dissolved reactive phosphorus (DRP) (nutrient outcome).

Metals	• Cu
	  ○ River – Dissolved Cu
	  ○ Harbour – Cu load reduction target[1]
	• Zn
	  ○ River – Dissolved Zn
	  ○ Harbour – Zn load reduction target[1]

Rivers – Periphyton	

[1] These sediment and metal load reductions are used as proxies for the Te Awarua-o-Porirua Harbour sedimentation rate and sediment Cu and Zn concentration coastal objectives in Table 1. For sediment and Zn they are expected to achieve the relevant coastal objectives. However, for Cu an additional 25% reduction in loads may be required. Consequently, the draft provisions being assessed as meeting the Cu load reduction targets does not necessarily mean they will achieve the sediment concentration objective.

2.2.1 Scenario assignment

To date the biophysical effects of the proposed provisions have not been explicitly modelled. Consequently, the CMP scenario testing outputs represent the best available information that can be used to assess the extent to which the proposed provisions will contribute to achievement of the 2A type TASs and coastal objectives in Table 1 and Table 2.

No single CMP scenario aligns perfectly with all the proposed provisions. Thus, for each activity managed by PC1 an assessment has been made of where the relevant proposed provisions sit in relation to the assumptions of the scenarios. This was based on:

- Where the proposed provisions require regulated parties to undertake specific actions (e.g., the installation of a specific treatment device in new urban developments), how similar those actions are to those assumed under the CMP scenarios; or
- Where the proposed provisions require regulated partied to achieve a certain outcome (e.g., a specific percentage reduction in contaminant loads) how similar those outcomes are to those assessed under the CMP scenarios.

The CMP scenario which most closely match the proposed provisions was 'assigned' to each of the following activities:

- Livestock exclusion;
- Riparian management;
- Retirement;
- Space planting (of trees);
- Earthworks;
- Stormwater management;
- Wastewater management;
- Land-use change (other than retirement); and
- Practice change (for the activities not listed above).

This activity-based assessment was then used to assign a CMP scenario to each of the attribute groups set out in Table 3:

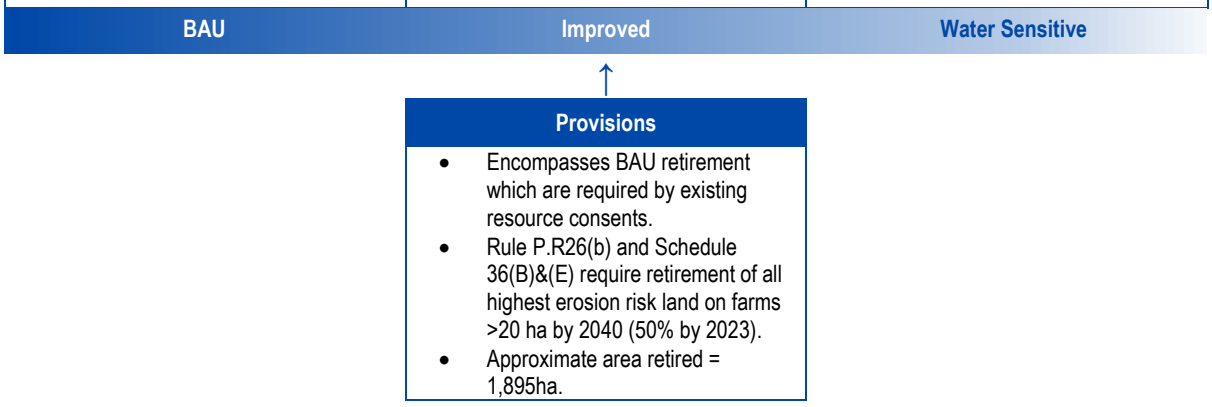
The scenario assignment process and outputs are described in full in Section 3. In short it was based on expert opinion and involved:

- Identifying the relevant scenario assumptions for each activity;
- Considering the actual and potential actions and outcomes required for each activity by the proposed provisions;
- Identifying the CMP scenario whose assumptions most closely matched the requirements of the proposed provisions for each activity using the template set out below in Table 4;
- Identifying which activities, and therefore, CMP scenarios, are most relevant to each of the attribute groups in Table 3;

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

Table 4: Example of the scenario alignment outputs for individual activities (in this case retirement).

BAU	Improved	Water Sensitive
275 ha in the headwaters of the Kenepuru Stream and Duck Creek retired as an offset for the Transmission Gully motorway project.	• As for BAU but with additional retirement of LUC class 7e and 8e land with grassland land cover. Assumed this land reverts to native cover. • Approximate area retired = 1,994 ha.	• As for Improved but with additional retirement of LUC class 6e land with grassland land cover. • Approximate area retired = 4,416 ha.



2.2.2 Identification and approach for 'maintain' 2A type TASs and coastal objectives

The 2A type TASs and coastal objectives that require an attribute be maintained were identified where:

- The baseline state for an attribute meets the TAS (Table 2);
- The baseline state is unknown, but the part-FMU default TAS requires the attribute be maintained (Table 2);
- The coastal narrative objective simply requires the attribute "*Maintain or improve*" (Table 1); or
- The baseline state does not meet the TAS, but current state and trend analysis (as reported in GW (2022)) indicates that the TAS is currently met and that this is likely to continue (i.e., improving trends are likely (>66% probability)). This applies to the Nitrate (toxicity) TAS for the Te Rio o Porirua and Rangituhi part-FMU.

For these 'maintain' 2A type TASs and coastal objectives, consideration was given to the modelled or assessed impacts of the CMP scenario assigned to the relevant attribute group, and whether the proposed provisions allow for degradation from the baseline state. For each attribute group (see Table 3), the results of these assessments were documented in a short narrative and summarised in the format of Table 5.

Table 5: Example of the summary tables produced for 'maintain' 2A type TASs and coastal objectives.

Part-FMU	Site	Attribute	Baseline state and TAS	Scenario results			Assigned scenario consistent with TAS
				BAU	Improved	Water Sensitive	
Part-FMU 1	Site 1	Attribute 1	A	Maintain	Maintain	Maintain	✓
Part-FMU 2	Site 2			Degrade	Maintain	Improve	
Part-FMU 3	Site 3			Degrade	Maintain	Improve	
Part-FMU 1	Site 1	Attribute 2	A	Degrade	Improve	Improve	
Part-FMU 2	Site 2			Degrade	Maintain	Improve	
Part-FMU 3	Site 3			Degrade	Improve	Improve	
					↑ Provisions		

The relevant scenario results for each attribute group were drawn from:

- Sediment:
  - Modelled loads = Easton *et al.* (2019b);
  - Visual clarity = Site specific sediment clarity relationships set out in Greer *et al.* (2023)).
- Nutrients = Easton *et al.* (2019b); and
- Metals = Easton *et al.* (2019b).

2.2.3 Identification and approach for 'improve' 2A type TASs and coastal objectives

The TASs and coastal objectives that require an improvement in a 2A type attribute were identified where:

- The baseline and current state (as reported in GW (2022)) of an attribute in a part-FMU does not meet the TAS (Table 2);
- The baseline state is unknown, but the part-FMU default TAS requires the attribute be improved (Table 2); or
- A numeric coastal objective has been set for the attribute in a part-FMU (Table 1).

The primary consideration given to these 'improve' 2A type TASs and coastal objectives was whether their achievement was modelled or predicted under the assigned CMP scenario. If not, consideration was given to the likely 'gap' that would need to be filled by action planning. For each attribute group (see Table 3), these assessments were documented in a short narrative and summarised in the format of Table 6.

Assessment of the proposed provisions against the 'improve TASs and coastal objectives for 2A type attributes relied on the CMP outputs listed below:

- Sediment:
  - Modelled loads = Easton *et al.* (2019b); and
  - Visual clarity = Site specific sediment clarity relationships set out in Greer *et al.* (2023)).

- Nutrients = Easton *et al.* (2019b);
- Metals = Easton *et al.* (2019b);
- Faecal indicator bacteria = Easton *et al.* (2019) (freshwater) and Oldman (2019) (harbour); and
- Periphyton = The expert assessments for ecological attributes provided on the GW website[6].

Note: These assessments do not make categorical conclusions about whether a specific TAS will be met by the proposed provisions. Rather results are given in terms of the likely outcomes of the proposed provisions and degree of consistency with the CMP scenarios predicted to achieve the TAS.

Table 6: Example of the summary tables produced for 'improve' 2A type TASs and coastal objectives.

Part-FMU	Site	Attribute	Baseline state	TAS	Scenario results			Provisions likely to achieve TAS?
					BAU	Improved	Water Sensitive	
Part-FMU 1	Site 1	Attribute 1	C	A	C	C	C	×
Part-FMU 2	Site 2		D	C	D	C	C	✓
Part-FMU 3	Site 3			C	D	D	C	×
Part-FMU 1	Site 1	Attribute 2	D	C	D	D	C	
Part-FMU 2	Site 2			C	D	D	C	
Part-FMU 3	Site 3			C	D	D	C	
						↑ Provisions		

2.3 Assessment method for 2B type attributes

Whether the TASs and coastal objectives in Table 1 to Table 2 require the maintenance or improvement of 2B type attributes was determined through the approach described in Sections 2.2.2 and 2.2.3. Through this process, the Macroinvertebrates (2 of 2) TAS for the Te Rio o Porirua and Rangituhi part-FMU was identified as requiring an improvement from the reported baseline state that has already been achieved (GW, 2022).

There is no NPS-FM 2020 requirement for the proposed regulatory provisions to contribute to the achievement of the target states or coastal objectives for the attributes in Table 1 and Table 2 that are not listed in Appendix 2A of the NPS-FM or Section 2.2 (hereafter referred to collectively as '2B type attributes'). Consequently, the assessment process for these attributes was not as detailed or structured as that described above for 2A type attributes.

For each of the 2B type attributes listed in Table 7 a simple narrative assessment was made of:

- The most applicable CMP scenario (based on expert opinion and the results of the scenario assignment described in Sections 2.2.1 and 3); and
- The likely outcome of the proposed provisions in each part-FMU based on the modelled or predicted outcome of the most applicable scenario.

Where the CMP outputs allowed, the assessments described above were also summarised in tables like those produced for 2A type attributes (see Table 5 and Table 6).

For the TASs and coastal objectives that require the maintenance of a 2B type attribute, this approach provided a general indication of whether the proposed provisions will result in their achievement.

Unlike for the 2A type attributes, the CMP outputs cannot be used to determine whether the proposed provisions will achieve those TASs and coastal objectives that require an improvement in 2B type attributes. This is because in the CMP these attributes were either:

- Not assessed;
- Considered using a different attribute state framework; or
- Assessed from a baseline state that is no longer relevant.

Consequently, the assessment of these 'improve' 2B type TASs and coastal objectives was generally limited to determining whether the proposed provisions are likely to result in an improvement in the state of the attribute and, therefore, contribute to the achievement of the TAS or coastal objective.

Relevant CMP scenario testing results were drawn from:

- Sediment = Easton *et al.* (2019b); and
- All other attributes = The ecological assessment summary sheets provided on the GW website[6,7].

Table 7: 2B type attributes.

Environment	Attribute
Rivers	• Deposited fine sediment (DFS) • Macroinvertebrate Community Index score and Quantitative Macroinvertebrate Community Index score (Q/MCI) • Macroinvertebrate Average Score Per Metric (ASPM) • Fish Index of Biotic Integrity (F-IBI) • Fish community health • Dissolved oxygen
Te Awarua-o-Porirua Harbour	• Muddiness (% area >50% mud) • Muddiness (% of sample) • Macroalgal Ecological Quality Rating (EQR)

[1] There are no data available for ecosystem metabolism and no attribute state framework. Furthermore, this attribute was not considered in the CMP. Consequently, this attribute is not considered in this report.

2.4 Assumptions

- It was not possible to determine which types of livestock are present on a given farm or part of a farm. Thus, it was assumed that livestock exclusion will occur on all rivers where the proposed provisions require the exclusion of beef cattle. This may have resulted in the extent of livestock exclusion under the proposed provisions being overestimated in areas where sheep are the only type of livestock present.
- It was assumed that it will generally not be possible to obtain resource consent for the non-complying activities in the proposed provisions. Similarly, based on the policies of the

operative NRP and PC1 it was assumed that it will be difficult to obtain resource consent allowing:

  - Livestock access to waterways as a discretionary activity; or
  - The use of land for farming activities without a Farm Environment Plan (FEP) and associated erosion risk treatment plan (ERTP) as a discretionary activity (only non-complying in the Takapū part-FMU).

