Assessment of alignment between the regulatory provisions and target attribute states in proposed Plan Change 1 to the Natural Resources Plan – Whaitua Te Whanganui-a-Tara

Report No. 2023-008

TORLESSE ENVIRONMENTAL LTD

Author

Michael Greer

Contact:

Dr Michael Greer
Principal Scientist, Director
Torlesse Environmental Ltd
M: +64 (27) 69 86 174
4 Ash Street, Christchurch 8011

Prepared for: Greater Wellington
Report No. 2023-008
Date: 04/10/2023

Quality Assurance (Report Status: Final)			
Role	**Responsibility**	**Date**	**Signature**
Prepared by	Michael Greer	04/10/2023	
Approved for issue by			
Structure and content reviewed by	Duncan Gray	11/07/2023	

RECOMMENDED CITATION: Greer, M.J.C. 2023. Assessment of alignment between the regulatory provisions and target attribute states in proposed Plan Change 1 to the Natural Resources Plan – Whaitua Te Whanganui-a-Tara. Torlesse Environmental Report No. 2023-008. Christchurch, New Zealand.

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 (i.e., are directly linked to the provisions)
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 (i.e., are not directly linked to the provisions)
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)
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))
The 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

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 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 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 WTWT is assessed using the scenario testing outputs of the Te Whanganui-a-Tara Biophysical Science Programme (BSP) which informed their selection by the WTWT Committee . The scenarios tested through the BSP 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 provisions of PC1 require outcomes and actions that are likely to achieve most (~85%) of the WTWT TASs and coastal objectives. However, there are still a number 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 BSP Water Sensitive scenario; e.g.:

- Planting 10 metre riparian buffers on all second order streams on pastoral land less than 15 degrees; and
- Retiring all high erosion risk land and highest erosion risk land (as defined in PC1).

Nonetheless, some TASs may not be met unless action planning includes greater non-regulatory actions than those described above, or land use is changed (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 BSP scenario assumptions.

<table>
<tr><th>Part Freshwater Management Unit</th><th>Attribute</th><th>Possible non-regulatory actions to fill the 'gap' between the proposed provisions and TAS/objective based on the BSP scenario assumptions</th></tr>
<tr><td>Wainuiomata rural streams</td><td rowspan="2">Periphyton biomass</td><td rowspan="2">Planting of five metre riparian buffers on all second order and above streams on pastoral land less than 10 degrees.

Note: The actions described above are likely only necessary to offset the effects of climate change at 2090. This attribute should be maintained by the proposed provisions at 2040.</td></tr>
<tr><td>Korokoro Stream</td></tr>
<tr><td>Wainuiomata rural streams</td><td>Suspended fine sediment</td><td rowspan="11">• Planting of 10 metre riparian buffers on all second order and above streams on pastoral land less than 15 degrees
• Retirement of all high risk erosion land.</td></tr>
<tr><td>Parangārehu catchment streams and South-west coast rural streams</td><td rowspan="2">Dissolved reactive phosphorus</td></tr>
<tr><td>Wainuiomata rural streams</td></tr>
<tr><td>Parangārehu catchment streams and South-west coast rural streams</td><td rowspan="2">E. coli</td></tr>
<tr><td>Te Awa Kairangi rural streams and mainstems</td></tr>
<tr><td>Te Whanganui-a-Tara (Harbour and estuaries)</td><td>Enterococci</td></tr>
<tr><td rowspan="3">Mākara Estuary</td><td>Muddiness (% area >50% mud)</td></tr>
<tr><td>Muddiness (% of sample)</td></tr>
<tr><td>Sedimentation rate</td></tr>
<tr><td>Te Awa Kairangi rural streams and mainstems</td><td rowspan="2">Macroinvertebrates</td></tr>
<tr><td>Wainuiomata rural streams</td></tr>
<tr><td>Te Awa Kairangi lower mainstem</td><td>Suspended fine sediment</td><td rowspan="2">• Planting of 10 metre riparian buffers on all second order and above streams on pastoral land less than 15 degrees
• Retirement of all high risk erosion land; and
• Additional mitigations not considered in BSP scenarios or land-use change.</td></tr>
<tr><td>Small forested and forested mainstems</td><td rowspan="3">Dissolved reactive phosphorus</td></tr>
<tr><td>Kaiwharawhara Stream</td><td rowspan="4">• Additional urban mitigations not considered in the BSP scenarios.</td></tr>
<tr><td>Waiwhetū Stream</td></tr>
<tr><td>Wellington urban</td><td rowspan="2">E. coli</td></tr>
<tr><td rowspan="2">Wainuiomata urban streams</td></tr>
<tr><td>Ammonia</td></tr>
<tr><td>Te Awa Kairangi rural streams and mainstems</td><td rowspan="2">Periphyton biomass</td><td rowspan="4">• Planting of 10 metre riparian buffers on all second order and above streams on pastoral land less than 15 degrees;
• Retirement of all high risk erosion land; and
• Additional mitigations not considered in the BSP scenarios or land-use change.</td></tr>
<tr><td rowspan="2">Te Awa Kairangi lower mainstem</td></tr>
<tr><td>Fish community health</td></tr>
<tr><td>Kaiwharawhara Stream</td><td rowspan="2">Macroinvertebrates</td></tr>
<tr><td>Te Awa Kairangi lower mainstem</td><td rowspan="3">Unlikely to be achieved by the proposed provisions or non-regulatory actions (i.e., outside of GW's control).</td></tr>
<tr><td>Small forested and forested mainstems</td><td>Fish community health</td></tr>
<tr><td>Te Awa Kairangi rural streams and mainstems</td><td rowspan="2">F-IBI</td></tr>
<tr><td>Te Awa Kairangi urban streams</td></tr>
</table>

Contents

Tables

Figures

1 Introduction

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 Whaitua Te Whanganui-a-Tara (WTWT) and the 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 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 WTWT are set out in Table 1 to Table 3. These are based on those published by WTWT Committee ('the Committee) in their Whaitua Implementation Programme (WIP). However, refinements have been made based on the recommendations of a technical advisory group (Greer *et al.*, 2023). For each river and lake attribute, the tables include a baseline and target state for each part Freshwater Management Unit (part-FMU) (Table 2, and Table 3). The differences between those states provide an indication of the magnitude of the improvement required by the TASs and, for rivers, have been used to define default TASs that prescribe the direction of change required for each attribute across each part-FMU[2] (Table 3).

The development of Table 1 to Table 3, 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 and lakes TASs in Table 2 and Table 3 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 WTWT.

Parameter	Unit	Statistic	Te Whanganui-a-Tara (Harbour and estuaries)	Mākara Estuary	Wainuiomata Estuary	Wai Tai
Benthic marine invertebrate diversity	**Subjective - State of ecosystem health and level of disturbance**		Maintain or improve	Maintain or improve	Maintain or improve	
Macroalgae	**EQR**	Latest score				
Phytoplankton	**mg chl-*a*/ m^3**					
Copper in sediment	**mg/kg**	Mean of latest round of replicate samples				
Zinc in sediment	**mg/kg**					
Muddiness	**% >50% mud**	Latest score		≤5		
	% of sample			<10		
Sedimentation rate	**Current:Natural**			≤2:1		
Enterococci	**cfu/100 mL**	95th %ile	≤200	Maintain or improve		

Table 2: Lakes TASs for WTWT.

				Lake Kōhangatera				Lake Kōhangapiripiri				Other lakes default TAS[1]
				Baseline		TAS[1]		Baseline		TAS[1]		
Parameter	**Unit**	**Statistic**	**Timeframe**	**Numeric**	**State**	**Numeric**	**State**	**Numeric**	**State**	**Numeric**	**State**	
Phytoplankton[2]	**mg chl-a/m³**	Median	By 2040	5.0	C	≤2	A	1.5	A	M	A	M
		Maximum		35		≤10		6.0				
Total nitrogen[2]	**mg/m³**	Median		480	B	M	B	660	C	≤500	B	
Total phosphorus[2]	**mg/m³**	Median		40	C	≤20	B	43	C	≤20	B	
Ammonia (toxicity)[2]	**mg/L**	Median		0.005	A	M	A	0.003	A	M	A	
		95th %ile		0.024				0.005				
***E. coli*[2]**	**/100mL**	Median		125	A		A	23	A		A	
		%>260/100mL		174				0				
		%>540/100mL		0				0				
		95th %ile		350				186				
Cyanobacteria (planktonic)[2]	**Total biovolume mm³/L**	80th %ile		0.248	A		A	0.008	A		A	
Submerged plants (natives)	**Native Condition Index (% of max)**	Latest		81.4	A		A	35.7	C	≥75	A	
Submerged plants (invasive species)	**Invasive Impact Index (% of max)**	Latest		15.6	B		B	61.5	C	≤25	B	
Lake-bottom dissolved oxygen[3]	**mg/L**	Annual minimum		Insufficient data		≥7.5	A	Insufficient data		≥7.5	A	

[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] Baseline state based on limited data collected over a period that is inconsistent with the monitoring requirements and baseline period defined in the NPS-FM 2020.

[3] 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.

Table 3: Rivers TASs for WTWT

				Te Awa Kairangi, Ōrongorongo and Wainuiomata																		
				Ōrongorongo, Te Awa Kairangi and Wainuiomata small forested and Te Awa Kairangi forested mainstems					Te Awa Kairangi lower mainstem					Te Awa Kairangi rural streams and rural mainstems					Te Awa Kairangi urban streams				
				Whakatikei R. @ Riverstone				Part-FMU default TAS[1]	Hutt R. @ Boulcott				Part-FMU default TAS[1]	Mangaroa R. @ Te Marua				Part-FMU default TAS[1]	Hulls Ck adj. Reynolds Bach Dr.				Part-FMU default TAS[1]
				Baseline		TAS[1]			Baseline		TAS[1]			Baseline		TAS[1]			Baseline[2]		TAS[1]		
Parameter	**Unit**	**Statistic**	**Timeframe**	**Numeric**	**State**	**Numeric**	**State**		**Numeric**	**State**	**Numeric**	**State**		**Numeric**	**State**	**Numeric**	**State**		**Numeric**	**State**	**Numeric**	**State**	
Periphyton biomass[2]	**mg chl-a/m²**	92nd %ile		Insufficient data		≤50	A		284	D	≤120	B	I	220	D	≤120	B	I	Insufficient data		≤200	C	
Ammonia (toxicity)	**mg/L**	Median		0.002	A		A		0.002	A		A		0.002	A		A		0.008	A		A	
		95th %ile		0.004					0.003		M		M	0.01		M		M	0.012				M
Nitrate (toxicity)	**mg/L**	Median		0.1	A		A		0.2	A		A		0.4	A		A		0.2	A	M	A	
		95th %ile		0.3					0.3					0.6					0.4				
Suspended fine sediment	**Black disc (m)**	Median		4	A	M	A	M	2.4	C	≥2.95	A	I	1.5	D	≥2.22	C	I	1.2	A		A	
E. coli	**/100mL**	Median		22	A		A		58	D	≤58	C	I	170	D	≤130	B	I	1,100	E	≤130	C	I
		%>260/100mL		5					18		≤18			35		≤30			100		≤34		
		%>540/100mL		3					8		≤8			18		≤10			79		≤20		
		95th %ile		290					1,250		≤1,200			2,450		≤1,000			13,000		≤1,200		
Fish	**Fish-IBI**	Latest		Insufficient data		≥34	A		Insufficient data		≥34	A	M	Insufficient data		≥34	A		Insufficient data		≥34	A	
Fish community health (abundance, structure and composition)		Expert assessment[3]				N/A[3]	A				N/A[3]	B	I			N/A[3]	B				N/A[3]	C	
Macroinvertebrates (1 of 2)	**MCI**	Median	By 2040	129.6	B	≥130	A	I	109.1	C	110	B	I	118.3	C	≥118.3	B				≥90	C	M
	QMCI	Median		7.0		≥7			5.5		5.5			5.7		≥5.7					≥4.5		
Macroinvertebrates (2 of 2)	**ASPM**	Median		0.56	B	≥0.6	A		0.4	B	M	B		0.5	B	M	B				≥0.3	C	
Deposited fine sediment[2]	**%cover**	Median		25	C	≤13	A		5	A		A		0	A		A	M	11	B	M	B	
Dissolved oxygen	**mg/L**	1-day minimum		Insufficient data		≥7.5	A	M	Insufficient data		≥7.5	A		Insufficient data		≥7.5	A		Insufficient data		≥7.5	A	
		7-day mean minimum				≥8.0					≥8.0					≥8.0					≥8.0		
Dissolved inorganic nitrogen[4]	**mg/L**	Median		0.15		M			0.2		M		M	0.44		M			0.24		M		
Dissolved reactive phosphorus[4]	**mg/L**	Median		0.008		≤0.006		I	0.004					0.010		≤0.006		I	0.018				
		95th%ile		0.011		≤0.011			0.008					0.015		≤0.015			0.027				
Dissolved copper	**µg/L**	Median		Insufficient data		≤1	A	M	0.3	A	M	A		Insufficient data		≤1	A	M	1.9	C	≤1.4	B	I
		95th %ile				≤1.4			0.6							≤1.4			3.6		≤1.8		
Dissolved zinc	**µg/L**	Median				≤2.4	A		0.5	A		A				≤2.4	A		8.0	C	≤8	B	
		95th %ile				≤8			1.9							≤8			19.2		≤15		
Ecosystem metabolism[5]	**g O_2 m^{-2} d^{-1}**	N/A[5]		M																			

				Te Awa Kairangi, Ōrongorongo and Wainuiomata														South-west coast, Mākara and Ōhariu catchment and Parangārehu Lakes				
				Waiwhetū Stream					Wainuiomata urban streams					Wainuiomata rural streams					Parangārehu catchment streams and South-west coast rural streams				
				Waiwhetū S. @ Whites Line East				Part-FMU default TAS[1]	Black Ck @ Rowe Parade				Part-FMU default TAS[1]	Wainuiomata River D/S of White Br.				Part-FMU default TAS[1]	Mākara S. @ Kennels				Part-FMU default TAS[1]
				Baseline		TAS[1]			Baseline[2]		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[2]	mg chl-a/m²	92nd %ile	By 2040	Insufficient data		≤200	C	M	Insufficient data		≤200	C	M	324	D	≤200	C	I	Insufficient data		≤200	C	
Ammonia (toxicity)	mg/L	Median		0.027	B	≤0.02	A	I	0.025	B	≤0.03	A	I	0.004	A	M	A	I	0.005	A	M	A	M
		95th %ile		0.076		≤0.05			0.066		≤0.05			0.025					0.023				
Nitrate (toxicity)	mg/L	Median		0.5	A	M	A	M	0.4	A	M	A	M	0.2	A		A		0.4	A		A	
		95th %ile		0.9					0.7					0.4					1.2				
Suspended fine sediment	Black disc(m)	Median		1.1	A		A		1.3	D	≥2.22	C		2.1	D	≥2.22	C		1.6	D	≥2.22	C	I
E. coli	/100mL	Median		495	E	≤130	C	I	1250	E	≤130	C	I	100	B	≤100	A	I	375	E	≤260	D	
		%>260/100mL		73		≤34			86		≤34			18		≤18			62		≤50		
		%>540/100mL		42		≤20			71		≤20			7		≤5			32		≤30		
		95th %ile		5,800		≤1200			4,360		≤1200			1,000		≤540			6,500		≤3,850		
Fish	Fish-IBI	Latest		Insufficient data		≥34	A	M	Insufficient data		≥34	A	M	Insufficient data		≥34	A	M	Insufficient data		≥34	A	M
Fish community health (abundance, structure and composition)		Expert assessment[3]				N/A[3]	C				N/A[3]	C				N/A[3]	B				N/A[3]	C	
Macroinvertebrates (1 of 2)	MCI	Median		55.4	D	≥90	C	I	Insufficient data		≥90	C	I	109.5	C	≥110	B	I	107.3	C	M	C	
	QMCI	Median		2.2		≥4.5					≥4.5			4.9		≥5.5			5.1				
Macroinvertebrates (2 of 2)	ASPM	Median		0.1	D	≥0.3	C				≥0.3	C		0.4	B	≥0.6	A		0.4	B		B	
Deposited fine sediment[2]	%cover	Median		30	D	≤29	C		11	A	M	A	M	20	C	≤13	A		85	D	≤27	C	I
Dissolved oxygen	mg/L	1-day minimum		Insufficient data		≥7.5	A		Insufficient data		≥7.5	A	M	Insufficient data		≥7.5	A	M	Insufficient data		≥7.5	A	M
		7-day mean minimum				≥8.0					≥8.0					≥8.0					≥8.0		
Dissolved inorganic nitrogen[4]	mg/L	Median		0.56		M		M	0.5		M			0.17		M			0.42		M		
Dissolved reactive phosphorus[4]	mg/L	Median		0.024		≤0.018		I	0.021		≤0.018		I	0.011		≤0.01		I	0.027		≤0.018		I
		95th%ile		0.049		≤0.049			0.035		≤0.035			0.023		≤0.023			0.064		≤0.054		
Dissolved copper	µg/L	Median		1.0	C	≤1	A	I	1.0	C	M	C	M	Insufficient data		≤1	A	M	Insufficient data		≤1	A	M
		95th %ile		4.0		≤1.4			2.0							≤1.4					≤1.4		
Dissolved zinc	µg/L	Median		18.3	D	≤8	B		11.2	D	≤11.2	C	I			≤2.4	A				≤2.4	A	
		95th %ile		51.5		≤15			71.2		≤42					≤8					≤8		
Ecosystem metabolism	g O_2 m^{-2} d^{-1}	N/A[5]		M																			

				Korokoro catchment					Wellington urban catchment									Island rivers TAS[1]
				Korokoro Stream					Kaiwharawhara Stream					Wellington urban				
				Korokoro S. @ Cornish St. Br.				Part-FMU default TAS[1]	Kaiwharawhara S. @ Ngaio Gorge				Part-FMU default TAS[1]	Karori S. @ Mākara Peak				Part-FMU default 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		
Periphyton biomass[2]	mg chl-a/m²	92nd %ile	By 2040	Insufficient data		≤120	B	M	191	D	≤200	C	I	Insufficient data		≤200	C	M	M
Ammonia (toxicity)	mg/L	Median				≤0.03	A		0.004	A	M	A	M	0.009	A	M	A		
		95th %ile				≤0.05			0.031					0.026					
Nitrate (toxicity)	mg/L	Median				≥1	A		1.1	B		B		1.3	B		B		
		95th %ile				≥1.5			1.5					1.6					
Suspended fine sediment	Black disc (m)	Median				≥2.95	A		3.2	A		A		3.2	A		A		
E. coli	/100mL	Median				≤130	B	I	530	E	≤130	C	I	1400	E	≤130	C	I	
		%>260/100mL				≤30			73		≤34			97		≤34			
		%>540/100mL				≤10			50		≤20			83		≤20			
		95th %ile				≤1,000			5,150		≤1,200			4,550		≤1,200			
Fish	Fish-IBI	Latest				≥34	A	M	Insufficient data		≥34	A	M	Insufficient data		≥34	A	M	
Fish community health (abundance, structure and composition)		Expert assessment[3]				N/A[3]	C	I			N/A[3]	C	I			N/A[3]	C	I	M
Macroinvertebrates (1 of 2)	MCI	Median				≥130	A		81.9	D	≥92.4	C		91.8	D	≥91.8	C		
	QMCI	Median				≥6.5			2.8		≥4.5			3.1		≥4.5			
Macroinvertebrates (2 of 2)	ASPM	Median				≥0.6	A		0.25	D	≥0.3	C		0.29	D	≥0.3	C		
Deposited fine sediment[2]	%cover	Median				≤13	A	M	20	C	≤13	A	I	25	C	≤19	B		
Dissolved oxygen	mg/L	1-day minimum				≥7.5	A		Insufficient data		≥7.5	A	M	Insufficient data		≥7.5	A	M	
		7-day mean minimum				≥8.0					≥8.0					≥8.0			
Dissolved inorganic nitrogen[4]	mg/L	Median				≤0.26			1.14		M			1.29		M			
Dissolved reactive phosphorus[4]	mg/L	Median				≤0.006		I	0.037		≤0.018			0.035					
		95th%ile				≤0.021			0.064		≤0.054			0.062					
Dissolved copper	µg/L	Median				≤1	A	M	1.3	C	≤1.3	B	I	1.3	D	≤1.3	C	I	
		95th %ile				≤1.4			2.8		≤1.8			5.9		≤4.3			
Dissolved zinc	µg/L	Median				≤2.4	A		6.1	B	≤2.4	A		16.2	D	≤16.2	C		
		95th %ile				≤8			12.8		≤8			43.0		≤42			
Ecosystem metabolism	g O_2 m^{-2} d^{-1}	N/A[5]		M															

[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] Baseline state based on limited data.

[3] 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.

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

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

1.3 Introduction to the Te Whanganui-a-Tara Biophysical Science Programme

1.3.1 Biophysical Science Programme framework

The decisions made by the Committee in the WIP were informed by the outputs of three expert panels that were convened for the Te Whanganui-a-Tara Biophysical Science Programme (BSP). These panels inputted into one another and covered river flows and allocation, freshwater quality and ecology, and coastal water quality and ecology.

The purpose of these panels 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 BSP 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.

1.3.2.2 Relevant expert panel outputs

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

- A proxy catchment assessment based on the extensive, well calibrated and validated Source modelling results for the TAoP Whaitua (Easton *et al.*, 2019b, 2019a). This provided an estimate of how water quality may change in certain catchments under the different scenarios based on the modelled results for similar characteristics in the TAoP Whaitua (Blyth, 2020).
- Whaitua specific baseline:

    - Contaminant yields generated by the urban Contaminant Load Model (CLM) (Easton and Hopkinson, 2020); and
    - Sediment loads generated using the Source dSedNet plugin for Source (Easton and Cetin, 2020).
- A detailed assessment of the current state and drivers of water quality and ecology in WTWT (Greer and Ausseil, 2018).

The methodology employed by the Freshwater Panel and their outputs are documented in Greer *et al.* (2022). They were also summarised for the Committee in a standalone executive summary.

Coastal ecology, sediment quality, deposition and texture under the BSP scenarios were assessed by a Coastal Expert Panel ('the Coastal Panel') whose assessments were informed by the inputs and outputs of the Freshwater Panel. Their assessments are published in Melidonis *et al.* (2020).

Note: The impacts of the scenarios on lakes were not tested as part of BSP.

1.4 Report objectives

The purpose of this report is to assess the extent to which the proposed regulatory provisions of PC1[3] ('the proposed provisions') will achieve the TASs and coastal objectives for WTWT (Table 1 to Table 3) using the expert panel outputs described in Section 1.3.2.2. This is necessary as the impacts of the proposed provisions were not explicitly tested through the BSP.

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 TWT WIP was published. Consequently, detailed introductions to the freshwater and coastal environments in WTWT, the NPS-FM 2020 and the NRP are not provided.
- While this report summarises the relevant publicly available scientific information produced by the BSP, it cannot describe the extent to which that information guided the Committee in their selection of 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 the extent to which achievability factored into the Committees' decisions is unknown.
- While this assessment relies heavily on the results of scenario testing conducted by the Freshwater and Coastal Panels, it is not one of their outputs. Rather it should be treated as the peer reviewed opinion of one expert.
- A comparable report has been prepared for TAoP Whaitua by Greer (2023). The similarities between the scenarios tested for that Whaitua and WTWT means that large parts of that report are replicated here.