- Full maps of the location and extent of high risk erosion prone land and highest risk erosion prone land were not produced in time to be considered in this assessment. Thus, the assumed area and location of this land was based off the extrapolation of interim mapping conducted for the Pouewe and Takapū part-FMUs.
- It is not possible to predict where individual types of soil conservation treatment will be applied in the future. Thus, for the purposes this assessment it was simply assumed that space planting of poplar and willow poles will be the primary treatment method applied on high erosion risk land. Space planting was chosen over the other treatment methods allowed for under the proposed provisions (Schedule 36 – Table D1) because:
  - It was the only one tested through the CMP scenario testing process other than revegetation;
  - The sediment load reduction factors cited for space planting in Phillips *et al.* (2020) and used in the CMP scenario modelling (Easton *et al.*, 2019b) (70%) reflect:
    - The mid-point of the range cited in Phillips *et al.* (2020) for the different soil conservation treatment types allowed for under the proposed provisions (50% to 90%); and
    - The cited *assumed* performance of erosion control methods in a well-implemented farm plan in Dymond *et al.* (2010).
- It was assumed that the proposed provisions have been fully implemented and complied with, and that the resulting effects on the environment have been fully realised.

3 Scenario assignment for 2A type attributes

3.1 Alignment between the proposed provisions and CMP scenarios by activity

3.1.1 Retirement

The ERTPs stipulated by clause (b) of Rule P.R26 of PC1 require:

- Woody vegetation capable of reaching canopy cover of ≥80% in ten years to be established on 50% of the highest erosion risk land on farms greater than 20 hectares (ha) by 2033 (Schedule 36 (E)(1)); and
- The remaining 50% of highest erosion risk land on farms greater than 20 ha to be revegetated by 2040[11] (Schedule 36 (B)).

The result of this revegetation is the affected land will effectively be retired from farming. Interim mapping of the highest erosion risk land in the Pouewe and Takapū part-FMUs indicates that this could result in approximately 1,620 ha of new retirement in the TAoP Whaitua, with an additional 275 ha required by existing resource consents (based on the assumptions of the CMP BAU scenario) (1,895 ha total retirement). This is most consistent with what was assumed under the CMP Improved scenario (1,994 ha) (Table 8).

Note: It is possible that some landowners will apply for resource consent to farm without an ERTP (non-complying activity in Takapū part-FMU[12]; discretionary elsewhere). However, it is unlikely it will be granted unless the application includes erosion control methods that are at least as effective as the ERTP requirements of PC1, given:

- *The significant load reductions required to meet the sedimentation coastal objectives for the harbour and the SFS TAS for the Takapū part-FMU; and*
- *The wording of Policy P.P22 which aims to "[r]educe discharges of sediment from farming activities on high and highest erosion risk land by [] **requiring** that farm environment plans prepared for farms with highest erosion risk land (pasture) and/or high erosion risk land (pasture) include an erosion risk treatment plan".*

[11] The proposed provisions do not require highest erosion land to be revegetated where it is not practicable and alternative erosion control treatment can be applied over the balance of the property that results in the same level of soil loss avoidance. However, given that revegetation is by far the most effective erosion control treatment, and that, by definition, highest erosion risk land has the highest soil losses, it is unlikely that this exemption will significantly reduce the amount of retirement required by 2040.

[12] Condition (a) of Rule P.R27 cannot be met.

Table 8: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the CMP scenario assumptions on retirement.

BAU	Improved	Water Sensitive
275 ha in the headwaters of the Kenepuru Stream and Duck Creek retired as an offset for the Transmission Gully motorway project.	• As for BAU but with additional retirement of LUC class 7e and 8e land with grassland land cover. Assumed this land reverts to native cover. • Approximate area retired = 1,994 ha.	• As for Improved but with additional retirement of LUC class 6e land with grassland land cover. • Approximate area retired = 4,416 ha.
BAU	Improved	Water Sensitive

↑

Provisions
• Encompasses BAU retirement which are required by existing resource consents. • Rule P.R26(b) and Schedule 36(B)&(E) require retirement of all highest erosion risk land on farms >20 ha by 2040 (50% by 2023). • Approximate area retired = 1,895ha.

3.1.2 Space planting (of trees)

The ERTPs stipulated by clause (b) of Rule P.R26 require high erosion risk land on farms greater than 20 ha to have "*appropriate soil conservation treatment*" to "*provide effective erosion control*" (Schedule 36(E)(3)(c)). Space planting of poplar and willow poles is effective at controlling erosion on slopes and in gullies (Phillips *et al.*, 2020). Thus, it can be assumed that there will be few instances where its application will not be required on high erosion risk land[13]. Consequently, the proposed provisions will likely require space planting across 2,428 ha of high erosion risk land[14]. This is consistent with what was assumed under the CMP Improved scenario (2,422 ha) (Table 9).

Note: It is possible that some landowners will apply for resource consent to farm without an. However, it is unlikely it will be granted (see Section 3.1.1).

[13] See Section 2.4 for reasoning behind the assumption that space planting will be the primary soil conservation treatment type applied to high erosion risk land.

[14] Based on interim mapping of the high erosion risk land in the Pouewe and Takapū part-FMUs.

Table 9: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the CMP scenario assumptions on space planting.

BAU	Improved	Water Sensitive
No additional space planting assumed.	• Space/pole planting of LUC class 6e land with grassland land cover. • Approximate area treated = 2,422 ha.	No additional space planting assumed as LUC class 6e land with grassland land cover is assumed to be retired under this scenario.
BAU	Improved	Water Sensitive
	↑	
	Provisions	
	• Rule P.R26(b) and Schedule 36 (E)(3)(c) require appropriate soil conservation treatment (assumed to be space planting) on all high erosion risk land on farms >20 ha. • Approximate area treated = 2,428 ha.	

3.1.3 Livestock exclusion

In combination, the proposed provisions and the Resource Management (Stock Exclusion) Regulations 2020 (the 'Stock Exclusion Regulations') provide some level of control over livestock access across at least 45 km of the River Environment Classification[15] network in the TAoP Whaitua. This is 45% less than assumed under the CMP Improved scenario (85 km[16] of the REC network (Easton *et al.*, 2019b)), and is, therefore, most consistent with BAU (Figure 3a) (Table 10).

The specifics of the livestock exclusion required by the proposed provisions and the Stock Exclusion Regulations are as follows:

- The Stock Exclusion Regulations require livestock exclusion from wide (greater than one metre (m)) rivers on all low slope land by 01/07/2025. This equates to approximately 31 kilometres (km) of the REC network length in the Whaitua; and
- The proposed provisions of PC1 are likely to result in livestock exclusion from an additional 14 km[17] of the REC network in areas retired under ERTPs ((WH.R27(b) and Schedule 36(B)&(E); see Section 3.1.1)

[15] The REC (v2.5) is a database of catchment spatial attributes, summarised for every segment in New Zealand's network of rivers.

[16] This is more than the figure cited in Easton *et al.* (2019b) as it includes existing stock exclusion.

[17] Represents the total length of REC network within LUC class 7e and 8e land with grassland land cover (proxy for highest erosion risk land). There is a high level of uncertainty in this figure as rivers are not evenly distributed through the landscape. Thus, while class LUC class 7e and 8e land may cover a similar amount of area to highest erosion risk land (interim mapping conducted for the Pouewe and Takapū part-FMUs), if it is distributed differently across the landscape, the length of river flowing through it may be significantly different.

Table 10: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the CMP scenario assumptions on livestock exclusion.

BAU	Improved	Water Sensitive
• No additional livestock exclusion except as a result of urban development or retirement required by existing resource consents. • Approximate length of livestock exclusion = 12.5 km.	• Livestock exclusion undertaken on all REC order 2 or greater streams with catchment slope less than 15 degrees. • All streams within retired areas receive livestock exclusion. • Approximate length of livestock exclusion = 85 km.	• Same as Improved but with greater impact from retirement. • Approximate length of livestock exclusion = 102 km.
BAU	Improved	Water Sensitive

↑

Provisions
Approximate length of livestock exclusion required by proposed provisions and existing regulations = 45 km. **Proposed provisions** • The ERTPs required under Rule P.R26(b) should result in the exclusion of livestock in rivers running through highest erosion risk land on farms >20 ha. Applies to 14 km of REC network. **Existing regulations** • Under the Stock Exclusion Regulations, livestock exclusion is required on all rivers greater than one metre wide on low slope land. Applies to ≥31 km of REC network.

Notes:

- *The length of river covered by the proposed provisions and the Stock Exclusion Regulations have been calculated using the REC network which does not detect smaller streams. Consequently, the cited length of rivers impacted by these documents will have been underestimated. This is also true for the cited length of river impacted by retirement under the CMP scenarios.*
- *Easton et al. (2019b) calculated that livestock exclusion has already occurred on 22 km of rivers in TAoP Whaitua (mostly on rivers covered by the Stock Exclusion Regulations). Furthermore, while not required by the proposed provisions, livestock exclusion may occur in as much as 12.5 km of river simply because of urban development (as assumed under the CMP BAU scenario) and retirement required by existing resource consents.*

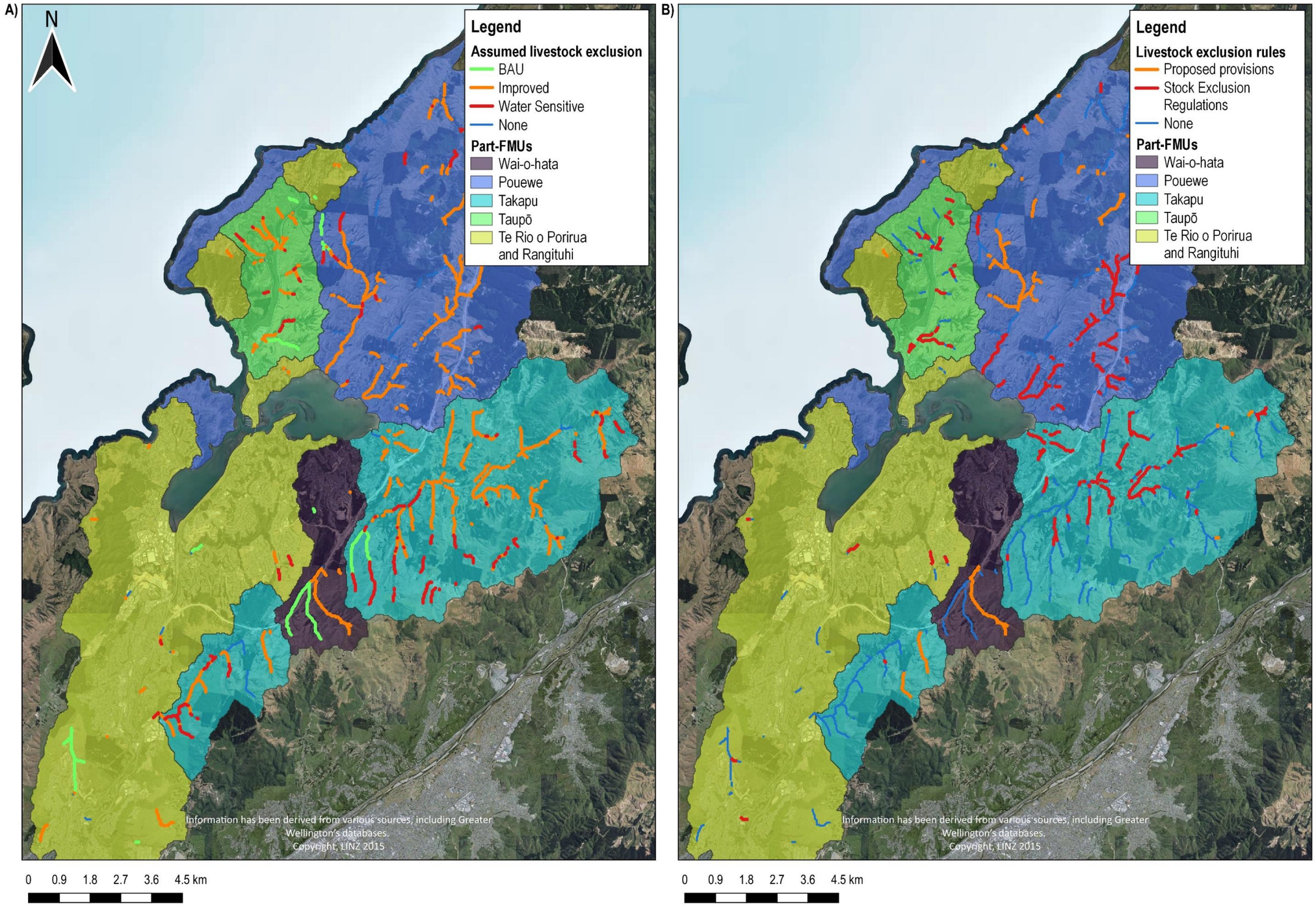


Figure 3: Livestock exclusion assumed under the different CMP scenarios (A) and the proposed provisions (B). The CMP scenarios are additive (i.e., exclusion under the CMP BAU scenario is also assumed under Improved and Water Sensitive).