[3] 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/

2 Methods

2.1 Scale of assessment

The impact of the proposed provisions on each of the attributes listed in Table 1 to Table 3 (except ecosystem metabolism) was assessed for each of the spatial areas set out in the headers of those tables (hereafter collectively referred to as 'part-FMUs'). This resulted in 215 TASs and coastal objectives being assessed across the 17 part-FMUs listed below and mapped in Figure 1:

- Rivers:
    - Ōrongorongo, Te Awa Kairangi and Wainuiomata small forested and Te Awa Kairangi forested mainstems (hereafter abbreviated to 'Small forested and forested mainstems');
    - Te Awa Kairangi lower mainstem
    - Te Awa Kairangi rural streams and rural mainstems (hereafter abbreviated to 'Te Awa Kairangi rural streams and mainstems');
    - Te Awa Kairangi urban streams;
    - Waiwhetū Stream;
    - Wainuiomata urban streams;
    - Wainuiomata rural streams;
    - Parangārehu catchment streams and South-west coast rural streams;
    - Korokoro Stream;
    - Kaiwharawhara Stream; and
    - Wellington urban.
- Lakes:
    - Lake Kōhangatera; and
    - Lake Kōhangapiripiri.
- Coastal:
    - Te Whanganui-a-Tara (Harbour and estuaries);
    - Mākara Estuary;
    - Wainuiomata Estuary; and
    - Wai Tai.

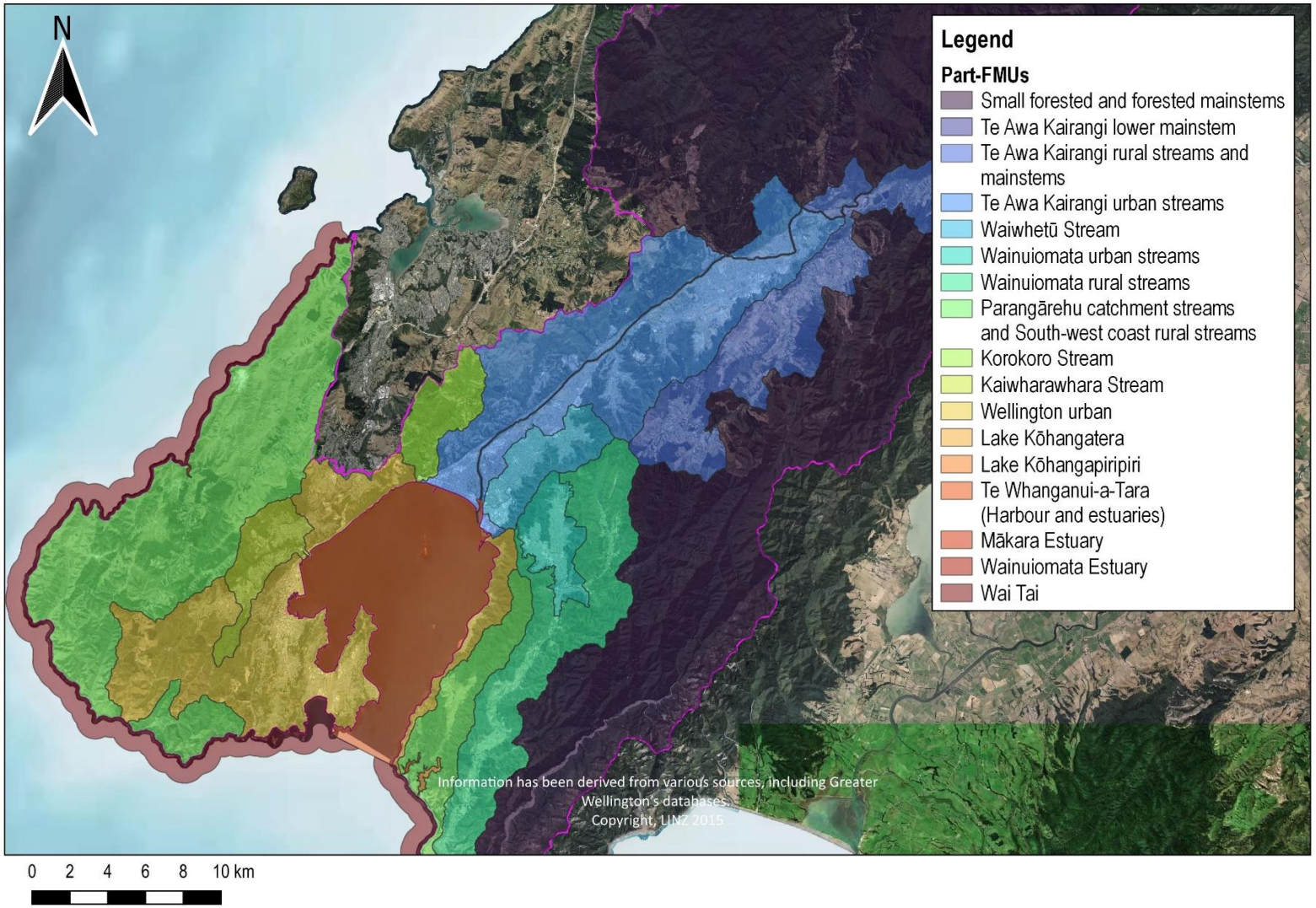


Figure 1: Map of WTWT part-FMUs

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 clause 3.13. Consequently, these attributes require a more detailed assessment methodology than the other attributes in Table 1 to Table 3. The proposed provisions are also directly linked to the TASs or coastal objectives for the following attributes:

- TASs for dissolved copper (Cu);
- TASs for dissolved zinc (Zn); and
- Coastal enterococci objectives.

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 4.

Table 4: 2A type attributes and attribute groups.

Attribute Group	2A type attributes
Sediment	• Rivers – Suspended fine sediment (SFS)
Faecal indicator bacteria	• Rivers – *E. coli* • Coast – 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	• Rivers – Dissolved copper (Cu) • Rivers – Dissolved zinc (Zn)
Rivers – Periphyton	

Note: The NPS-FM 2020 Appendix 2A attributes for lakes cannot be assessed in the same way as the 2A type attributes in Table 4 as applicable scenario testing results are not available. More detail is provided in Section 2.3.

2.2.1 Scenario assignment

To date, the biophysical effects of the proposed provisions have not been explicitly assessed. Consequently, the BSP 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 3.

No single BSP scenario aligns perfectly with all the proposed provisions. Thus, for each activity managed by the proposed provisions an assessment has been made of where the relevant 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 BSP 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 BSP scenarios.

The BSP 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 BSP scenario to each of the attribute groups set out in Table 4. The distribution of rural and urban land-cover differs significantly between the part-FMUs listed in Section 2.1. Accordingly, so too does the relative importance of different activities on water quality and ecology. To account for this, most attributes had different scenarios assigned for:

- Urban part-FMUs (i.e., those almost entirely in urban land-cover):
    - Te Awa Kairangi urban streams;
    - Waiwhetū Stream;
    - Wainuiomata urban streams;
    - Kaiwharawhara Stream; and
    - Wellington urban.

  ; and
- Rural and mixed-rural part-FMUs (i.e., those not classified as 'urban').

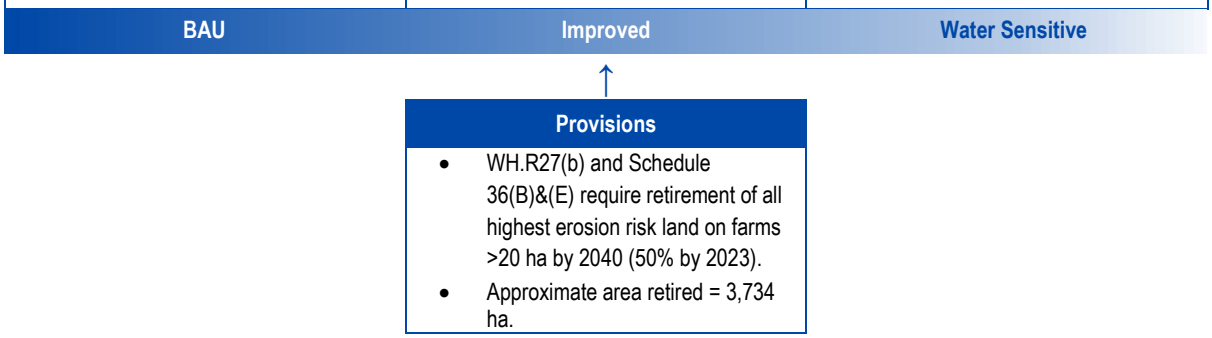
The scenario assignment process and outputs are described in full in Section 3. In short it was based on expert opinion and involved:

- 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 BSP scenario whose assumptions most closely matched the requirements of the proposed provisions for each activity using the template set out below in Table 5;
- Identifying which activities, and therefore, BSP scenarios, are most relevant to each of the attribute groups in Table 4;

- Providing a detailed 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 5: Example of the scenario alignment outputs for individual activities (in this case retirement).

BAU	Improved	Water Sensitive
No retirement.	• Retirement of LUC class 7e and 8e land with grassland land cover. Assumed this land reverts to native cover. • Approximate area retired = 3,733 ha.	• As for Improved but with additional retirement of LUC class 6e land with grassland land cover. • Approximate area retired = 27,985 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 3);
- The baseline state is unknown, but the part-FMU default TAS requires the attribute be maintained (Table 3);
- 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:
    - Ammonia (toxicity) – Waiwhetū Stream part-FMU; and
    - Periphyton biomass (trend analysis results not available):
        - Kaiwharawhara Stream part-FMU; and
        - Wainuiomata rural streams part-FMU.

For these 'maintain' 2A type TASs and coastal objectives, consideration was given to the Freshwater and Coastal Panel's assessment of the assigned BSP scenario (Greer *et al.*, 2022; Melidonis *et al.*, 2020), and whether the proposed provisions allow for degradation from the baseline state. For each attribute group (see Table 4), the results of these assessments were documented in a short narrative and summarised in the format of Table 6.

Table 6: Example of the summary tables produced for maintain 2A type attributes.

Part-FMU	Site	Attribute	Baseline state and TAS	Scenario results			Provisions likely to achieve 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		

2.2.3 Identification of 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 3);
- The baseline state is unknown, but the part-FMU default TAS requires the attribute be improved (Table 3); 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 predicted by the Freshwater and Coastal Panels under the assigned 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 4), these assessments were documented in a short narrative and summarised in the format of Table 7. For the sediment attribute group, the results of national-scale modelling were considered alongside the Freshwater Panel outputs. Thus, two summary tables were produced (more detail below).

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 BSP scenarios predicted to achieve the TAS.

Table 7: 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

The Freshwater Panel's assessments for suspended fine sediment (SFS) factored in the impacts of climate change (at 2090) on increased winter flood frequency (Greer *et al.*, 2022). In most rural part-FMUs this resulted in the benefits of the BSP scenario assumptions on visual clarity being partially or fully offset by an increase in event sediment loads caused by factors outside of GW's control (Greer *et al.*, 2022). In order to better understand the impacts of the different BSP scenarios on SFS without climate change, the results of erosion modelling by Neverman *et al.* (2019) were paired with site specific sediment clarity relationships documented in Greer *et al.* (2023) to generate SFS predictions for the following part-FMUs under each scenario:

- Te Awa Kairangi lower mainstem;
- Te Awa Kairangi rural streams and rural mainstems; and
- Parangārehu catchment streams and South-west coast rural streams.

This approach is considered appropriate as the modelling by Neverman *et al.* (2019):

- Tested the effects of a range of rural mitigations on sediment loads that are broadly consistent with the relevant assumptions of the BSP scenarios; and
- Did not consider the potential impacts of climate change on sediment loads.