3.1.4 Riparian management

The future riparian management required by regulation (including the proposed provisions) in TAoP Whaitua is most consistent with that assumed under the CMP BAU scenario (Table 11).

The proposed provisions do not explicitly require riparian planting of streams. However, the Stock Exclusion Regulations require livestock exclusion with a three-metre setback on wide rivers on all low slope land by 01/07/2025. This equates to approximately 31 km of REC network length. While planting of these setbacks is not required, it can be assumed that some form of vegetation will establish in them over time, even if it is just grass and scrub. Furthermore, the ERTPs stipulated by the proposed provisions (Rule P.R26(b) and Schedule 36(B)&(E)) require that woody vegetation be established on all highest erosion risk land on farms greater than 20 ha by 2040, which equates to 14 km[17] of the REC network in the TAoP Whaitua.

In combination, the proposed provisions and the Stock Exclusion Regulations could require some form of riparian management along 45 km of the REC network in the TAoP Whaitua. An additional four kilometres is also required by the conditions of existing resource consents (49 km total). While this is greater than that assumed under the CMP BAU scenario (3.8 km), it falls well short of the 76 km assumed under the Improved scenario (Figure 4). Furthermore, the required riparian management on most rivers under the Stock Exclusion Regulations (three metre setback) will likely be less effective at sediment and *E. coli* removal than that assumed under the Improved scenario (~10% (Semadenis-Davies *et al.*, 2020)).

Notes:

- *The length of river covered by the proposed provisions and the Stock Exclusion Regulations have been calculated using the REC network which does not detect smaller streams. Consequently, the length of impacted rivers will have been underestimated. This is also true for the cited length of river impacted by retirement under the CMP scenarios.*
- *Easton et al.* (2019b) *calculated that riparian planting has already occurred in 22 km of river in TAoP Whaitua (mostly on rivers covered by the Stock Exclusion Regulations). Furthermore, riparian planting will likely occur on an additional 3.8 km of river because of retirement required by existing resource consents.*

Table 11: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the CMP scenario assumptions on riparian management.

BAU	Improved	Water Sensitive
• No additional riparian planting except that resulting from retirement required by existing resource consent conditions. • Approximate length of riparian planting = 3.8 km.	• Five metres of riparian planting undertaken on all REC order 2 or greater streams with catchment slope less than 15 degrees. • All streams within retired areas receive riparian planting • Approximate length of new riparian planting = 76 km.	• Same as improved but with greater impact from retirement. • Approximate length of riparian planting = 94 km.
BAU	Improved	Water Sensitive

↑

Provisions
Approximate length of riparian management required by proposed provisions/consents = 49 km. **Proposed provisions** • The ERTPs required under Rule P.R26(b) require riparian planting of rivers running through highest erosion risk land on farms >20 ha. Applies to 14 km of REC network. **Existing regulations** • Under the Stock Exclusion Regulations livestock exclusion with a three-metre setback is required on all rivers greater than one metre wide on low slope land. Applies to ~31 km of REC network.

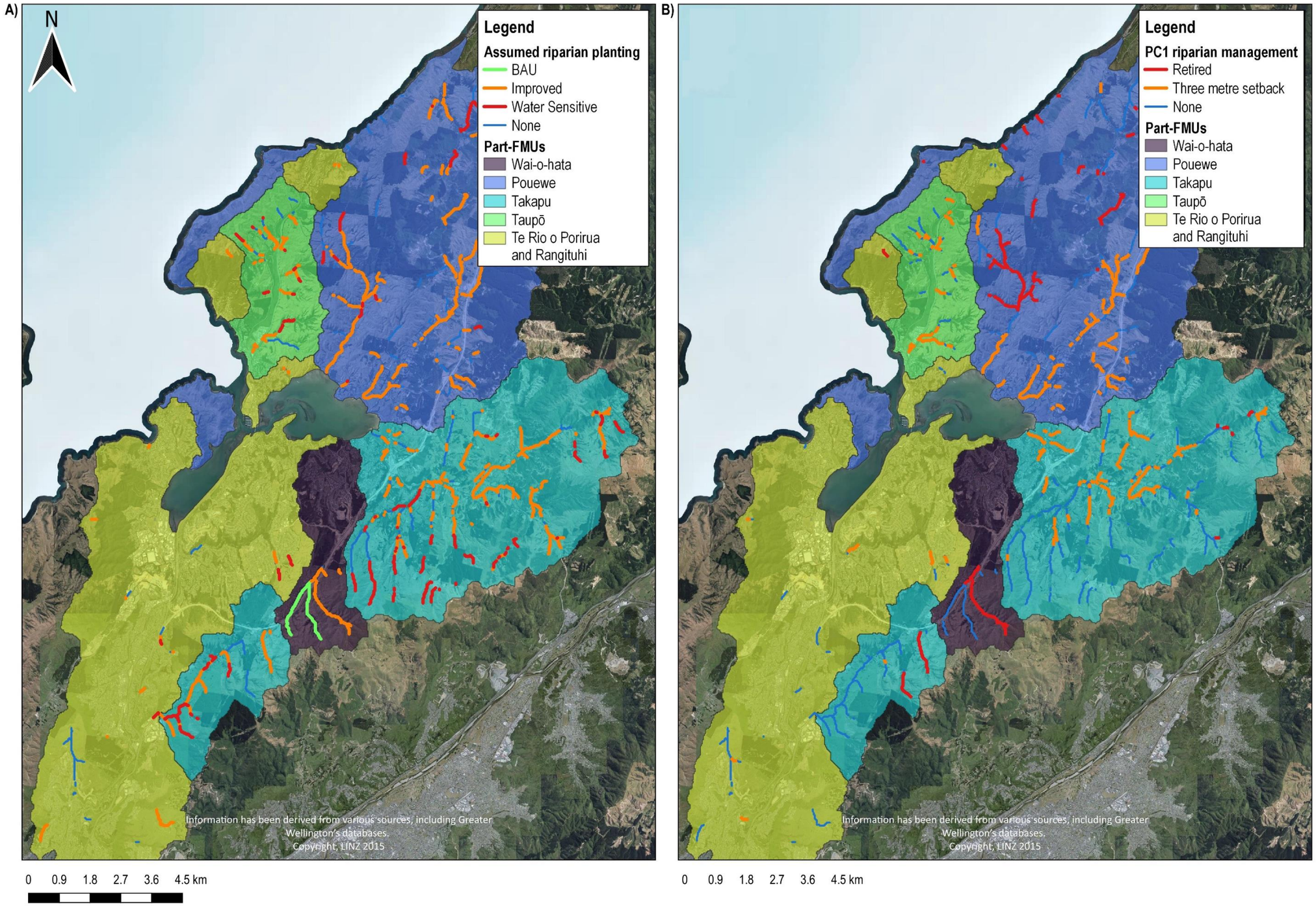


Figure 4: Riparian management assumed under the different CMP scenarios (A) and the proposed provisions (B). The CMP scenarios are additive (i.e., riparian management under the CMP BAU scenario is also assumed under Improved and Water Sensitive).

3.1.5 Earthworks

Policy P.P27 combined with the conditions of Rule P.R22 and the matters of discretion in Rule P.R23 should ensure that the *Erosion and Sediment Control Guide for Land Disturbing Activities in the Wellington Region* (the 'erosion and sediment control guidelines') (Leersnyder *et al.*, 2021) is followed across all earthworks sites. The erosion and sediment control guidelines combined with the total suspended solids (TSS) standards in Policy P.P28 should also ensure the widespread use of chemically treated sediment retention ponds at sites between 0.3 ha and 5 ha (due to the challenges of meeting the TSS standard without flocculation (ARC, 2004)). It can also be assumed that the activity status of Rule P.R24 (non-complying) will make it difficult to obtain resource consent to conduct earthworks operations that are contrary to the erosion and sediment control guidelines and the TSS standards in Policy P.P28.

All the CMP scenarios assumed compliance with the erosion and sediment control guidelines and the widespread use of well-managed chemically treated sediment retention ponds (to reduce sediment loads from earthworks sites by 90%). Consequently, the proposed earthworks provisions are consistent with the CMP Water Sensitive Scenario[18] (Table 12).

Table 12: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the CMP scenario assumptions on earthworks.

BAU	Improved	Water Sensitive
• Construction sediment control practices across 100% of construction areas. • Assumes GW Erosion and Sediment Control guidelines are followed and the widespread use of well-managed chemically treated sediment retention ponds		
BAU	Improved	Water Sensitive
		↑
		Provisions
		• Policy P.P27, Rule P.R22 and Rule P.R23 require that the erosion and sediment control guidelines are followed across all earthworks sites covered by those rules. • Policy P.P28 should ensure the widespread use of chemically treated sediment retention ponds at sites between 0.3 ha and 5 ha.

[18] Note: While Easton *et al.* (2019) assumed the CMP scenario assumptions would result in the removal of 90% of the sediment load generated by earthworks sites, there is uncertainty around the exact treatment performance of various erosion and sediment control practices. For example, Phillips *et al.*, (2020) cites studies where treated pond performance ranges between 68% and 99% and provides a general figure of 70%. However, it is outside the scope of this assessment to critically review the Easton *et al.*'s (2019) model inputs.

3.1.6 Stormwater management

The stormwater management required by the proposed provisions goes beyond that assumed under the CMP Water Sensitive scenario (Table 13).

Table 13: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the CMP scenario assumptions on stormwater management.

BAU	Improved	Water Sensitive

No storm water capture or treatment.	• Installation of rainwater tanks on 50% of new greenfield and infill dwellings and 10% of existing residential dwellings (relevant to sediment).
	• In greenfield and infill development, the treatment of:
	  ○ 40% of roads with bioretention; and
	  ○ 100% of paved and rooved surfaces with wetlands.
	• In existing urban areas, the treatment of 50% runoff from major roads and paved commercial and industrial areas with media filters.
		• Installation of rainwater tanks on 100% of new greenfield and infill dwellings and 50% of existing residential dwellings
		• In greenfield and infill development, the treatment of:
		  ○ 50% of paved surface in new greenfield dwellings and 25% of infill dwellings with permeable paving;
		  ○ 90% of roads with bioretention; and
		  ○ 100% of paved and rooved surfaces with wetlands.
		• In existing urban areas, the treatment of:
		  ○ 100% runoff from major roads with wetlands
		  ○ 100% runoff from paved industrial areas with media filters
		  ○ 100% runoff from paved commercial areas with bioretention.

BAU	Improved	Water Sensitive ↑

Provisions
• Most new infill and urban developments carried out under Rule P.R5, Rule P.R6 and Rule P.R7 (<0.3 ha of new impervious surface) required to provide hydrological controls • New infill and urban developments carried out under Rule P.R6 and Rule P.R7 generally required to treat stormwater with the equivalent of a bioretention device. • Some infill and urban developments >0.3 ha carried out under Rule P.R10 required to provide treatment and hydrological controls through consent conditions (Policy P.P10 and Policy P.P13). • Stormwater network operators required by Rule P.R8 and Schedule 31 to reduce contaminant loads from existing urban areas to meet the relevant TASs and coastal objectives for Cu and Zn (not achieved under the CMP Water Sensitive scenario).