The alignment between the mitigations tested by Neverman *et al.* (2019) and the assumptions of the BSP scenarios is described in Table 8.

Table 8: Alignment between the rural erosion mitigations tested by by Neverman *et al.* (2019) and the relevant assumptions of BSP scenarios assessed by the Freshwater Panel. The sediment load reduction factors for the BSP scenarios were drawn directly from assumptions of the scenarios (where applicable – Appendix B), or the commonly used performance values cited in Phillips *et al.* (2020).

BSP scenario	Relevant mitigations modelled by Neverman *et al.* (2019)		Relevant BSP scenario assumptions	
	Actions	Indicative load reduction factor	Actions	Indicative load reduction factor
BAU	Riparian exclusion on all 'major streams'		80% (stream bank erosion)	50% (Phillips *et al.*, 2020)
Improved	Riparian exclusion on all 'major streams'	80% (stream bank erosion)	BAU + livestock exclusion with 5m of riparian planting on all REC order ≥2 streams catchment slope <15°	80% (stream bank erosion)
	Whole Farm Plans on all LUC class 6e, 71 and 8e land	70%	Space planting of class 6e land	70%
			Retirement of class 7e and 8e land	90% (Phillips *et al.*, 2020)
Water Sensitive	Riparian exclusion on all 'major streams'	80% (stream bank erosion)	BAU + livestock exclusion with 10m of riparian planting on all REC order ≥2 streams catchment slope <15°	80% (stream bank erosion)
	Retirement of class 6e, 7e and 8e land	90%	Retirement of class 6e, 7e and 8e land	90% (Phillips *et al.*, 2020)

2.3 Assessment method for 2B type attributes

2.3.1 Identification of 'maintain' and 'improve' 2B type TASs and coastal objectives

Whether the TASs and coastal objectives in Table 1 to Table 3 require the maintenance or improvement of the 2B type attributes listed in Table 9 was determined through the approach described in Sections 2.2.2 and 2.2.3. Through this process, the following 'maintain' TASs were identified as requiring an improvement from the reported baseline state that has already been achieved (GW, 2022):

- Small forested and forested mainstems:
    - Deposited fine sediment;
    - Macroinvertebrates (1 of 2); and
    - Macroinvertebrates (2 of 2).
- Kaiwharawhara Stream:
    - Deposited fine sediment (DFS); and
    - Macroinvertebrates (2 of 2).
- Wellington urban streams – Macroinvertebrates (2 of 2);
- Wainuiomata rural streams – Deposited fine sediment; and
- Lake Kōhangapiripiri:
    - Submerged plants (natives); and
    - Submerged plants (invasive species).

Table 9: 2B type attributes.

Environment	Attribute
Rivers[1]	• 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
Lakes	• Phytoplankton • Total nitrogen (TN) • Total phosphorus (TP) • NH_4-N • *E. coli* • Cyanobacteria (planktonic) • Submerged plants (natives) • Submerged plants (invasive species) • Lake-bottom dissolved oxygen
Coastal water	• Benthic marine invertebrate diversity • Macroalgal Ecological Quality Rating (EQR) • Phytoplankton • Cu in sediment • Zn in sediment • Muddiness (% area >50% mud) • Muddiness (% of sample) • Sedimentation rate

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

2.3.2 River TASs and coastal objectives

There is no NPS-FM 2020 requirement for the proposed provisions to contribute to the achievement of the target states or coastal objectives for the attributes in Table 1 and Table 3 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 2B type TAS and coastal objectives in Table 1 to Table 3 a narrative assessment was made of:

- The most applicable BSP scenario (based on expert opinion and the results of the scenario assignment process described in Sections 2.2 and 3); and
- The likely outcome of the proposed provisions based on the Freshwater and Coastal Panel outputs for the most applicable scenario.

Where the outputs of the Freshwater and Coastal Panels allowed, the assessments described above were also summarised in tables like those produced for 2A type attributes (see Table 6 and Table 7).

This approach provided a general indication of whether the proposed provisions are likely to result in the achievement of most 2B type river TASs and coastal objectives. However, there is a high level of uncertainty around the assessments made for DFS. Since it was not assessed by the Freshwater Panel due to uncertainties around the response of this attribute to the BSP scenario assumptions (Greer *et al.*, 2022 – Addendum 1).

2.3.3 Lake TASs

It was not possible to conduct a detailed assessment of the impacts of the proposed provisions on the lake attributes in Table 2, as the effects of the BSP scenarios on the Parangārehu Lakes and their upstream river catchments were not assessed by the Freshwater Panel. Consequently, they were also treated as 2B type attributes in this report, despite many being listed in Appendix 2A of the NPS-FM 2020. Furthermore, the assessment of these lake attributes is generally limited to determining whether the proposed provisions are consistent with at least the maintenance of the lake attributes and, therefore, not in direct conflict with the achievement of the relevant TASs.

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 applies in some urban part-FMUs; non-complying activity elsewhere).
- 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 interim mapping conducted for the Pouewe and Takapū part-FMUs in the TAoP Whaitua.
- 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 BSP scenario testing process other than revegetation;
  - The sediment load reduction factors cited for space planting in Phillips *et al.* (2020) and assumed in the BSP scenario testing (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 BSP scenarios by activity

3.1.1 Retirement

The erosion risk treatment plans (ERTPs) stipulated by clause (b) of Rule WH.R27 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[4] (Schedule 36 (B)).

The result of this revegetation is the affected land will effectively be retired from farming. The location and extent of the highest risk erosion land in WTWT had not been fully mapped at the time of writing. However, interim mapping of the Pouewe and Takapū part-FMUs in the TAoP Whaitua by Collaborations (Taylor Collaborations Ltd), suggests that there is a good alignment between highest risk erosion land and the Land Use Capability (LUC) class 7e and 8e land[5] Thus, the proposed provisions will likely require 3,734 ha of retirement[6], which is the same as was assumed under the BSP Improved scenario (Table 10).

Note: It is possible that some landowners will apply for resource consent to farm without an ERTP. 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:

- *Farming without an ERTP is a non-complying activity in all rural and mixed rural part-FMUs[7].*
- *The significant (>20%) load reductions required to meet the SFS TASs for the following part-FMUs:*
    - *Te Awa Kairangi rural streams and mainstems;*
    - *Te Awa Kairangi lower mainstem;*
    - *Wainuiomata urban streams; and*
    - *Parangārehu catchment streams and south-west coast rural streams.*

[4] The proposed provisions do not require highest erosion land to be revegetated where it is not practicable and alternative erosion control treatment is applied over the balance of the property that result 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 reduce the amount of retirement required by 2040.

[5] Area of highest risk erosion land in the Pouewe and Takapū part FMUs 10% greater than area of LUC class 7e and 8e land (Stuart Easton *pers. comm.*)

[6] Calculated through geospatial analysis of the LUC system (all class 7e and 8e land) and the Land Cover Database version 5.0.

[7] Condition (a) of Rule WH.R30 cannot be met as the no single rural or mixed rural part-FMU meets all TASs for DIN, DRP and visual clarity.

- The wording of Policy WH.P23 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".*

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

BAU	Improved	Water Sensitive
No retirement.	• Retirement of LUC class 7e and 8e land with grassland land cover. Assumed this land reverts to native cover. • Approximate area retired = 3,734 ha.	• As for Improved but with additional retirement of LUC class 6e land with grassland land cover. • Approximate area retired = 27,985 ha.
BAU	Improved	Water Sensitive

↑

Provisions
• WH.R27(b) and Schedule 36(B)&(E) require retirement of all highest erosion risk land on farms >20 ha by 2040 (50% by 2023). • Approximate area retired = 3,734 ha.

3.1.2 Space planting (of trees)

The ERTPs stipulated by clause (b) of Rule WH.R27 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[8].

Based on interim mapping of the Pouewe and Takapū part-FMUs in the TAoP whaitua, there is a good alignment between high risk erosion land and the LUC class 6e land[9]. Thus, the proposed provisions will likely require space planting across 3,337 ha of high erosion risk land[10], which is the same as assumed under the BSP Improved scenario (Table 11).

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).

[8] 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.

[9] Area of high risk erosion land in the Pouewe and Takapū part-FMUs 6% greater than area of LUC class 6e land (Stuart Easton *pers. comm.*)

[10] Calculated through geospatial analysis of the LUC system and the LCDB.

Table 11: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the BSP 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 = 3,337 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 WH.R27(b) and Schedule 36 (E)(3)(c) require appropriate soil conservation treatment (assumed to be space planting) of all high erosion risk land on farms >20 ha. • Approximate area treated = 3,337 ha.

3.1.3 Livestock exclusion

The Resource Management (Stock Exclusion) Regulations 2020 (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 86 kilometres (km) of the River Environment Classification[11] network length in WTWT. Furthermore, the permitted activity conditions in Rule R98((b),(c)[12]) of the NRP means that livestock access to an additional 45 km of Category 2 surface water bodies will be a discretionary activity on that date (Rule R99).

It cannot be said with any certainty how much livestock exclusion the existing NRP provisions will result in. However, many land-owners will choose to farm under the permitted activity rule and will exclude livestock from all rivers on low slope land. Furthermore, it is unlikely that those who choose to apply for resource consent for livestock access will obtain it for all rivers on their property given:

- The Farm Environment Plan (FEP) requirements of the operative NRP and PC1;and
- The need to reduce sediment and *E. coli* losses across the WTWT to meet the TASs and coastal objectives.

The proposed provisions of PC1 that drive livestock exclusion beyond what is already required by the Stock Exclusion Regulations and the NRP are rules WH.R28, WH.R29 and WH.R27:

- Rule WH.R29 makes livestock access to rivers in the Mangaroa River and Mākara Stream catchments a discretionary activity except where a small stream riparian programme has been developed in accordance with Schedule 36(F) (Rule WH.R28(b)). This affects 10 km

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

[12] With the exception of the Mangaroa Catchment almost all WTWT rivers in the lowland areas shown on Map 45 of the operative NRP are listed in Schedule F1 of the NRP and are, therefore, category 2 surface water bodies.

and 65 km of the REC network in the Mangaroa River and Mākara Stream catchments respectively as well as an additional unknown length of unmapped river.

- The retirement required by the proposed provisions (WH.R27(b) and Schedule 36(B)&(E); see Section 3.1.1) will likely result in livestock being excluded from rivers in impacted areas. Geospatial analysis of the REC and LUC system suggest that this could impact approximately 30 km[13] of the REC network in WTWT.

In combination, the proposed provisions, the current NRP provisions and the Stock Exclusion Regulations provide some level of control over livestock access across at least 237 km of the rivers in WTWT (Figure 2b). On 86 km livestock access will be not allowed by the Stock Exclusion Regulations, on 121 km it will be a discretionary activity, and on the remaining 30 km it will be a non-complying activity (consequence of proposed provisions relating to farming on highest erosion risk land (see Section 3.1.1).

The total extent of stock exclusion required under the proposed provisions far exceeds that assumed under the BSP Water Sensitive scenario (197 km[14] (Figure 2a and Table 12)). However, 32% (76 km) is expected to occur in just the Mākara Stream Catchment, which makes up just 7% of the Whaitua and 44% of the Parangārehu catchment streams and South-west coast rural streams part-FMU (Figure 2). Consequently, for the vast majority of WTWT the proposed stock exclusion stock exclusion provisions are generally consistent with the assumptions of the BSP Water Sensitive scenario (predicted stock exclusion outside of Mākara Stream Catchment = 160 km and 145 km under the proposed provisions and the Water Sensitive scenario respectively (Table 12).

[13] Represents the total length of REC network within pastoral areas of LUC class 7e and 8e land.

[14] Calculated through geospatial analysis of the REC, the LUC system and the New Zealand Land Cover Database.