3.1.6.1 New urban development as defined in PC1

Under the proposed provisions almost all new small (less than 0.3 ha of new impervious surface) infill and urban developments carried out as a permitted (Rule P.R5 - <0.1 ha of new impervious surface) or controlled activity (Rule P.R6 and Rule P.R7- 0.1 to 0.3 ha of new impervious surface) will be required to provide hydrological controls (most likely to be in the form of rainwater tanks). Furthermore, all new infill and urban developments carried out as a controlled activity will be required to treat stormwater with a device that achieves copper (Cu) and zinc (Zn) load reduction factors equivalent to that of a bioretention device (commonly known as a 'raingarden'). While not an absolute requirement of the proposed provisions, the wording of Policy P.P10 and Policy P.P13 means it is also likely that most infill and urban developments greater than 0.3 ha carried out as a discretionary activity (Rule P.R10) will be required by consent conditions to provide a similar level of contaminant treatment and hydrological control to that required by Rule P.R6.

Easton *et al.* (2019b) assumed raingardens achieved the contaminant load reduction factors set out in Table 14, and notes that these were "*derived from the International Stormwater Best Management Practices (BMP) database and agreed on within the TAoP MLG*". These load reduction factors are broadly consistent with that achieved through the treatment chain assumed for new developments under the CMP Water Sensitive scenario (Table 14). Thus, in terms of stormwater contaminant losses from new urban developments it can be concluded that proposed provisions are consistent with the assumptions of that scenario.

Table 14: Load reduction factors for raingardens compared to the treatment chain load reduction factors assumed for new urban developments under the CMP Improved and Water Sensitive scenarios (all values from *Easton et al.*, (2019b))

Contaminant	Raingarden load reduction factors (same as required by proposed provisions)	Treatment chain load reduction factor – Improved	Treatment chain load reduction factor – Water Sensitive
Sediment	90%	80% - 84%	75% - 89%
E. coli	90%	90%	45% - 90%
Total Nitrogen	40%	40%	40%
Total phosphorus	60%	50% - 54%	48% - 59%
Copper	80%	70% - 74%	55% - 79%
Zinc	80%	70% - 74%	55% - 79%

The hydrological control requirements for new urban developments with greater than 0.3 ha of new impervious surface area in the proposed provisions are more stringent than the assumptions of the CMP Improved scenario (50% of new dwelling have rain tanks installed). However, the proposed provisions are more lenient than that assumed under the Water Sensitive scenario (100% of new dwellings have rain tanks installed) as they do not apply to infill developments with less than 0.1 ha of new impervious surface area. Consequently, the proposed provisions should be at least as effective as the assumptions of the CMP Improved scenarios at mitigating the impacts of new urban development on bank erosion (which contributes to sediment loads).

3.1.6.2 Existing discharges from stormwater networks

Rule P.R8 and Schedule 31 ((1)(c)-(e), and (2)(b)) of the proposed provisions requires stormwater network operators to reduce their Cu and Zn loads over time to meet the relevant TASs and harbour load reduction targets (Zn = 40%; Cu = 15% (an additional 25% required through action planning)). As some of these TASs and targets were predicted not to be met under the CMP Water Sensitive scenario (Easton *et al.*, 2019b) it is likely the proposed provisions will require actions beyond those assumed under that scenario (Table 15).

Note: Stormwater treatment does not only remove Cu and Zn; it also treats the other contaminants assessed in this report (see Table 14 for the comparative impacts of stormwater treatment on different contaminants).

3.1.7 Discharges from wastewater networks

The proposed provisions go beyond the wastewater management assumptions of CMP Water Sensitive scenario (Table 15).

Table 15: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the CMP scenario assumptions on wastewater management

BAU	Improved	Water Sensitive
New urban development does not increase the frequency or volume of wastewater overflows or dry-weather wastewater discharges through cross-connections.	• All cross connections repaired resulting in a 77% reduction in *E. coli* yields where they currently occur. • Wastewater overflows reduced from 12 per year on average to four (66% reduction in load).	As for Improved but wastewater overflows reduced to two per year (83% reduction in load).
BAU	Improved	Water Sensitive
		↑
		Provisions
		Networks operators to reduce wastewater discharge volumes and loads by up to 92% (commensurate with that required to meet *E. coli* TASs and enterococci objectives (Rule P.R13).

Rule P.R13 of the proposed provisions require that for a wastewater network discharge to coastal and/or freshwater to be a restricted discretionary activity (rather than non-complying) network operators must include a strategy within their resource consent applications to progressively reduce and remove wastewater network catchment discharges (in accordance with Schedule 32) including:

"the reduction of Escherichia coli or enterococci is commensurate with what is required in the receiving environment to meet the target attribute state in Table 9.2 or coastal water objective in Table 9.1 for the relevant part FMU or coastal water management unit"

The proportional reductions in *E. coli* load needed to achieve the TASs range between 59% (Takapū) and 92% (Te Rio o Porirua and Rangituhi) depending on the part-FMU (Table 16).

Under the CMP Water Sensitive scenario:

- The repair of all cross connections between the wastewater and stormwater network was only assumed to achieve a 77% (maximum) reduction in dry weather wastewater discharge *E. coli* loads (based on yields listed in Easton *et al.* (2019b)); and
- Overflow loads were assumed to be reduced by 83% (12 overflows per year on average reduced to two).

Consequently, it can be expected that to achieve the *E. coli* and enterococci load reductions required by Rule P.R13, network operators may have to reduce wastewater discharge volumes (and associated contaminant loads) by even more than that assumed under the CMP Water Sensitive Scenario.

Table 16: Estimated *E. coli* load reduction required to meet the *E. coli* TAS in each part-FMU (based on the relationships between *E. coli* loads and concentrations under the different CMP scenarios (Easton *et al.*, 2019b)).

Part-FMU	Calculated % reduction for TAS
Pouewe	-67%
Te Rio o Porirua and Rangituhi	-92%
Wai-o-hata	-83%
Takapū	-59%
Taupō*	-88%

3.1.8 Land-use change not associated with retirement.

3.1.8.1 Urban development or rural land

All three CMP scenarios assumed greenfield, infill and rural residential development would occur within council identified development zones to accommodate population projections to 2043. While the provisions cannot ensure the land-use change assumed in the CMP scenarios goes ahead, the proposed urban development provisions prohibit new unplanned urban development (Rule P.R12). Consequently, they are broadly consistent with the CMP Water Sensitive scenario assumptions (Table 17).

3.1.8.2 Change of rural land uses

The CMP scenarios assumed that rural land use would not change from the baseline period except for conversion to urban development. The proposed provisions are consistent with this assumption (Table 17), in that any change to a higher intensity land use will generally be a non-complying activity (Rule P.R29) as the *E. coli* component of Rule P.R28 (Condition (e)) is unlikely to be met over the life of the plan (more detail provided in Section 4.1.2.2). Furthermore, the FEPs required by Rule P.R26(a) will further ensure land use intensity does not increase, by requiring the avoidance of an increase in the "*risk of loss of nitrogen, phosphorus, sediment or E.coli to water*" (Schedule Z(B)(2) of the operative NRP).

Table 17: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the CMP scenario assumptions on land-use change not associated with retirement.

BAU	Improved	Water Sensitive
• Greenfield, infill and rural residential development assumed to occur within council identified development zones to accommodate population projections to 2043. • No change in rural and land use except where it relates to urban development.		
BAU	Improved	Water Sensitive
		↑
		Provisions • Rule P.R12 prohibits unplanned urban development • Change to a higher intensity rural land-use is a non-complying activity (Rule P.R28(e) and Rule P.R29).

Note: The proposed provisions also require that highest erosion risk land currently used for plantation forestry must no longer be used for this once existing trees are harvested. However, this is not considered in this assessment as the implications on land-cover and sediment losses are unclear.

3.1.9 Practice change other than livestock exclusion, riparian planting and space planting

The proposed provisions require that land use practices improve beyond that assumed under the CMP Water Sensitive scenario (Table 18).

None of CMP scenarios assumed changes in land use practice except the livestock exclusion, riparian planting, space planting and sediment control (earthworks) described above in Sections 3.1.1 to 3.1.5 above. However, the proposed provisions require some level of good management practices for:

- Vegetation Clearance on land with high erosion risk (Rule P.R16 to Rule P.R18);
- Plantation Forestry (Rule P.R19 to Rule P.R21); and
- Farming activities on 20ha or more of land (Rule P.R26).

The impact this will have on contaminant losses cannot be quantified, but it is likely negligible compared to the required retirement, livestock exclusion and space planting.

Table 18: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the CMP scenario assumptions on practice change not associated with livestock exclusion, riparian planting and space planting.

BAU	Improved	Water Sensitive
Assumes no change in practice other than **livestock** exclusion, riparian planting, space planting and sediment control (earthworks)		
BAU	Improved	Water Sensitive
		↑
		Provisions
		Require some level of good management practices for: • Vegetation clearance on land with high erosion risk (Rule P.R16 - Rule P.R18); • Plantation Forestry (Rule P.R19 – Rule P.R21); and • Farming activities on 20ha or more of land (Rule P.R26).

3.2 Alignment between the proposed provisions and CMP scenarios by attribute group

3.2.1 Sediment

For the sediment attribute group, the proposed provisions are most consistent with what has been assumed under the CMP Improved scenario in that they require a similar or higher level of:

- Retirement;
- Sediment control on earthworks sites;
- Stormwater management; and
- Space planting of high erosion risk land;
- Land use change (excluding retirement).

However, they are still likely to result in slightly lower sediment load reductions than were modelled under that scenario as:

- The proposed provisions require 5% less retirement than the CMP Improved scenario. However, based on the treatment efficiencies cited in Phillips *et al.*, (2020)[19] this is likely to only result in 2% lower sediment load reductions[20] (Table 19); and
- The stock exclusion and riparian management required by the proposed provisions is less extensive than that assumed under the CMP Improved scenario (44%) and, on low slope land, may also be 25% less effective at reducing sediment loads (based on the load reduction factors presented for three and five metre setbacks in Semadenis-Davies *et al.*, (2020)).

[19] Treatment performance (% reduction from baseline erosion) of afforestation = 90% for landslide, gully and earthflow erosions compared to 70% for space planting.

[20] There is very high degree of uncertainty around this figure.

Table 19: Potential differences in sediment load reduction under the proposed provisions and the CMP Improved scenario based on the cited treatment performances for afforestation and space planting in Phillips *et al.*, (2020).

Sediment treatment	Treatment performance (gully, earthflow & landslide erosion)	Improved		Provisions	
		Area (ha)	Equivalent area with 100% treatment (ha)	Area (ha)	Equivalent area with 100% treatment (ha)
None	0	15,819	0	16,722	0
Space planting	0.7	2,422	1,695	2,428	1,699
Retirement	0.9	1,994	1,795	1,895	1,704
Total equivalent area with 100% treatment		**3,490**		**3,404**	
Difference between provisions and Improved scenario		**-2%**			

3.2.2 Faecal indicator bacteria

The proposed provisions are likely to impact the faecal indicator bacteria attribute group in a manner most consistent with the modelled outcomes of the CMP Improved scenario as:

- They require a similar level of retirement, and Easton *et al.* (2019b) noted that this was the main driver of the modelled improvements in *E. coli* in rural areas under that scenario;
- They require urban sources of faecal indicator bacteria to be reduced by more than that assumed under the CMP Water Sensitive scenario (see Sections 3.1.6 and 3.1.7). However, this is unlikely to result in the *E. coli* reductions beyond what was modelled under the Improved scenario given the relative contribution of rural sources (modelled instream *E. coli* concentrations generally in the E state upstream of urban influences (Easton *et al.*, 2019b)).

However, it must be noted that the proposed provisions do require significantly less extensive (44%) and effective[21] stock exclusion and riparian planting than assumed under the Improved scenario.

3.2.3 Nitrogen

The proposed provisions are most consistent with the nitrogen management assumptions of the CMP Improved scenario. The reasons for this are the same as those provided for faecal indicator bacteria in Section 3.2.2.

3.2.4 Phosphorus

For the same reasons as provided for sediment (Section 3.2.1) the proposed provisions relevant to the phosphorus attribute group are most consistent with the assumptions of the CMP Improved scenario.

[21] Potentially 15% for rivers on low slope and (Semadenis-Davies *et al.*, 2020).

3.2.5 Metals

The stormwater management required by the proposed provisions goes beyond that assumed under the CMP Water Sensitive scenario (see Section 3.1.6). Accordingly, they are likely to result in reductions in Cu and Zn concentrations equal to or greater than those modelled under that scenario.

Note: Only the stormwater management provisions are relevant to this attribute group.