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

BAU	Improved	Water Sensitive
• No livestock access to Category 1 or 2 waterbodies. • No additional livestock exclusion except because of urban development or retirement required by existing resource consents. • Approximate length of livestock exclusion = 91 km (excluding Mākara Stream Catchment).	• 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 = 143 km (excluding Mākara Stream Catchment).	• Same as Improved but with greater impact from retirement. • Approximate length of livestock exclusion outside of the Mākara Stream Catchment = 145 km (excluding Mākara Stream Catchment).
BAU	Improved	Water Sensitive
		↑
		Provisions
		Approximate length of livestock exclusion required by proposed provisions and existing regulations outside of the Mākara Stream Catchment = 160 km (excluding Mākara Stream Catchment) **Proposed provisions** • The ERTPs required under Rule WH.R27(b) should result in the exclusion of livestock in rivers running through highest erosion risk land on farms >20 ha. Applies to 22 km of REC network. • Rule WH.R28 requires livestock exclusion on all rivers in the Mangaroa River Catchment unless resource consent is obtained (Rule WH.R29) or a small stream riparian programme is developed (Rule WH.R28(b) and Schedule 36(F)). Applies to 9 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 85 km of REC network. • Rule R98(b)&(c) of the NRP requires livestock exclusion on all Category 2 surface water bodies unless resource consent is obtained (Rule R99). Applies to 45 km of REC network.

Notes:

- *In the Mākara Stream Catchment the proposed stock exclusion provisions go beyond the assumptions of the BSP Water Sensitive Scenario; and*
- *The length of river covered by the proposed provisions, the current NRP 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 scenarios.*

3.1.4 Riparian management

The future riparian management required by regulation (including the proposed provisions) in WTWT is most consistent with that assumed under the BSP BAU scenario (Table 13).

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 86 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 WH.R27(b) and Schedule 36(B)&(E)) require that woody vegetation be established on on all highest erosion risk land on farms greater than 20 ha by 2040, which equates to 30 km[13] of the REC network in WTWT receiving riparian planting.

In combination, the proposed provisions and the Stock Exclusion Regulations could require some form of riparian management along 116 km of the REC network in WTWT. While this is greater than that assumed under the BSP BAU scenario (no additional riparian planting), it falls short of the 165 km assumed under the Improved scenario[2] (Figure 3). Furthermore, the required riparian management (simple three metre setback) on the 86 km of river covered by the Stock Exclusion Regulations will likely:

- be far less effective at shading out periphyton (unlikely to result in the establishment of tall trees); and
- strip less sediment and *E. coli* from run-off (~10% (Semadenis-Davies *et al.*, 2020)),

than the five metre planted riparian margins (minimum) assumed under that scenario.

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

BAU	Improved	Water Sensitive
No additional riparian planting.	• 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 = 164 km.	• Same as improved but with 10 metres of riparian plating and greater impact from retirement. • Approximate length of riparian planting = 196 km.
BAU	Improved	Water Sensitive
↑		
Provisions		
Approximate length of riparian management required by proposed provisions = 116 km **Proposed provisions** • The ERTPs required under Rule WH.R27(b) requires riparian planting of rivers running through highest erosion risk land on farms >20 ha. Applies to 30 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 86 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 BSP scenarios.*

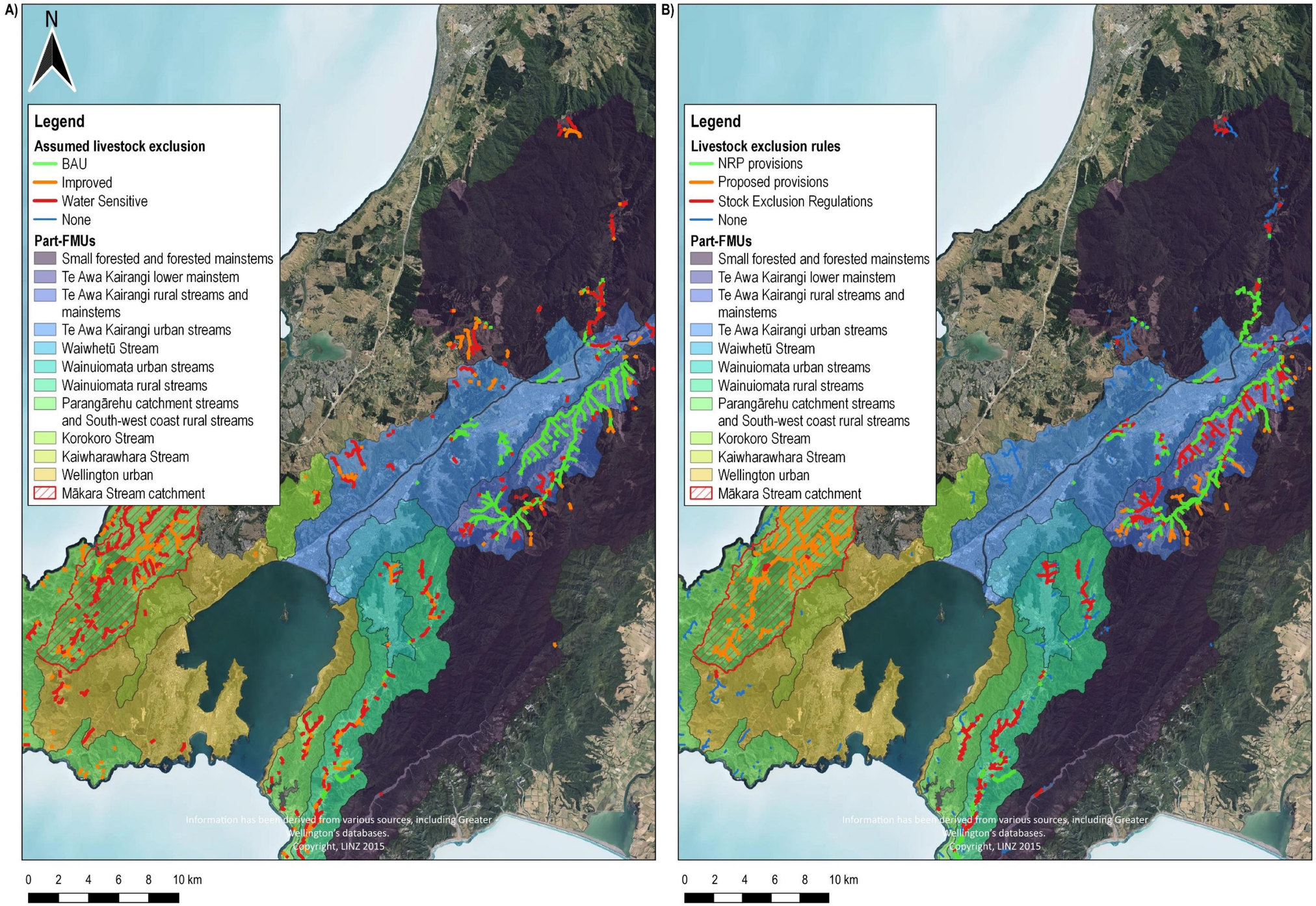


Figure 2: Livestock exclusion assumed under the different BSP scenarios (A) and the proposed provisions (B). The BSP scenarios are additive (i.e., exclusion under the BSP BAU scenario is also assumed under Improved and Water Sensitive).The Mākara Stream Catchment boundary is shown in red.

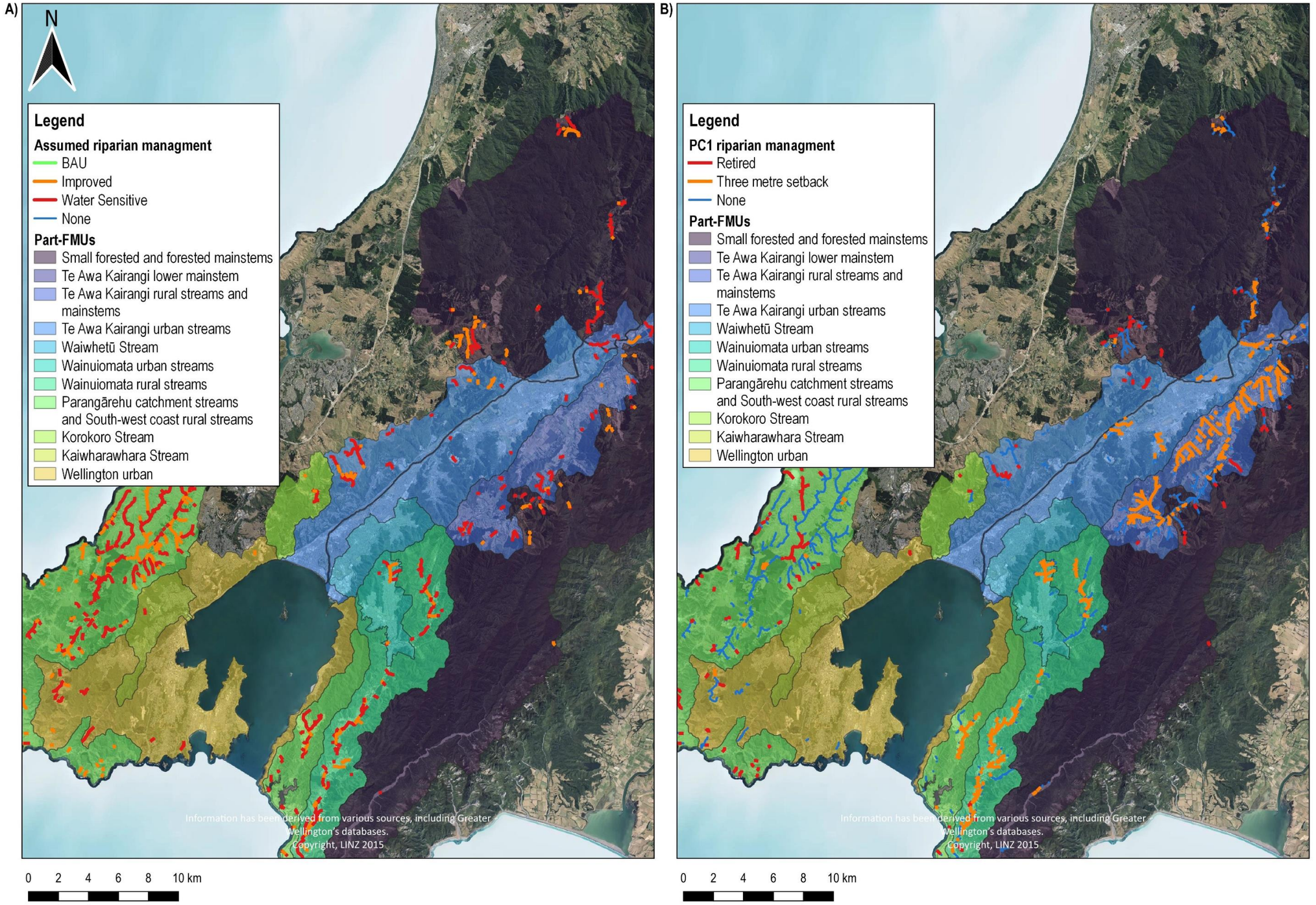


Figure 3: Riparian management assumed under the different BSP scenarios (A) and the proposed provisions (B). The BSP scenarios are additive (i.e., riparian management under the BSP BAU scenario is also assumed under Improved and Water Sensitive).

3.1.5 Earthworks

Policy WH.P29 combined with the conditions of Rule WH.R23 and the matters of discretion in Rule WH.R24 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 WH.P30 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 WH.R25 (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 WH.P30.

All the BSP 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 BSP Water Sensitive Scenario (Table 14).

Table 14: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the BSP scenario assumptions on earthworks.

BAU	Improved	Water Sensitive
• Construction sediment control practices across 100% of 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 WH.P29, Rule WH.R23 and Rule WH.R24 require that the erosion and sediment control guidelines are followed across all earthworks sites covered by those rules. • Policy WH.P30 should ensure the widespread use of chemically treated sediment retention ponds at sites between 0.3 ha and 5 ha.

3.1.6 Stormwater management

The stormwater management required by the proposed provisions goes beyond that assumed under the BSP Water Sensitive scenario (Table 15).

Table 15: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the BSP 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 WH.R5, Rule WH.R6 and Rule WH.R7 (<0.3 ha of new impervious surface) required to provide hydrological controls. • New infill and urban developments carried out under Rule Rule WH.R6 and Rule WH.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 WH.R11 required to provide treatment and hydrological controls through consent conditions (Policy WH.P10 and Policy WH.P14). • Stormwater network operators required by Rule WH.R9 and Schedule 31 to reduce contaminant loads from existing urban areas to meet the relevant TASs for Cu and Zn (not achieved under the BSP 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 WH.R5 - <0.1 ha of new impervious surface) or controlled activity (Rule WH.R6 and Rule WH.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 WH.P10 and Policy WH.P14 means it is also likely that most infill and urban developments greater than 0.3 ha carried out as a discretionary activity (Rule WH.R11) will be required by consent conditions to provide a similar level of contaminant treatment and hydrological control to what is required by Rule WH.R6.

The stormwater treatment assumed under the BSP scenarios are the same as what was assumed for the equivalent TAoP Collaborative Modelling Project (CMP) scenarios. Easton *et al.* (2019b), who documented the freshwater scenario modelling conducted for the CMP, assumed the contaminant load reduction factors for rain gardens set out in Table 16, and noted that these were "*derived from the International Stormwater Best Management Practices (BMP) database and agreed on within the TAoP (Modelling Leadership Group (MLG)*". These load reduction factors are broadly consistent with what was assumed to be achieved through the treatment chains for new developments under the BSP Improved and Water Sensitive scenarios (Table 16). Thus, in terms of stormwater contaminant losses from new urban developments it can be concluded that proposed provisions are consistent with the assumptions of those scenarios.

Table 16: Load reduction factors for raingardens compared to the treatment chain load reduction factors assumed for new urban developments under the BSP Improved and Water Sensitive scenarios (rain garden values from Easton *et al.*, (2019b) , scenario values from assumptions (Appendix B)).

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%	75% - 90%
E. coli	90%	90%	90%
TN	40%	40%	40% - 60%
TP	60%	50%	40% - 60%
Cu	80%	70%	50% - 80%
Zn	80%	70%	50% - 80%

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 BSP Improved scenario (50% of new dwelling have rain tanks installed). However, they are more lenient than 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 BSP Improved scenario 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 WH.R9 and Schedule 31 ((1)(c)-(e), and (2)(b)) of the proposed provisions require stormwater network operators to reduce their Cu and Zn loads over time to meet the relevant TASs. The Freshwater Panel outputs in Greer *et al.* (2022) indicates that some of these TASs may not met be met even with the implementation of the BSP Water Sensitive scenario assumptions. Accordingly, the proposed provisions are likely to result in all stormwater contaminant loads from existing urban area being reduced by as much as would occur under that scenario.

Notes: Stormwater treatment does not only remove Cu and Zn; it also treats the other contaminants assessed in this report (see Table 16 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 BSP Water Sensitive scenario (Table 17).

Rule WH.R14 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 8.2 or coastal water objective in Table 8.1 for the relevant part FMU or coastal water management unit"

The Freshwater Panel outputs suggest that some of the *E. coli* TASs for urban catchments are not expected to be met under the BSP Water Sensitive scenario. Consequently, it can be expected that to achieve the *E. coli* and enterococci reductions required by Rule WH.R14, network operators may have to reduce wastewater discharge volumes (and associated contaminant loads) by at least as much as was assumed under that scenario.

Table 17: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the BSP scenario assumptions on wastewater management.

BAU	Improved	Water Sensitive
New urban development does not increase the frequency or volume of wastewater overflows of dry-weather wastewater discharges through cross-connections.	• All cross connections repaired. • Wastewater overflows reduced from 12 per year on average to four.	As for Improved but wastewater overflows reduced to two per year.
BAU	Improved	Water Sensitive
		↑
		Provisions Networks operators to wastewater discharge volumes and loads to meet *E. coli* TASs and enterococci objectives (Rule WH.R14).

3.1.8 Land-use change not associated with retirement.

3.1.8.1 Urban development or rural land

All three BSP 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 BSP scenarios goes ahead, the proposed urban development provisions prohibit new unplanned urban development (Rule WH.R13). Consequently, they are broadly consistent with the BSP Water Sensitive scenario assumptions (Table 18).

3.1.8.2 Change of rural land uses

The BSP scenarios all 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 18), in that any change to a higher intensity land use will generally be a non-complying activity (Rule WH.R32), as Condition (d) of Rule WH.R31 is not met in any rural or mixed rural part-FMU[15]. Furthermore, the FEPs required by Rule WH.R27(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).

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.

[15] No single rural or mixed rural part-FMU meets all TASs for DIN, DRP and visual clarity and only the Small forested and forested mainstems part-FMU currently meets the TASs for *E. coli*.

Table 18: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the BSP 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 WH.RU9 prohibits unplanned urban development. • Change to a higher intensity rural land-use is a non-complying activity (Rule WH.R31(d) and Rule WH.R32).

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 BSP Water Sensitive scenario (Table 19).

None of BSP scenarios assumed changes in land use practice except the livestock exclusion, riparian planting, space planting and sediment control (earthworks) described above in Sections 3.1.2 to 3.1.5 above. However, the proposed provisions require some level of good management practice for:

- Vegetation Clearance on land with high erosion risk (Rule WH.R17 to Rule WH.R19);
- Plantation Forestry (Rule WH.R20 to Rule WH.R22);and
- Farming activities on 20ha or more of land (Rule WH.R27).

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 19: Summary assessment of where the proposed provisions sit (denoted by the ↑) in relation to the BSP 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 WH.R17 - Rule WH.R19); • Plantation Forestry (Rule WH.R20 - Rule WH.R22); and • Farming activities on 20ha or more of land (Rule WH.R27).

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

3.2.1 Sediment

3.2.1.1 Rural and mixed-rural part-FMUs

In rural and mixed rural part-FMUs the proposed provisions relevant to the sediment attribute group are most consistent with the assumptions of the BSP Improved scenario in that they require a similar or greater level of:

- Retirement;
- Space planting of high erosion risk land;
- Livestock exclusion; and
- Land use change (excluding retirement).

However, in some part-FMUs they may still result in slightly lower sediment load reductions than were predicted under that scenario as the required riparian management is less extensive than that assumed under Improved (30%) and, on low slope land, may 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)).

3.2.1.2 Urban part-FMUs

The proposed provisions require sediment loads in stormwater (including from earthworks sites) and wastewater be reduced to the same extent assumed under BSP Water Sensitive scenario (see Sections 3.1.5, 3.1.6 and 3.1.7). Thus, in purely urban catchments the proposed provisions should achieve the same outcomes for this attribute group as predicted under that scenario.

3.2.2 Faecal indicator bacteria

3.2.2.1 Rural and mixed-rural part-FMUs

In rural and mixed rural catchments, the proposed provisions are likely to impact the faecal indicator bacteria attribute group in a manner most consistent with the predicted outcomes of the BSP Improved scenario, as they require a similar level of retirement and a slightly greater level of stock exclusion. However, as for sediment they may still result in slightly lower *E. coli* reductions than predicted under Improved as the required riparian management is likely to be less effective at stripping microbial contaminants than assumed under that scenario [16].

3.2.2.2 Urban part-FMUs

As stated in Section 3.1.7, the proposed provisions require urban sources of faecal indicator bacteria to be reduced to the same extent assumed under BSP Water Sensitive scenario. Consequently, in purely urban catchments the proposed provisions should achieve the same outcomes for *E. coli* and enterococci as predicted under that scenario (Greer *et al.*, 2022).

3.2.3 Nitrogen

3.2.3.1 Rural and mixed rural catchments

In rural and mixed rural catchments, the proposed provisions are most consistent with the nitrogen management assumptions of the BSP Improved scenario. The reasons for this are the same as those provided for faecal indicator bacteria in Section 3.2.2.1.

3.2.3.2 Urban catchments

The proposed provisions require nitrogen loads in stormwater and wastewater be reduced to the same extent assumed under the BSP Water Sensitive scenario (see Sections 3.1.6 and 3.1.7).

3.2.4 Phosphorus

3.2.4.1 Rural and mixed rural catchments

For the same reasons as provided for sediment (Section 3.2.1.1) the proposed provisions relevant to the phosphorus attribute group are most consistent with the assumptions of the BSP Improved scenario.

3.2.4.2 Urban catchments

The proposed provisions require phosphorous loads in stormwater and wastewater be reduced to the same extent assumed under the BSP Water Sensitive scenario (see Sections 3.1.6 and 3.1.7).

[16] 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 BSP 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 predicted under that scenario.

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

3.2.6 Periphyton

3.2.6.1 Rural and mixed-rural catchments

Based on the Freshwater Panel's scenario assessments(Greer *et al.*, 2022), shade was considered a key driver of the predicted changes in this attribute under the different BSP 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 riparian management (i.e., shading) they require is most consistent with what was assumed under that scenario (see Section 3.1.4).

3.2.6.2 Urban catchments

The proposed provisions require that nitrogen and phosphorus loads in stormwater and wastewater be reduced by at least the amount assumed under the BSP Water Sensitive scenario. In urban areas the riparian management required by the provisions (i.e., none) is also consistent with the Water Sensitive scenario. Thus, in urban part-FMUs the proposed provisions are likely to achieve the periphyton outcomes predicted under that scenario.

3.2.7 Summary

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

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

Attribute group	Most applicable scenario	Indication of where provisions sit in relation to scenarios
Sediment (rural and mixed-rural part-FMUs)	Improved	BAU — Improved — Water Sensitive ↑ Provisions
Sediment (urban part-FMUs)	Water Sensitive	BAU — Improved — Water Sensitive ↑ Provisions
Faecal indicator bacteria (rural and mixed-rural part-FMUs)	Improved	BAU — Improved — Water Sensitive ↑ Provisions
Faecal indicator bacteria (urban part-FMUs)	Water Sensitive	BAU — Improved — Water Sensitive ↑ Provisions
Nitrogen (rural and mixed-rural part-FMUs)	Improved	BAU — Improved — Water Sensitive ↑ Provisions
Nitrogen (urban part-FMUs)	Water Sensitive	BAU — Improved — Water Sensitive ↑ Provisions
Phosphorus (rural and mixed-rural part-FMUs)	Improved	BAU — Improved — Water Sensitive ↑ Provisions
Phosphorus (urban part-FMUs)	Water Sensitive	BAU — Improved — Water Sensitive ↑ Provisions
Metals	Water Sensitive	BAU — Improved — Water Sensitive ↑ Provisions
Periphyton (rural and mixed rural part-FMUs)	Improved	BAU — Improved — Water Sensitive ↑ Provisions
Periphyton (urban part-FMUs)	Water Sensitive	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

Depending on the part-FMU, the proposed provisions that manage sediment and phosphorus losses are most consistent with either the BSP Improved scenario (rural and mixed-rural part-FMUs) or the Water Sensitive scenario (urban part-FMUs). The Freshwater Panel predicted suspended fine sediment (SFS (measured through visual clarity)) and dissolved reactive phosphorus (DRP) concentrations would at least be maintained in all part-FMUs under both those scenarios; despite background loads increasing due to to climate change (Greer *et al.*, 2022) (Table 21 and Table 22). Thus, the proposed provisions are likely sufficient to ensure the maintenance of these attributes in those part-FMUs where the TASs require this.