3.2.6 Periphyton

Periphyton growth is driven by flow, shade and nutrient concentrations. However, based on the expert assessment for ecological attributes[6], shade was considered the primary driver of the predicted changes in this attribute under the different CMP scenarios. On that basis the proposed provisions' impact on periphyton growth is likely to be most similar to what was projected under that the BAU scenario, given the required riparian management (i.e., shading) is most consistent with the assumptions of that scenario (see Section 3.1.4).

Note: While the proposed provisions are most consistent with the assumptions of the CMP BAU scenario, they do require significantly more nutrient mitigations than assumed under that scenario (see Sections 3.2.3 and 3.2.4.).

3.2.7 Summary

Table 20 summarises the likely impact of the proposed provisions on each attribute group compared to the assumptions of the CMP scenarios.

Table 20: Summary of where the likely impacts of the proposed provisions on each attribute group sit in relation to the CMP scenarios.

Attribute group	Most applicable scenario	Indication of where provisions sit in relation to scenarios
Sediment	Improved	BAU — Improved — Water Sensitive ↑ Provisions
Faecal indicator bacteria	Improved	BAU — Improved — Water Sensitive ↑ Provisions
Nitrogen	Improved	BAU — Improved — Water Sensitive ↑ Provisions
Phosphorus	Improved	BAU — Improved — Water Sensitive ↑ Provisions
Metals	Water Sensitive	BAU — Improved — Water Sensitive ↑ Provisions
Periphyton	BAU	BAU — Improved — Water Sensitive ↑ Provisions

4 Results

4.1 Assessment of whether the proposed provisions are likely to achieve the TASs and coastal objectives for 2A type attributes

4.1.1 Maintain TASs and coastal objectives

4.1.1.1 Sediment and phosphorus attribute groups

The proposed provisions that manage sediment and phosphorus losses, are most consistent with the assumptions of the CMP Improved scenario (albeit with 45% and 35% less stock exclusion and riparian planting respectively). That scenario was modelled to result in significant reductions in sediment/phosphorus loads and improvements in suspended fine sediment (SFS; as measured by visual clarity) in all part-FMUs (Easton *et al.*, 2019b; Greer *et al.*, 2023). While the proposed provisions might not result in the same level of improvement, they will likely ensure that SFS and dissolved reactive phosphorus (DRP) concentrations are maintained in those part-FMUs where the TASs require this (Table 21 and Table 22).

Table 21: The modelled direction of change in SFS under the different CMP scenarios in the part-FMUs where the TASs require the maintenance of this attribute (based on modelled sediment loads in Easton *et al.*, (2019b). and the site specific sediment clarity relationships set out in Greer *et al.* (2023)). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for this attribute and whether they are likely to result in the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state and TAS	Scenario results			Provisions likely to achieve TAS?
				BAU	Improved	Water Sensitive	
Taupō	Taupō S. @ Plimmerton Domain	SFS	A	Degrade	Improve	Improve	✓
Pouewe	Horokiri S. @ Snodgrass		C	Improve			
Wai-o-hata	Duck Ck		A				
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot			Degrade			
					↑ Provisions		

Table 22: The modelled direction of change in DRP concentrations under the different CMP scenarios in the part-FMUs where the TASs require the maintenance of this attribute (Easton *et al.*, 2019b). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for this attribute and whether they are likely to result in the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state and TAS	Scenario results			Provisions likely to achieve TAS?
				BAU	Improved	Water Sensitive	
Taupō	Taupō S. @ Plimmerton Domain	DRP (median mg/L)	0.017	Improve	Improve	Improve	✓
Pouewe	Horokiri S. @ Snodgrass		0.011				
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.		0.018				
Takapū	Pāuatahanui S. @ Elmwood Br.		0.014				
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot		0.018				
Taupō	Taupō S. @ Plimmerton Domain	DRP (95th %ile mg/L)	0.047	Improve	Improve	Improve	
Pouewe	Horokiri S. @ Snodgrass		0.026				
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.		0.050				
Takapū	Pāuatahanui S. @ Elmwood Br.		0.022				
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot		0.034				
					↑ Provisions		

4.1.1.2 Nitrogen attribute group

Under the assigned CMP scenario (Improved), modelled dissolved inorganic nitrogen (DIN), nitrate-nitrogen (NO_3-N) and ammoniacal-nitrogen (NH_4-N) concentrations were improved in all part-FMUs where the TASs require they be maintained (Table 23) (Easton *et al.*, 2019b). Consequently, the proposed provisions will likely result in the achievement of these TASs.

Table 23: The modelled direction of change in DIN, NO_3-N, and NH_4-N concentrations under the different CMP scenarios in the part-FMUs where the TASs require the maintenance of these attributes (Easton *et al.*, 2019b). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for these attributes and whether they are likely to result in the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state and TAS	Scenario results			Provisions likely to achieve TAS?
				BAU	Improved	Water Sensitive	
Taupō	Taupō S. @ Plimmerton Domain	DIN (median mg/L)	0.41	Improve	Improve	Improve	✓
Pouewe	Horokiri S. @ Snodgrass		0.64				
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.		0.48				
Takapū	Pāuatahanui S. @ Elmwood Br.		0.33				
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot		0.92				
Pouewe	Horokiri S. @ Snodgrass	NH_4-N	A	Improve	Improve	Improve	
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.						
Takapū	Pāuatahanui S. @ Elmwood Br.						
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot						
Pouewe	Horokiri S. @ Snodgrass	NO_3-N	A	Improve	Improve	Improve	
Takapū	Pāuatahanui S. @ Elmwood Br.						
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot		A[1]				
					↑ Provisions		

[1] Baseline state is B. However, current state is A and trend analysis indicates it will remain so (GW, 2022).

4.1.1.3 Metals attribute group

The proposed provisions require that the Cu and Zn TASs be met through the actions of stormwater network operators (see Section 3.1.6). Consequently, for the purposes of this assessment it is assumed that they are sufficient to ensure the achievement of these TASs (Table 24).

Table 24: The modelled direction of change in dissolved Zn and Cn concentrations under the different CMP scenarios in the part-FMUs where the TASs require the maintenance of these attributes (Easton *et al.*, 2019b). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for these attributes and whether they are likely to result in the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state and TAS	Scenario results			Provisions likely to achieve TAS?
				BAU	Improved	Water Sensitive	
Pouewe	Horokiri S. @ Snodgrass	Cu	A	Degrade	Degrade	Degrade	✓
Takapū	Pāuatahanui S. @ Elmwood Br.		A				
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot		C		Maintain		
Pouewe	Horokiri S. @ Snodgrass	Zn	A	Degrade	Degrade	Degrade	
Takapū	Pāuatahanui S. @ Elmwood Br.						
						↑ Provisions	

4.1.2 Improve TASs and coastal objectives

4.1.2.1 Sediment attribute group

The CMP modelling outputs for the Improved scenario suggest that the proposed provisions may achieve all of the sediment TASs and coastal objectives that require an improvement from baseline state (Easton *et al.*, 2019b; Greer *et al.*, 2023) (Table 25).

It must be noted, however, that the proposed provisions require less stock exclusion and riparian management than assumed under the CMP Improved scenario and may result in slightly smaller sediment load reductions.

Table 25: Modelled SFS attribute states (rivers) and sediment load reductions (coast) under the different CMP scenarios in the rural and mixed-rural part-FMUs where the TASs or coastal objectives require an improvement in these attributes (based on modelled sediment loads in Easton *et al.*, (2019b) and the site specific sediment clarity relationships set out in Greer *et al.* (2023)). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for these attributes and whether they are likely to result in the achievement of the TASs/coastal objectives.

Part-FMU	Site	Attribute	Baseline state	TAS/ objective	Scenario results			Provisions likely to achieve TAS/ objective?
					BAU	Improved	Water Sensitive	
Takapū	Pāuatahanui S. @ Elmwood Br.	SFS	D	C	D	C	C	✓
Onepoto Arm		Sediment load Δ	5,200 t/yr.	-40%	-11%	-46%	-49%	
Pāuatahanui Inlet			8,000 t/yr.		-1%	-40%	-46%	
						↑ Provisions		

4.1.2.2 *Faecal indicator bacteria attribute group*

E. coli and enterococci modelling by Easton *et al.*(2019b) and Oldman (2019) for the CMP Improved scenario indicates that the proposed provisions are unlikely to be sufficient to achieve any of the relevant TASs and coastal objectives (Table 26).

That many of the *E. coli* TASs and enterococci coastal objectives were not predicted to be met under the CMP Water Sensitive scenario suggests that their achievement may require the implementation of non-regulatory actions beyond those assumed under that scenario (Table 26); i.e:

- Excluding stock and planting all second order and above streams on low slope pastural land; and
- Retiring all high erosion risk land.

Table 26: Modelled *E. coli* attribute states (rivers) and enterococci concentrations (coast) under the different CMP scenarios in the rural and mixed-rural part-FMUs where the TASs or coastal objectives require an improvement in these attributes (Easton *et al.*, 2019b; Oldman, 2019). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for these attributes and whether they are likely to result in the achievement of the TASs/coastal objectives.

<table>
<tr><th rowspan="2">Part-FMU</th><th rowspan="2">Site</th><th rowspan="2">Attribute</th><th rowspan="2">Baseline state</th><th rowspan="2">TAS</th><th colspan="3">Scenario results</th><th rowspan="2">Provisions likely to achieve TAS/ objective?</th></tr>
<tr><th>BAU</th><th>Improved</th><th>Water Sensitive</th></tr>
<tr><td>Taupō</td><td>Taupō S. @ Plimmerton Domain</td><td rowspan="6">E. coli</td><td>E[1]</td><td>B</td><td>E</td><td>D</td><td>C</td><td rowspan="8">×</td></tr>
<tr><td>Pouewe</td><td>Horokiri S. @ Snodgrass</td><td rowspan="5">E</td><td>B</td><td>D</td><td>C</td><td>B</td></tr>
<tr><td>Wai-o-hata</td><td>Duck Ck @ Tradewinds Dr. Br.</td><td rowspan="3">C</td><td>E</td><td rowspan="2">D</td><td>D</td></tr>
<tr><td>Takapū</td><td>Pāuatahanui S. @ Elmwood Br.</td><td>D</td><td>C</td></tr>
<tr><td>Te Rio o Porirua and Rangituhi</td><td>Porirua S. @ Milk Depot</td><td>E</td><td>E</td><td>D</td></tr>
<tr><td colspan="2">Onepoto Arm</td><td rowspan="2">Enterococci (95th %ile /100mL)</td><td rowspan="2">>500</td><td>≤500</td><td rowspan="2">>500</td><td rowspan="2">N/A</td><td>>500</td></tr>
<tr><td colspan="2">Pāuatahanui Inlet</td><td>≤200</td><td>>200 - ≤500</td></tr>
<tr><td colspan="5"></td><td colspan="3">↑
Provisions</td><td></td></tr>
</table>

[1] Modelled as D in Easton *et al.*, (2019b).

4.1.2.3 *Nitrogen attribute group*

Modelling by Easton *et al.* (2019b) suggests that the assumptions of the CMP Improved scenario and, therefore, the proposed provisions are likely sufficient to achieve almost all of the TASs for the nitrogen attribute group that represent an improvement from baseline state. The exception is the NO_3-N TAS for the Taupō part-FMU (Table 27). That TAS was only modelled as being met under the Water Sensitive scenario (Table 27). Thus, it may not be achieved without additional non-regulatory actions equivalent to those assumed under that scenario; i.e.:

- Excluding stock and planting all second order and above streams on low slope pastural land; and
- Retiring all high erosion risk land.

Table 27: Modelled NH_4-N and NO_3-N attribute states under the different CMP scenarios in the part-FMUs where the TASs require an improvement in these attributes (Easton *et al.*, 2019b). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for these attributes and whether they are likely to result in the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state	TAS	Scenario results			Provisions likely to achieve TAS?
					BAU	Improved	Water Sensitive	
Taupō	Taupō S. @ Plimmerton Domain	NH_4-N	B	A	A	A	A	✓
		NO_3-N	B	A	B	B	A	×
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.				A	A		✓
						↑ Provisions		

4.1.2.4 *Phosphorus attribute group*

None of the TASs for DRP require an improvement in this attribute.

4.1.2.5 *Metals attribute group*

The proposed provisions require that the Cu and Zn TASs in Table 2 be met through the actions of stormwater network operators (via loads; see Section 3.1.6). Consequently, it is simply assumed that the provisions are sufficient to ensure that these TASs are achieved, even in those part-FMUs where the modelling by Easton *et al.* (2019b) suggests it will require actions beyond the assumptions of the CMP Water Sensitive Scenario (Table 28).