Table 21: The predicted direction of change in SFS under the different BSP scenarios in the part-FMUs where the TASs require the maintenance of this attribute (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Small forested and forested mainstems	Whakatikei R. @ Riverstone	SFS	A	Maintain	Maintain	Maintain	✓
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.			Degrade		Improve	
Waiwhetū Stream	Waiwhetu S. @ Whites Line East						
Korokoro Stream	Korokoro S. @ Cornish St. Br.[1]				Improve		
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge				Maintain		
Wellington urban	Karori S. @ Mākara Peak[2]				Improve		
					↑ Provisions (rural part-FMUs)	↑ Provisions (urban part-FMUs)	

[1] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained.
[2] Assessed as B in Greer *et al.* (2022).

Table 22: The predicted direction of change in DRP concentrations under the different BSP scenarios in the part-FMUs where the TASs require the maintenance of this attribute (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott	DRP (Median mg/L)	0.004	Maintain	Improve	Improve	✓
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.		0.018				
Wellington urban	Karori S. @ Mākara Peak		0.035				
Small forested and forested mainstems	Whakatikei R. @ Riverstone	DRP (95th %ile mg/L)	0.011	Maintain	Maintain	Maintain	
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott		0.008		Improve	Improve	
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua		0.015	Improve			
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.		0.027	Maintain			
Waiwhetū Stream	Waiwhetu S. @ Whites Line East		0.049				
Wainuiomata urban streams	Black Ck @ Rowe Parade		0.035				
Wainuiomata rural streams	Wainuiomata River D/S of White Br.		0.017				
Wellington urban	Karori S. @ Mākara Peak		0.062				
					↑ Provisions (rural part-FMUs)	↑ Provisions (urban part-FMUs)	

4.1.1.2 Faecal indicator bacteria attribute group

For faecal indicator bacteria, the proposed provisions are most consistent with the BSP Improved scenario (Section 3.2.2) in rural and mixed-rural part-FMUs. Based on the Freshwater and Coastal Panels' assessment of this scenario (Greer *et al.*, 2022; Melidonis *et al.*, 2020), it is likely that the proposed provisions will ensure that *E. coli* and enterococci concentrations are maintained in those part-FMUs where this is required by the TASs and coastal objectives (Table 23).

4.1.1.3 Nitrogen attribute group

In rural and mixed-rural part-FMUs, the proposed provisions that manage nitrogen losses are most consistent with assumptions of the BSP Improved scenario, while in urban areas they align better with the Water Sensitive scenario. The Freshwater Panel's assessment of both of those scenarios (Greer *et al.*, 2022), indicates that the proposed provisions are likely to achieve those TASs that require dissolved inorganic nitrogen (DIN), nitrate-nitrogen (NO_3-N) and ammoniacal nitrogen (NH_4-N) concentrations to be maintained (Table 24 and Table 25).

Table 23: The predicted direction of change in *E. coli* (rivers) and enterococci (coast) concentrations under the different BSP scenarios in the part-FMUs where the TASs/coastal objectives require the maintenance of these attributes (based on the outputs of the Freshwater and Coastal Panels (Greer *et al.*, 2022; Melidonis *et al.*, 2020)). 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 and TAS/ objective	Scenario results			Provisions likely to achieve TAS/ objective?
				BAU	Improved	Water Sensitive	
Small forested and forested mainstems	Whakatikei R. @ Riverstone	*E. coli*	A[1]	Maintain	Maintain	Maintain	✓
Mākara Estuary		Enterococci (95th %ile /100mL)	Maintain or improve	Maintain	Improve	Improve	
Wainuiomata Estuary							
Wai Tai							
					↑ Provisions		

[1] Assessed as B in Greer *et al.* (2022).

Table 24: The predicted direction of change in DIN, NO_3-N, and NH_4-N concentrations under the different BSP scenarios in the urban part-FMUs where the TASs require the maintenance of these attributes (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.	NH_4-N	A	Maintain	Improve	Improve	✓
Waiwhetū Stream	Waiwhetu S. @ Whites Line East		A[1]				
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge		B				
Wellington urban	Karori S. @ Mākara Peak		A				
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.	NO_3-N	A	Maintain	Improve	Improve	
Waiwhetū Stream	Waiwhetu S. @ Whites Line East						
Wainuiomata urban streams	Black Ck @ Rowe Parade						
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge		B				
Wellington urban	Karori S. @ Mākara Peak						
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.	DIN (median mg/L)	0.24	Maintain	Improve	Improve	
Waiwhetū Stream	Waiwhetu S. @ Whites Line East		0.56				
Wainuiomata urban streams	Black Ck @ Rowe Parade		0.5				
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge		1.14				
Wellington urban	Karori S. @ Mākara Peak		1.29				
						↑ Provisions	

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

Table 25: The predicted direction of change in DIN, NO_3-N, and NH_4-N concentrations under the different BSP scenarios in the rural and mixed-rural part-FMUs where the TASs require the maintenance of these attributes (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Small forested and forested mainstems	Whakatikei R. @ Riverstone	NH_4-N	A	Maintain	Maintain	Maintain	✓
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott				Improve	Improve	
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua				Maintain	Maintain	
Wainuiomata rural streams	Wainuiomata River D/S of White Br.				Improve	Improve	
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels				Maintain	Maintain	
Korokoro Stream	Korokoro S. @ Cornish St. Br.		A[1]				
Small forested and forested mainstems	Whakatikei R. @ Riverstone	NO_3-N	A	Maintain	Maintain	Maintain	
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott				Improve	Improve	
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua						
Wainuiomata rural streams	Wainuiomata River D/S of White Br.						
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels						
Korokoro Stream	Korokoro S. @ Cornish St. Br.		A[1]				
Small forested and forested mainstems	Whakatikei R. @ Riverstone	DIN (median mg/L)	0.15	Maintain	Maintain	Maintain	
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott		0.2		Improve	Improve	
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua		0.44				
Wainuiomata rural streams	Wainuiomata River D/S of White Br.		0.17				
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels		0.42				
Korokoro Stream	Korokoro S. @ Cornish St. Br.		≤0.263[1]				
					↑ Provisions		

[1] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained.

4.1.1.4 Metals attribute group

The proposed provisions require that the TASs for Cu and Zn in Table 3 be met through the actions of stormwater network operators (via loads; see Section 3.1.6). Consequently, for the purposes of this assessment it is assumed that the proposed provisions are sufficient to ensure the achievement of those TASs (Table 26).

Table 26: The predicted direction of change in Zn and Cu concentrations under the different BSP scenarios in the part-FMUs where the TASs require the maintenance of these attributes (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Small forested and forested mainstems	Whakatikei R. @ Riverstone	Cu	A[1]	Maintain	Maintain	Maintain	✓
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott		A[2]	Degrade	Improve	Improve	
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua		A[1]	Maintain	Maintain	Maintain	
Wainuiomata urban streams	Black Ck @ Rowe Parade		C	Degrade			
Wainuiomata rural streams	Wainuiomata River D/S of White Br.		A[1]				
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels			Maintain			
Korokoro Stream	Korokoro S. @ Cornish St. Br.						
Small forested and forested mainstems	Whakatikei R. @ Riverstone	Zn	A[1]	Maintain	Maintain	Maintain	
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott		A	Degrade	Improve	Improve	
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua		A[1]	Maintain	Maintain	Maintain	
Wainuiomata rural streams	Wainuiomata River D/S of White Br.			Degrade	Improve	Improve	
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels			Maintain	Maintain	Maintain	
Korokoro Stream	Korokoro S. @ Cornish St. Br.						
						↑ Provisions	

[1] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained.
[2] Assessed as B in Greer *et al.* (2022).

4.1.1.5 *Periphyton*

The Freshwater Panel's assessment of the BSP BAU and Water Sensitive scenarios suggests that the proposed provisions are likely sufficient to ensure the maintenance of periphyton biomass in all but two of the part-FMUs where this is required by the TASs (Table 27 and Table 28).

Furthermore, while the Freshwater Panel did predict that this attribute would degrade in the Wainuiomata rural streams and Korokoro Stream part-FMUs under the assigned BSP scenario (BAU), this is because they accounted for the impacts of climate change at 2090 on summer low flows (Greer *et al.*, 2022). There is no reason to expect that the proposed provisions themselves will cause a degradation in periphyton biomass in these part-FMUs; rather they are just unlikely to mitigate the adverse effects of climate change.

Table 27: The predicted direction of change in periphyton biomass under the different BSP scenarios in the urban part-FMUs where the TASs require the maintenance of this attribute (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.	Periphyton biomass	C[1]	Degrade	Maintain	Improve	✓
Waiwhetū Stream	Waiwhetu S. @ Whites Line East						
Wainuiomata urban streams	Black Ck @ Rowe Parade						
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge		C[2]	Maintain	Maintain		
Wellington urban	Karori S. @ Mākara Peak		C[1]				
						↑ Provisions	

[1] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained.
[2] Baseline state is D. However, current state is C (GW, 2022).

Table 28: The predicted direction of change in periphyton biomass under the different BSP scenarios in the rural and mixed-rural part-FMUs where the TASs require the maintenance of this attribute (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Small forested and forested mainstems	Whakatikei R. @ Riverstone	Periphyton biomass	A[1]	Maintain	Maintain	Maintain	✓
Wainuiomata rural streams	Wainuiomata River D/S of White Br.		C[2]	Degrade		Improve	×
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels		C[1]	Maintain	Improve		✓
Korokoro Stream	Korokoro S. @ Cornish St. Br.			Degrade			×
				↑ Provisions			

[1] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained.
[2] Baseline state is D. However, current state is C (GW, 2022).

4.1.2 Improve TASs and coastal objectives

4.1.2.1 Sediment attribute group

In combination[17], the Freshwater Panel's BSP Improved and Water Sensitive scenario assessments and the national scale erosion modelling by Neverman *et al.* (2019) suggest that the proposed provisions may achieve all but two of the TASs that require an improvement in SFS (Greer *et al.*, 2022) (Table 29 and Table 30). The part-FMUs where this is not the case are:

- Te Awa Kairangi lower mainstem; and
- Wainuiomata rural streams.

Based on the Freshwater Panel outputs, the achievement of those TASs will require the implementation of the proposed provisions and additional non-regulatory actions that are at least as effective at reducing rural sediment losses as those assumed under that BSP Water Sensitive scenario (Table 29); i.e.:

- Planting 10-m riparian buffers on all second order and above streams on low slope (<15°) pastoral land; and
- Retiring all high erosion risk land.

[17] I.e., TAS predicted to be met under assigned scenario based on outputs of either Neverman *et al.* (2019) or Greer *et al.* (2022).

Table 29: Predicted SFS attribute states under the different BSP scenarios in the part-FMUs where the TASs require an improvement in this attribute (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott	SFS	C[1]	A	C	C	C	×
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua		D	C	D			✓
Wainuiomata urban streams	Black Ck @ Rowe Parade		D[2]			D		
Wainuiomata rural streams	Wainuiomata River D/S of White Br.		D					×
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels							
						↑ Provisions (rural part-FMUs)	↑ Provisions (urban part-FMUs)	

[1] Assessed as B in Greer *et al.* (2022); the states presented for WSP scenarios are based on the baseline state in Table 3 and the Freshwater Panels 'change' assessments.
[2] Not assessed in Greer *et al.* (2022); the states presented for WSP scenarios are based on the baseline state in Table 3 and the Freshwater Panels 'change' assessments.

Table 30: Predicted SFS attribute states (and sediment load reductions) and under the different BSP scenarios in the rural and mixed-rural part-FMUs where the TASs require an improvement in this attribute (based on modelled sediment loads in Neverman *et al.* (2019) 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	TAS	Scenario results			Provisions likely to achieve TAS?
					BAU	Improved	Water Sensitive	
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott	SFS	C[1]	A	C (-7%)	C (-8%)	B (-8.3%)	×
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua		D	C	D (-5%)	D (-34%)	C (-43%)	
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels		D	C	D (-3%)	C (-53%)	A (-55%)	✓
						↑ Provisions		

[1] Assessed as B in Greer *et al.* (2022); the states presented for WSP scenarios are based on the baseline state in Table 3 and the Freshwater Panels 'change' assessments.