Table 28: Modelled Cu and Zn attribute states (rivers) and load reductions (coast) under the different CMP scenarios in the part-FMUs where the TASs or coastal objectives require an improvement in these attributes (Easton *et al.*, 2019b). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for these attributes and whether they are likely to result in the achievement of the TASs/coastal objectives.

Part-FMU	Site	Attribute	Baseline state	TAS/ objective	Scenario results			Provisions likely to achieve TAS/ objective?
					BAU	Improved	Water Sensitive	
Taupō	Taupō S. @ Plimmerton Domain	Cu	D	B	C	C	C	✓
Wai-o-hata	Duck Ck		C	A				
Onepoto Arm		Cu load Δ	240 kg/yr.	-15%	+6%	-7%	-20%	
Pāuatahanui Inlet			70 kg/yr.		+33%	+9%	-18%	
Taupō	Taupō S. @ Plimmerton Domain	Zn	C	A	C	B	A	
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.		B		B			
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot		D[1]	C	C	C	C	
Onepoto Arm		Zn load Δ	2,650 kg/yr.	-40%	+1%	-30%	-60%	
Pāuatahanui Inlet			580 kg/yr.		+17%	-14%	-46%	
							↑ Provisions	

[1] Modelled as C in Easton *et al.*, (2019b).

4.1.2.6 Periphyton

The expert assessment for ecological attributes[6] indicate that assumptions of the CMP scenario most consistent with the proposed provisions (BAU) are unlikely to achieve the periphyton TASs in the part-FMUs where improvements in this attribute are required (Table 29). This is, however, not unexpected as (non-regulatory) riparian planting is the primary mechanism by which GW intends to reduce periphyton biomass[22]. It is also uncertain whether the TASs for the Wai-o-hata, Takapū, Te Rio o Porirua and Rangituhi part-FMUs actually require an improvement in this attribute as relevant biomass data do not exist.

[22] This is accounted for in the nutrient outcomes set out in Greer *et al.* (2023) and is possible (i.e., there is currently limited shading) at TAS sites in the Pouewe, Wai-o-hata, Takapū, Te Rio o Porirua and Rangituhi part-FMUs (based on a shading assessment conducted by GW).

Table 29: Predicted periphyton biomass attribute states under the different CMP scenarios in the part-FMUs where the TASs require an improvement in this attribute (based on the expert assessment for ecological attributes[6]). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for this attribute and whether they are likely to result in the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state	TAS	Scenario results			Provisions likely to achieve TAS?
					BAU	Improved	Water Sensitive	
Pouewe	Horokiri S. @ Snodgrass	Periphyton biomass	D[1]	B	C	B	B	×
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.		N/A[2]			C	C	?
Takapū	Pāuatahanui S. @ Elmwood Br.					B	B	
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot				B			
					↑ Provisions			

[1] Baseline state based on limited data.
[2] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or be maintained at a better state.

4.2 Assessment of the proposed provisions against the TASs and coastal objectives for 2B type attributes

4.2.1 Maintain TAS and coastal objectives

4.2.1.1 Deposited sediment

Based on the modelling outputs for the CMP Improved Scenario ((Easton *et al.*, 2019b)), the proposed provisions are expected to reduce sediment loads in all part-FMUs and, consequently, should not increase deposited fine sediment (DFS) in those part-FMUs where the TASs require this attribute be maintained (Table 30). Similarly, the provisions should be sufficient to achieve the maintenance of coastal objectives for 'muddiness' (Table 30), given that this was the predicted result of the BAU scenario (Miller and King, 2018c; Oldman, 2019).

Table 30: The predicted direction of change in DFS and muddiness under the different CMP scenarios in the part-FMUs where the TASs or coastal objectives require the maintenance of these attributes. The direction of change in DFS under the scenarios mirrors the predicted change in modelled sediment loads in Easton *et al.*, (2019b). Muddiness results are drawn from Miller and King (2018c) (% area >50% mud) and Oldman (2019) (% of sample). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for these attributes and whether they are consistent with the achievement of the TASs/coastal objectives.

Part-FMU	Site	Attribute	Baseline state and TAS/objective	Scenarios results			Provisions consistent with TAS/ objective?
				BAU	Improved	Water Sensitive	
Pouewe	Horokiri S. @ Snodgrass	DFS	A	Improve	Improve	Improve	✓
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.		N/A[1]	Improve			
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot		C	Degrade			
Onepoto Arm	Intertidal	Muddiness (% area >50% mud)	Maintain or improve	Maintain	Maintain	Maintain	
Pāuatahanui Inlet					Improve	Improve	
Onepoto Arm		Muddiness (% of sample)		Improve	Not modelled	Improve	
Pāuatahanui Inlet				Maintain			
					↑ Provisions		

[1] Baseline state unknown. TAS is simply to maintain.

4.2.1.2 Macroalgae

Miller and King (2018c) note that the coastal macroalgae ecological quality rating (EQR) attribute is a proxy for nutrient enrichment. On that basis, it is likely that the proposed provisions will, at a minimum, achieve the coastal objectives that require the maintenance of this attribute given that was the predicted outcome of CMP scenario assigned to the nitrogen and phosphorus attribute groups (Improved – see Sections 3.2.3 and 3.2.4) (Table 31).

Table 31: The predicted direction of change in EQR under the different CMP scenarios in the part-FMUs where the coastal objectives require the maintenance of this attribute (Miller and King (2018c)). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for this attribute and whether they are likely to result in the achievement of the coastal objectives.

Part-FMU	Site	Attribute	Baseline state and objective	Scenarios result			Provisions likely to achieve objective?
				BAU	Improved	Water Sensitive	
Onepoto Arm	Intertidal	EQR	Maintain or improve	Maintain	Maintain	Improve	✓
Pāuatahanui Inlet	Intertidal						
					↑ Provisions		

4.2.1.3 *Dissolved oxygen*

Dissolved oxygen (DO) was not explicitly assessed in the expert assessment for ecological attributes[6]. However, given that primary production is major driver of DO in streams (He *et al.*, 2011) it can be assumed that the direction, but not the magnitude, of change in this attribute under the proposed provisions will not be dissimilar to that predicted for periphyton under the CMP BAU scenario (see Section 3.2.6). On that basis it is likely that they will maintain DO in all part-FMUs where that is required by the TASs (Table 32).

Table 32: The predicted direction of change in DO concentrations under the different CMP scenarios in the part-FMUs where the TASs require the maintenance of this attribute (based on the periphyton assessments in the expert assessment for ecological attributes[6]). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for this attribute and whether they are likely to result in the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state and TAS	Scenario results			Provisions likely to achieve TAS?
				BAU	Improved	Water Sensitive	
Taupō	Taupō S. @ Plimmerton Domain	DO	N/A[1]	Maintain	Maintain	Maintain	✓
Pouewe	Horokiri S. @ Snodgrass						
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.						
Takapū	Pāuatahanui S. @ Elmwood Br.						
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot						
				↑ Provisions			

[1] Baseline state unknown. TAS is simply to maintain.

4.2.1.4 *Fish and macroinvertebrates*

The impacts of the proposed provisions on fish and macroinvertebrate communities are likely to be most consistent with those predicted under CMP Improved scenario given they are expected to achieve similar or better outcomes for the sediment and metal attribute groups (both oft cited as important stressors in the expert assessment for ecological attributes[6]). However, it must be noted that the proposed provisions may not result in as large an improvement as predicted under the Improved scenario given they do not require as much stock exclusion and riparian planting (see Sections 3.1.3 and 3.1.4).

A change in the fish index of biotic integrity (F-IBI) requires the introduction or extirpation of one or more species. Accordingly, it is unlikely that the state of the F-IBI attribute would change in response to the assumptions of any of the CMP scenarios (Table 33). While this is not supported by any TAoP CMP outputs (as F-IBI was not assessed), it is consistent with the results of the WTWT Biophysical Science Programme (BSP) scenario testing process (Greer *et al.*, 2022). Consequently, the proposed provisions are likely to result in the achievement of the F-IBI TASs for all part-FMUs . Furthermore, the expert assessment for ecological attributes[6] indicates that the proposed provisions will likely achieve those TASs that require the maintenance of the macroinvertebrate average score per metric (ASPM) (Table 34).

Table 33: The likely direction of change in F-IBI under the different CMP scenarios in the part-FMUs where the TASs require the maintenance of this attribute. This attribute was not tested as part of the CMP scenario modelling, and the results below are based on expert opinion supported by the results of the WTWT scenario testing process. The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for this attribute and whether they are likely to result in the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state and TAS	Scenario results			Provisions likely to achieve TAS?
				BAU	Improved	Water Sensitive	
Taupō	Taupō S. @ Plimmerton Domain	F-IBI	N/A[1]	Maintain			✓
Pouewe	Horokiri S. @ Snodgrass						
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.						
Takapū	Pāuatahanui S. @ Elmwood Br.						
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot						
					↑ Provisions		

[1] Baseline state unknown. TAS is simply to maintain.

Table 34: The predicted direction of change in ASPM under the different CMP scenarios in the part-FMUs where the TASs require the maintenance of this attribute (based on the MCI assessments in the expert assessment for ecological attributes[6]). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for this attribute and whether they are likely to result in the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state and TAS	Scenario results			Provisions likely to achieve TAS?
				BAU	Improved	Water Sensitive	
Pouewe	Horokiri S. @ Snodgrass	ASPM	A	Improve	Improve	Improve	✓
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot		C[1]	Maintain			
					↑ Provisions		

[1] Baseline state is D. However, current state is C and trend analysis for Q/MCI indicates it will remain so (GW, 2022).

4.2.2 Improve TASs and coastal objectives

4.2.2.1 Deposited sediment

Based on the modelling by Easton *et al.*, (2019b), the proposed provisions will likely reduce sediment loads throughout TAoP Whaitua, and this may contribute to the improvement in DFS required by the TASs for the Takapū part-FMU (Table 35). However, as DFS was not assessed as part of the CMP it not possible to determine whether the proposed provisions will be sufficient to ensure the achievement of this TASs on their own.

Table 35: The predicted direction of change in DFS under the different CMP scenarios in the part-FMUs where the TASs require an improvement in this attribute (based on modelled sediment loads in Easton *et al.*, (2019b)). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for this attribute and whether they are consistent with the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state	TAS	Scenario results			Provisions consistent with TAS?
					BAU	Improved	Water Sensitive	
Takapū	Pāuatahanui S. @ Elmwood Br.	DFS	D	C	Degrade	Improve	Improve	✓
						↑ Provisions		

4.2.2.2 Fish and macroinvertebrates

Based on the CMP Improved scenario results provided in the expert assessment for ecological attributes[6] the proposed provisions will likely contribute to the achievement of the fish community health, Q/MCI[23] and ASPM TASs in all part-FMUs where those attributes are required to improve, except in the Wai-o-hata part-FMU were they may only maintain fish community health (Table 36 and Table 37)

Table 36: The predicted direction of change in fish community health under the different CMP scenarios in the part-FMUs where the TASs require an improvement in this attribute (based on the expert assessment for ecological attributes[6]). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for this attribute and whether they are consistent with the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state	TAS	Scenario results			Provisions consistent with TAS?
					BAU	Improved	Water Sensitive	
Taupō	Taupō S. @ Plimmerton Domain	Fish community health	N/A[1]	B	Maintain	Improve	Improve	✓
Pouewe	Horokiri S. @ Snodgrass			A				
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.			B		Maintain		×
Takapū	Pāuatahanui S. @ Elmwood Br.					Improve	Improve	✓
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot			C				
						↑ Provisions		

[1] Baseline state unknown. Assumed that the TAS represents an improvement based on part-FMU default TAS.

[23] Macroinvertebrate community index score and quantitative macroinvertebrate community index score.

Table 37: The predicted direction of change in Q/MCI and ASPM under the different CMP scenarios in the part-FMUs where the TASs require an improvement in these attributes (based on the expert assessment for ecological attributes[6]). The bottom row and right hand column provide an indication of where the proposed provisions sit in relation to the scenarios for this attribute and whether they are consistent with the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state	TAS	Scenario results			Provisions consistent with TAS?
					BAU	Improved	Water Sensitive	
Taupō	Taupō S. @ Plimmerton Domain	Q/MCI	N/A[1]	B	Maintain	Improve	Improve	✓
Pouewe	Horokiri S. @ Snodgrass		B	A	Improve			
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.		N/A[1]	B	Maintain			
Takapū	Pāuatahanui S. @ Elmwood Br.		D					
Te Rio o Porirua and Rangituhi	Porirua S. @ Milk Depot			C				
Taupō	Taupō S. @ Plimmerton Domain	ASPM	N/A[1]	B	Maintain	Improve	Improve	
Wai-o-hata	Duck Ck @ Tradewinds Dr. Br.							
						↑ Provisions		

[1] Baseline state unknown. Assumed that the TAS represents an improvement based on part-FMU default TAS.

5 Conclusions

The results of this assessment suggest that the proposed provisions of PC1 require outcomes and actions that are likely to achieve most (~90%) of the TAoP TASs and coastal objectives. However, there are several that are unlikely to be met through the proposed provisions alone. In most cases, the 'gap' between the outcome of the proposed provisions and the TAS/coastal objective can be filled through non-regulatory actions like those assumed under the middle of the road CMP (Improved) scenario (e.g., excluding stock and planting five metre riparian buffers on all second order streams on low slope pastoral land).

Nonetheless, a small number of TAS and coastal objectives may not be met unless action planning includes greater non-regulatory actions than those described above, such as as the retirement of all high erosion risk land (as defined in PC1) or even mitigations that go beyond the assumptions of the most aspirational (Water Sensitive) CMP scenario (Table 38).

Table 38: Description of the TAS and coastal objectives that will either not be met through the provisions alone (2A type attributes) or require an improvement where the proposed provisions are not expected to result in one (2B type attributes). The non-regulatory actions that could potentially fill these 'gaps' are also identified from the CMP scenario assumptions.

Part-FMU	Attribute	Attribute type	Possible non-regulatory actions to plug 'gap' between provisions and TAS/objective
Pouewe	Periphyton biomass		Planting of riparian buffers on all second order and above streams on low slope pastoral land.
Taupō	NO_3-N		• Planting of riparian buffers on all second order and above streams on low slope pastoral land.; and • Retirement of all high erosion risk land.
Pouewe	*E. coli*		
Takapū			
Wai-o-hata			• Everything above; and • Additional mitigations not considered in CMP scenarios or land-use change.
Te Rio o Porirua and Rangituhi			
Onepoto Arm	Enterococci		
Pāuatahanui Inlet			
Wai-o-hata	Fish community health	2B	• Planting of riparian buffers on all second order and above streams on low slope pastoral land • Retirement of all high erosion risk land and highest erosion risk land.

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Appendices

Appendix A – Attribute state tables

Table 1: Attribute states for dissolved copper (toxicity) developed by GW.

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	**Dissolved Copper (Toxicity)**		
Attribute Unit	µg DCu/L (micrograms of dissolved Copper per litre)		
Attribute State	**Numeric Attribute State**		**Narrative Attribute State**
	Median*	**95th percentile**	
A	≤1	≤1.4	99% species protection level: No observed effect on any species tested
B	>1 and ≤1.4	>1.4 and ≤1.8	95% species protection level: Starts impacting occasionally on the 5% most sensitive species
C	>1.4 and ≤2.5	>1.8 and ≤4.3	80% species protection level: Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species)
D	>2.5	>4.3	Starts approaching acute impact level (i.e., risk of death) for sensitive species

Table 2: Attribute states for dissolved zinc (toxicity) developed by GW.

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	**Dissolved Zinc (Toxicity)**		
Attribute Unit	µg DZn/L (micrograms of dissolved Zinc per litre)		
Attribute State	**Numeric Attribute State**		**Narrative Attribute State**
	Median*	**95th percentile**	
A	≤2.4	≤8	99% species protection level: No observed effect on any species tested
B	>2.4 and ≤8	>8 and ≤15	95% species protection level: Starts impacting occasionally on the 5% most sensitive species
C	>8 and ≤31	>15 and ≤42	80% species protection level: Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species)
D	>31	>42	Starts approaching acute impact level (i.e., risk of death) for sensitive species

Values for this metal should be expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a standard hardness for ANZG 2018 guidelines of 30 mg CaCO3/L. Criteria values for other hardness may be calculated as per the equation presented in the ANZG 2018 guidelines.

Table 3: Attribute states for ammonia (toxicity) taken from Appendix 2A of the NPS-FM 2020.

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	**Ammonia (Toxicity)**		
Attribute Unit	mg NH_4-N/L (milligrams ammoniacal-nitrogen per litre)		
Attribute State	**Numeric Attribute State**		**Narrative Attribute State**
	Annual Median	**Annual 95th percentile**	
A	≤0.03	≤0.05	99% species protection level. No observed effect on any species.
B	>0.03 and ≤0.24	>0.05 and ≤0.40	95% species protection level. Starts impacting occasionally on the 5% most sensitive species.
National Bottom Line	**0.24**	**0.4**	
C	>0.24 and ≤1.30	>0.40 and ≤2.020	80% species protection level. Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species).
D	>1.30	>2.20	Starts approaching acute impact level (i.e., risk of death) for sensitive species.

Numeric attribute state is based on pH 8 and temperature of 20°C. Compliance with the numeric attribute states should be undertaken after pH adjustment.

Table 4: Attribute states for nitrate (toxicity) taken from Appendix 2A of the NPS-FM 2020.

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	**Nitrate (Toxicity)**		
Attribute Unit	mg NO_3-N/L (milligrams nitrate-nitrogen per litre)		
Attribute State	**Numeric Attribute State**		**Narrative Attribute State**
	Annual Median	**Annual 95th Percentile**	
A	≤1.0	≤1.5	High conservation value system. Unlikely to be effects even on sensitive species.
B	>1.0 and ≤2.4	>1.5 and ≤3.5	Some growth effect on up to 5% of species.
National Bottom Line	**2.4**	**3.5**	
C	>2.4 and ≤6.9	>3.5 and ≤9.8	Growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects.
D	>6.9	>9.8	Impacts on growth of multiple species, and starts approaching acute impact level (i.e., risk of death) for sensitive species at higher concentrations (> 20 mg/l).

Note: This attribute measures the toxic effect of nitrate, not the trophic state. Where other attributes measure trophic state, for example periphyton, freshwater objectives, limits and/or methods for those attributes will be more stringent.

Table 5: Attribute states for suspended fine sediment (visual clarity) taken from Appendix 2A of the NPS-FM 2020.

Value	Ecosystem health				
Freshwater Body Type	Rivers				
Attribute	**Suspended fine sediment**				
Attribute Unit	Visual clarity (metres)				
Attribute State	**Numeric Attribute state by suspended sediment class**				**Narrative Attribute State**
	Median				
	1	**2**	**3**	**4**	
A	≥1.78	≥0.93	≥2.95	≥1.38	Minimal impact of suspended sediment on instream biota. Ecological communities are similar to those observed in natural reference conditions.
B	<1.78 and ≥1.55	<0.93 and ≥0.76	<2.95 and ≥2.57	<1.38 and ≥1.17	Low to moderate impact of suspended sediment on instream biota. Abundance of sensitive fish species may be reduced.
C	<1.55 and >1.34	<0.76 and >0.61	<2.57 and >2.22	<1.17 and >0.98	Moderate to high impact of suspended sediment on instream biota. Sensitive fish species may be lost
National Bottom Line	**1.34**	**0.61**	**2.22**	**0.98**	
D	<1.34	<0.61	<2.22	<0.98	High impact of suspended sediment on instream biota. Ecological communities are significantly altered, and sensitive fish and macroinvertebrate species are lost or at high risk of being lost.

Based on a monthly monitoring regime where sites are visited on a regular basis regardless of weather and flow conditions. Record length for grading a site based on 5 years.

Councils may monitor turbidity and convert the measures to visual clarity.

See Appendix 2C Tables 23 and 26 for the definition of suspended sediment classes and their composition.

The following are examples of naturally occurring processes relevant for suspended sediment:

- naturally highly coloured brown-water streams
- glacial flour affected streams and rivers
- selected lake-fed REC classes (particularly warm climate classes) where low visual clarity may reflect autochthonous phytoplankton production

Table 6: Attribute states for *E. coli* taken from Appendix 2A of the NPS-FM 2020.

Value	Human health for recreation				
Freshwater Body Type	Lakes and rivers				
Attribute	***E. coli***				
Attribute Unit	*E. coli* / 100ml (number of *E. coli* per hundred millilitres)				
Attribute State	**Numeric Attribute State**				**Narrative Attribute State**
	% exceedances over 540 cfu/100ml	**% exceedances over 260 cfu/100ml**	**Median concentration (cfu/100ml)**	**95th percentile of *E. coli* /100ml**	**Description of risk of *Campylobacter* infection (based on *E. coli* indicator)**
A (blue)	<5%	<20%	<130	<540	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk). The predicted average infection risk is 1% .
B (green)	5-10%	20-30%	<130	<1000	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk). The predicted average infection risk is 2%.
C (yellow)	10-20%	20-34%	<130	<1200	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk). The predicted average infection risk is 3% *.
D (orange)	20-30%	>34%	>130	>1200	20-30% of the time the estimated risk is >50 in 1000 (>5% risk). The predicted average infection risk is >3%.
E (red)	>30%	>50%	>260	>1200	For more than 30% of the time the estimated risk is >50 in 1000 (>5% risk). The predicted average infection risk is >7%.

Based on a monthly monitoring regime where sites are visited on a regular basis regardless of weather and flow conditions. Record length for grading a site based on 5 years.

Table 7: Attribute states for periphyton (trophic state) taken from Appendix 2A of the NPS-FM 2020.

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	**Periphyton (Trophic state)**		
Attribute Unit	mg chl-a/m^2 (milligrams chlorophyll-a per square metre)		
Attribute State	**Numeric Attribute State (Default Class)**	**Numeric Attribute State (Productive Class[1])**	**Narrative Attribute State**
	Exceeded no more than 8% of samples[2]	**Exceeded no more than 17% of samples[2]**	
A	≤50	≤50	Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat
B	>50 and ≤120	>50 and ≤120	Occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat
C	>120 and ≤200	>120 and ≤200	Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or alteration of the natural flow regime or habitat
National Bottom Line	**200**	**200**	
D	>200	>200	Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat

At low risk sites monitoring may be conducted using visual estimates of periphyton cover. Should monitoring based on visual cover estimates indicate that a site is approaching the relevant periphyton abundance threshold, monitoring should then be upgraded to include measurement of chlorophyll-a.

Classes are streams and rivers defined according to types in the River Environment Classification (REC). The Productive periphyton class is defined by the combination of REC "Dry" Climate categories (that is, Warm-Dry (WD) and Cool-Dry (CD)) and REC Geology categories that have naturally high levels of nutrient enrichment due to their catchment geology (that is, Soft-Sedimentary (SS), Volcanic Acidic (VA) and Volcanic Basic (VB)). Therefore, the productive category is defined by the following REC defined types: WD/SS, WD/VB, WD/VA, CD/SS, CD/VB, CD/VA. The Default class includes all REC types not in the Productive class.

Based on a monthly monitoring regime. The minimum record length for grading a site based on periphyton (chlorophyll-a) is 3 years.

Table 8: Attribute states for the Fish index of Biotic Integrity taken from Appendix 2B of the NPS-FM 2020.

Value	Ecosystem health	
Freshwater Body Type	Rivers	
Attribute	**Fish (rivers)**	
Attribute Unit	Fish Index of Biotic Integrity (F-IBI)	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
A	≥34	High integrity of fish community. Habitat and migratory access have minimal degradation.
B	<34 and ≥28	Moderate integrity of fish community. Habitat and/or migratory access are reduced and show some signs of stress.
C	<28 and ≥18	Low integrity of fish community. Habitat and/or migratory access is considerably impairing and stressing the community
D	<18	Severe loss of fish community integrity. There is substantial loss of habitat and/or migratory access, causing a high level of stress on the community.

Sampling is to occur at least annually between December and April (inclusive) following the protocols for at least one of the backpack electrofishing method, spotlighting method, or trapping method in Joy M, David B, and Lake M. 2013. New Zealand Freshwater Fish Sampling Protocols (Part 1): Wadeable rivers and streams. Massey University: Palmerston North, New Zealand. (See clause 1.8)

The F-IBI score is to be calculated using the general method defined by Joy, MK, and Death RG. 2004. Application of the Index of Biotic Integrity Methodology to New Zealand Freshwater Fish Communities. Environmental Management, 34(3), 415-428 (see clause 1.8).

Table 9: Attribute states for the Macroinvertebrate Community Index score and Quantitative Macroinvertebrate Community Index score taken from Appendix 2B of the NPS-FM 2020.

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	**Macroinvertebrates (1 of 2)**		
Attribute Unit	Macroinvertebrate Community Index (MCI) score and Quantitative Macroinvertebrate Community Index (QMCI) score		
Attribute State	**Numeric Attribute State**		**Narrative Attribute State**
	QMCI	**MCI**	
A	≥6.5	≥130	Macroinvertebrate community, indicative of pristine conditions with almost no organic pollution or nutrient enrichment
B	≥5.5 and <6.5	≥110 and <130	Macroinvertebrate community indicative of mild organic pollution or nutrient enrichment. Largely composed of taxa sensitive to organic pollution/nutrient enrichment.
C	≥4.5 and <5.5	≥90 and <110	Macroinvertebrate community indicative of moderate organic pollution or nutrient enrichment. There is a mix of taxa sensitive and insensitive to organic pollution/nutrient enrichment.
National Bottom Line	**4.5**	**90**	
D	<4.5	<90	Macroinvertebrate community indicative of severe organic pollution or nutrient enrichment. Communities are largely composed of taxa insensitive to inorganic pollution/nutrient enrichment.

MCI and QMCI scores to be determined using annual samples taken between 1 November and 30 April with either fixed counts with at least 200 individuals, or full counts, and with current state calculated as the five-year median score. All sites for which the deposited sediment attribute does not apply, whether because they are in river environment classes shown in Table 25 in Appendix 2C or because they require alternate habitat monitoring under clause 3.25 are to use soft sediment sensitivity scores and taxonomic resolution as defined in table A1.1 in Clapcott *et al.* 2017 Macroinvertebrate metrics for the National Policy Statement for Freshwater Management. Cawthron Institute: Nelson, New Zealand (see clause 1.8).

MCI and QMCI to be assessed using the method defined in Stark JD, and Maxted, JR. 2007 A user guide for the Macroinvertebrate Community Index. Cawthron Institute: Nelson, New Zealand (See Clause 1.8), except for sites for which the deposited sediment attribute does not apply, which require use of the soft-sediment sensitivity scores and taxonomic resolution defined in table A1.1 in Clapcott *et al.* 2017 Macroinvertebrate metrics for the National Policy Statement for Freshwater Management. Cawthron Institute: Nelson, New Zealand (see clause 1.8).

Table 10: Attribute states for the Macroinvertebrate Average Score Per Metric taken from Appendix 2B of the NPS-FM 2020.

Value	Ecosystem health	
Freshwater Body Type	Rivers	
Attribute	**Macroinvertebrates (2 of 2)**	
Attribute Unit	Macroinvertebrate Average Score Per Metric (ASPM)	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
A	≥0.6	Macroinvertebrate communities have high ecological integrity, similar to that expected in reference conditions.
B	<0.6 and ≥0.4	Macroinvertebrate communities have mild-to-moderate loss of ecological integrity.
C	<0.4 and ≥0.3	Macroinvertebrate communities have moderate-to severe loss of ecological integrity.
National Bottom Line	**0.3**	
D	<0.3	Macroinvertebrate communities have severe loss of ecological integrity.

Sampling is to occur at least annually between December and April (inclusive) following the protocols for at least one of the backpack electrofishing method, spotlighting method, or trapping method in Joy M, David B, and Lake M. 2013. New Zealand Freshwater Fish Sampling Protocols (Part 1): Wadeable rivers and streams. Massey University: Palmerston North, New Zealand. (see clause 1.8)

The F-IBI score is to be calculated using the general method defined by Joy, MK, and Death RG. 2004. Application of the Index of Biotic Integrity Methodology to New Zealand Freshwater Fish Communities. Environmental Management, 34(3), 415-428. (see clause 1.8)

Table 11: Attribute states for dissolved reactive phosphorus taken from Appendix 2B of the NPS-FM 2020.

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	**Dissolved reactive phosphorus**		
Attribute Unit	mg DRP/L (milligrams dissolved inorganic nitrogen per litre)		
Attribute State	**Numeric Attribute State**		**Narrative Attribute State**
	Median*	**95th percentile**	
A	≤0.006	≤0.021	Ecological communities and ecosystem processes are similar to those of natural reference conditions. No adverse effects attributable to DRP enrichment are expected.
B	>0.006 and ≤0.010	>0.021 and ≤0.030	Ecological communities are slightly impacted by minor DRP 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.
C	>0.010 and ≤0.018	>0.030 and ≤0.054	Ecological communities are impacted by moderate DRP elevation above natural reference conditions, but sensitive species are not experiencing nitrate toxicity. If other conditions also favour eutrophication, DRP enrichment may cause increased algal and plant growth, loss of sensitive macroinvertebrate & fish taxa, and high rates of respiration and decay.
D	>0.018	>0.054	Ecological communities impacted by substantial DRP elevation above natural reference conditions. In combination with other conditions favouring eutrophication, DIN enrichment drives excessive primary production and significant changes in macroinvertebrate and fish communities, as taxa sensitive to hypoxia are lost

Numeric attribute state must be derived from the rolling median of monthly monitoring over five years.

Table 12: Attribute states for dissolved oxygen taken from Appendix 2B of the NPS-FM 2020.

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	**Dissolved oxygen**		
Attribute Unit	mg/L (milligrams per litre)		
Attribute State	**Numeric Attribute State**		**Narrative Attribute State**
	7-day mean minimum	**1-day minimum**	
A	≥8.0	≥7.5	No stress caused by low dissolved oxygen on any aquatic organisms that are present at matched reference (near pristine) sites.
B	≥7.0 and <8.0	≥5.0 and <7.5	Occasional minor stress on sensitive organisms caused by short periods (a few hours each day) of lower dissolved oxygen. Risk of reduced abundance of sensitive fish and macroinvertebrate species.
C	≥5.0 and <7.0	≥4.0 and <5.0	Moderate stress on a number of aquatic organisms caused by dissolved oxygen levels exceeding preference levels for periods of several hours each day. Risk of sensitive fish and macroinvertebrate species being lost.
National Bottom Line	**5.0**	**4.0**	
D	<5.0	<4.0	Significant, persistent stress on a range of aquatic organisms caused by dissolved oxygen exceeding tolerance levels. Likelihood of local extinctions of keystone species and loss of ecological integrity.

The 7-day mean minimum is the mean value of 7 consecutive daily minimum values.

The 1-day minimum is the lowest daily minimum across the summer period (1 November to 30 April).

Appendix B – Detailed CMP scenario assumptions

BAU scenario

- No storm water capture or treatment.
- Greenfield, infill and rural residential development is located within Wellington City and Porirua City councils identified development zones. The number of additional dwellings represents what would be required to accommodate residential population growth to 2043 with current development practice (i.e., density and development form) .
- Assumed new development form for new dwellings:
    - Within existing residential zones:
        - Wellington City = 43% urban grassland and parks, 15% roads, 17% paved, 25% roofs.
        - Porirua City = 51% urban grassland and parks, 19% paved, 29% roofs (road area modelled).
    - In greenfield development zones = 36% urban grassland and parks, 20% roads, 14% paved, 30% roofs.
- Standalone houses and greenfield development replace forest and pasture covers, while terrace style housing replaces urban grass and parks and residential impervious covers.
- 275 hectares in the headwaters of the Kenepuru Stream and Duck Creek retired as an offset for the Transmission Gully motorway project (applies to all scenarios).
- Transmission Gully and Petone to Grenada are operational (applies to all scenarios).
- Sediment control applied to all construction sites, with a 90% effectiveness for removal of generated sediment, metals (dissolved and particulate zinc and copper), and nutrients (nitrogen and phosphorus and sub-species).
- Wastewater network condition does not change, and additional dwellings and population does not increase the wastewater overflows.

Improved scenario

- Numbers of additional dwellings the same as under BAU but for greenfield and infill sites there is an increased proportion of urban greenspace, and a corresponding decrease in impervious surfaces. Greenfield development zones = 37% urban grassland and parks, 20% roads, 12% paved, 30% roofs
- Rain tanks fitted to 50% of new greenfield and infill dwellings to reduce total flow from these by 4.7% and 1.9% respectively.
- A mixture of site and catchment scale stormwater retention devices fitted to catch and treat runoff from impervious surfaces of residential developments. These treatment trains result in the following (approximate) reductions in contaminate yields and flow from impervious surfaces:
    - Suspended sediment, 80%
    - Total and dissolved zinc, 70%
    - Total and dissolved copper, 70%
    - Total nitrogen, 40%
    - Total phosphorus, 50%
    - *E. coli*, 90%
    - Total flow, 6% (includes benefits of rain tanks).
- Rain tanks retrofitted to 10% existing residential roofs to reduce total flow from these by 1%.

- 50% of runoff from existing commercial and industrial paved surfaces and major roads receives media filter treatment. These result in the following weighted (approximate) reductions for these surfaces:
    - Suspended sediment, 40%.
    - Total and dissolved zinc and copper, 25%.
    - Total nitrogen and phosphorus, 20%.
    - *E. coli*, 40%.
- 50% of commercial and industrial roofs and existing residential roofs are replaced/treated with low zinc yielding materials.
- Sediment control applied to all construction sites, with a 90% effectiveness for removal of generated sediment, metals, and nutrients.
- Wastewater network condition is significantly improved to remove dry weather leaks and remove overflows in all but the four largest rainfalls each year.
- Livestock exclusion is undertaken on all REC order 2 or greater streams with grassland land cover and catchment slope less than 15 degrees. All areas of exclusion receive five meters of riparian planting. These result in weighted reduction factors for runoff from pastoral lands of:
    - Total and dissolved phosphorus, 50%;
    - *E. coli*, 44%; and
    - Streambank erosion component of suspended sediment, 80%.
- Space/pole planting of Land Use Capability (LUC) class 6e land with grassland land cover. Poles assumed to have reached maturity and act to reduce hillslope erosion sediment yields and particulate phosphorus yields by 70%.
- Retirement of LUC class 7e and 8e land with grassland land cover. Assumed this land reverts to native cover and adopts the relevant contaminant and flow generation characteristics. Streams within these areas are assumed to receive livestock exclusion through the retirement.

Water Sensitive scenario

- Numbers of additional dwellings and land cover replacement for are the same as for BAU. However, the development form changes to have less paved surfaces and greater urban grassland and parks.
    - Greenfield development zones = 54% urban grassland and parks, 20% roads, 6% paved, 20% roofs.
    - Within existing residential zones:
        - Wellington City = 48% urban grassland and parks, 15% roads, 11% paved, 25% roofs.
        - Porirua City = 57% urban grassland and parks, 13% paved, 29% roofs (road area modelled).
- Rain tanks fitted to 100% of new greenfield and infill dwellings to reduce total flow from these by 25.2 % and 22.3% respectively.
- A mixture of site and catchment scale stormwater retention devices are fitted to catch and treat runoff from greater areas of impervious surfaces of residential developments than under Improved. Load reduction factors are largely the same as in the Improved scenario, but greater use and size of rain tanks reduces total flow by around 37% and shift the frequency of ‘channel forming flows and cumulative frequency distribution towards a pre-development state.
- Rain tanks retrofitted to 50% existing residential roofs reduce total flow from these by 30%.
- 100% of runoff from commercial and industrial paved surfaces and major roads receives different types of runoff treatment. These result in the following weighted (approximate) reductions for these surfaces:

    - Suspended sediment, 75-90%;
    - Total and dissolved zinc and copper, 50-80%;
    - Total nitrogen and phosphorus, 40-60%; and
    - *E. coli*, 90%.
- 100% of existing commercial and industrial roofs and existing residential roofs are replaced/treated with low zinc yielding materials.
- Sediment control is applied to all construction sites, with a 90% effectiveness for removal of generated sediment, metals, and nutrients.
- The wastewater network condition is significantly improved to remove dry weather leaks remove overflows in all but the two largest rainfalls each year.
- As for Improved, livestock exclusion and riparian planting (five meters) is undertaken on all REC order 2 or greater streams with grassland land cover and catchment slope less than 15 degrees.
- Retirement of LUC classes 6e, 7e and 8e land with grassland land cover.

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