4.1.2.2 *Faecal indicator bacteria attribute group*

The Freshwater Panels' assessment of the BSP Improved (rural and mixed rural part-FMUs) and Water Sensitive scenario (urban part-FMUs) suggest the proposed provisions are likely to achieve all of the *E. coli* TASs that require an improvement except in the following part-FMUs: (Table 31 and Table 32) (Greer *et al.*, 2022):

- Rural and mixed rural part-FMUs:
  - Te Awa Kairangi rural streams and mainstems; and
  - Parangārehu catchment streams and South-west coast rural streams.
- Urban part-FMUs:
  - Wainuiomata urban streams; and
  - Wellington urban.

In contrast, the outputs Coastal Panels' assessment indicate that the proposed provisions are unlikely to result in the achievement of the only coastal objective that requires an improvement in enterococci (Table 31) (Melidonis *et al.*, 2020).

In rural and mixed rural part-FMUs all *E. coli* TASs and enterococci coastal objectives were predicted to be met under the BSP Water Sensitive scenario. This suggests that in areas where the proposed provisions are unlikely to result in their achievement (Table 31), additional non-regulatory actions like those assumed under that scenario may be required; i.e.:

- Planting 10-m riparian buffers on all second order and above streams on low slope (<15°) pastoral land; and
- Retiring all high erosion risk land.

Note: The information produced by the BSP does not allow for the identification of specific non-regulatory actions that could result in the achievement of the E. coli TASs for the Wainuiomata urban streams; and Wellington urban part-FMUs.

Table 31: Predicted *E. coli* attribute states (rivers) and enterococci concentrations (coast) under the different BSP scenarios in the rural and mixed-rural part-FMUs where the TASs or coastal objectives require an improvement in these attributes (based on the outputs of the freshwater and Coastal Panels (Greer *et al.*, 2022; Melidonis *et al.*, 2020)). 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	
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott	*E. coli*	D	C	D	C	B	✓
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua		D	B	D	C	B	×
Wainuiomata rural streams	Wainuiomata River D/S of White Br.		B[1]	A	B	A	A	✓
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels		E	D	E	E	D	×
Korokoro Stream	Korokoro S. @ Cornish St. Br.		N/A[2]	B	Maintain	Improve (within attribute state)	Improve (one attribute state)	?
Te Whanganui-a-Tara (Harbour and estuaries)		Enterococci (95th %ile /100mL)	>200	≤200	>200	>200	≤200	×

↑ Provisions

[1] Assessed as D in Greer *et al.* (2022); the states presented for WSP scenarios are based on the baseline state in Table 3 and the Freshwater Panels 'change' assessments.
[2] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained.

Table 32: Predicted *E. coli* attribute states under the different BSP scenarios in the urban part-FMUs where the TASs require an improvement in this attribute (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.	*E. coli*	E[1]	C	E	C	C	✓
Waiwhetū Stream	Waiwhetu S. @ Whites Line East		E					
Wainuiomata urban streams	Black Ck @ Rowe Parade		E[1]			D	D	×
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge		E			C	C	✓
Wellington urban	Karori S. @ Mākara Peak					D	D	×

↑ Provisions

[1] Not assessed in Greer *et al.* (2022); the states presented for WSP scenarios are based on the baseline state in Table 3 and the Freshwater Panels 'change' assessments.

4.1.2.3 *Nitrogen attribute group*

The Freshwater Panel's assessment of the BSP Water Sensitive Scenario suggests that the proposed provisions are unlikely to achieve the reductions in NH_4-N concentrations required by the TAS for the Wainuiomata urban streams part-FMU (Table 33) (Greer *et al.*, 2022). Unfortunately, it is not possible to identify specific non-regulatory actions that could achieve this TAS using information produced by the BSP.

Table 33: Predicted NH_4-N attribute states under the different BSP scenarios in the part-FMUs where the TASs require an improvement in this attribute (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Wainuiomata urban streams	Black Ck @ Rowe Parade	NH_4-N	B	A	B	B	B	×
							↑ Provisions	

4.1.2.4 *Phosphorus attribute group*

It is unlikely that the proposed provisions will achieve most of the TASs that require an improvement in DRP given the Freshwater Panel's assessment of the BSP Improved and Water Sensitive scenarios (Table 34 and Table 35) (Greer *et al.*, 2022). Furthermore, in most part-FMUs it is likely that these TASs will not be achieved without non-regulatory actions that are more effective at reducing phosphorus losses than those assumed under the BSP Water Sensitive scenario (Table 34 and Table 35); i.e.:

- Planting 10-m riparian buffers on all second order and above streams on low slope (<15°) pastoral land; and
- Retiring all high erosion risk land.

Table 34: Predicted DRP concentrations under the different BSP scenarios in the rural and mixed-rural part-FMUs where the TASs require an improvement in this attribute (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). Ranges are given in this table as the Freshwater Panel considered change in NPS-FM 2020 attribute state rather than mass concentration. 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	
Small forested and forested mainstems	Whakatikei R. @ Riverstone	DRP (Median mg/L)	0.008	≤0.006	0.008	0.008	0.008	×
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua		0.01	≤0.006	0.006 – 0.01	≤0.006	≤0.006	✓
Wainuiomata rural streams	Wainuiomata River D/S of White Br.		0.011	≤0.01	0.011	0.01 – 0.011	≤0.01	×
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels		0.027	≤0.018	>0.027	0.018 – 0.027	≤0.018	
Korokoro Stream	Korokoro S. @ Cornish St. Br.		N/A[1]	≤0.006	Maintain	Improve	Improve	?
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels	DRP (95th %ile mg/L)	0.064	≤0.054	>0.064	0.054 – 0.064	≤0.054	×
Korokoro Stream	Korokoro S. @ Cornish St. Br.		N/A[1]	≤0.021	Maintain	Improve	Improve	?
						↑ Provisions		

[1] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained.

Table 35: Predicted DRP concentrations under the different BSP scenarios in the urban part-FMUs where the TASs require an improvement in this attribute (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). Ranges are given in this table as the Freshwater Panel considered change in NPS-FM 2020 attribute state rather than mass concentration. 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	
Waiwhetū Stream	Waiwhetu S. @ Whites Line East	DRP (Median mg/L)	0.024	≤0.018	0.024	0.018 – 0.024	0.018 – 0.024	×
Wainuiomata urban streams	Black Ck @ Rowe Parade		0.021	≤0.018	0.021	0.018 – 0.021	≤0.018	✓
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge		0.037	≤0.018	0.037	0.018 – 0.037	0.018 – 0.037	×
		DRP (95th %ile mg/L)	0.064	≤0.054	0.064	0.054 – 0.064	0.054 – 0.064	
							↑ Provisions	

4.1.2.5 *Metals attribute group*

The proposed provisions require that the Cu and Zn TASs in Table 3 be met through the actions of stormwater network operators (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 Freshwater Panel's outputs suggests this will require actions beyond the assumptions of the BSP Water Sensitive Scenario (i.e., Te Awa Kairangi urban streams, Waiwhetū Stream, Kaiwharawhara Stream, Wellington urban) (Table 36).

Table 36: Predicted Cu and Zn attribute states under the different BSP scenarios in the part-FMUs where the TASs require an improvement in these attributes (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.	Cu	C[1]	B	C	C	A	✓
Waiwhetū Stream	Waiwhetu S. @ Whites Line East		C	A	D	D	B	
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge			B		C	C	
Wellington urban	Karori S. @ Mākara Peak		D	C		D	D	
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.	Zn	C[1]	B	C	B	A	
Waiwhetū Stream	Waiwhetu S. @ Whites Line East		D	B	D	C	B	
Wainuiomata urban streams	Black Ck @ Rowe Parade		D[1]	C		B	A	
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge		B	A		C	B	
Wellington urban	Karori S. @ Mākara Peak		D	C				
						↑ Provisions		

[1] Not assessed in Greer *et al.* (2022); the states presented for WSP scenarios are based on the baseline state in Table 3 and the Freshwater Panels 'change' assessments.

4.1.2.6 *Periphyton*

The Freshwater Panel outputs indicate that the proposed provisions are unlikely to improve periphyton biomass in the Te Awa Kairangi rural streams and mainstems part-FMU or the Te Awa Kairangi lower mainstem part-FMU to the extent required by the relevant TASs (Table 37). Furthermore, it is unlikely that that those TASs will be met without additional non-regulatory actions that go beyond those assumed under the BSP Water Sensitive scenario (Table 37).

Table 37: Predicted periphyton biomass attribute states under the different BSP scenarios in the part-FMUs where the TASs require an improvement in this attribute (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott	Periphyton biomass	D[1]	B	D	D	D	×
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua						C	
					↑ Provisions			

[1] Assessed as C in Greer *et al.* (2022); the states presented for WSP scenarios are based on the baseline state in Table 3 and the Freshwater Panels 'change' assessments.

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

4.2.1 Maintain TASs and coastal objectives

4.2.1.1 Deposited sediment

Based on the Freshwater Panel's assessment of the BSP Improved and Water Sensitive scenarios, 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 38). Similarly, the Coastal Panel's assessment of the BSP Improved scenario suggests that the proposed provisions should be sufficient to achieve the maintenance of the 'muddiness' and 'sedimentation rate' attributes where this is required by the coastal objectives (Melidonis *et al.*, 2020) (Table 38).

Table 38: The predicted direction of change in DFS (rivers), muddiness (coast) and sedimentation rate (coast) under the different BSP scenarios in the part-FMUs where the TASs and coastal objectives require the maintenance of these attributes (based on the outputs of the freshwater and Coastal Panels (Greer *et al.*, 2022; Melidonis *et al.*, 2020)). 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 consistent with the achievement of the TASs/coastal objectives.

Part-FMU	Site	Attribute	Baseline state and TAS/ objective	Scenario results			Provisions consistent with the TAS/ objective?
				BAU	Improved	Water Sensitive	
Small forested and forested mainstems	Whakatikei R. @ Riverstone	DFS	A[1]	Maintain	Maintain	Maintain	✓
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott		A		Improve	Improve	
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua			Improve			
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.		B	Degrade	Maintain		
Wainuiomata urban streams	Black Ck @ Rowe Parade		A		Improve		
Wainuiomata rural streams	Wainuiomata River D/S of White Br.		A[1]				
Korokoro Stream	Korokoro S. @ Cornish St. Br.		A[2]				
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge		A[1]		Maintain		
Te Whanganui-a-Tara (Harbour and estuaries)		Muddiness (% area >50% mud and % of sample)	Maintain or improve	Degrade	Maintain	Improve	
Wainuiomata Estuary					Improve		
Wai Tai					Maintain	Maintain	
Te Whanganui-a-Tara (Harbour and estuaries)		Sedimentation rate (C:N)	Maintain or improve	Degrade	Maintain	Improve	
Wainuiomata Estuary					Improve		
Wai Tai					Maintain	Maintain	
					↑ Provisions (rural part-FMUs)	↑ Provisions (urban part-FMUs)	

[1] Baseline state is C. However, current state is A (GW, 2022).
[2] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained

4.2.1.2 Faecal indicator bacteria in lakes

The Freshwater Panel outputs indicate that *E. coli* inputs to lakes from rivers in rural and mixed-rural part-FMUs would not increase under the assumptions of the BSP Improved scenario (Greer *et al.*, 2022). Consequently, it can be assumed that the proposed provisions will be sufficient to meet the *E. coli* TASs for Lake Kōhangatera and Lake Kōhangapiripiri (Table 39).

Table 39: The predicted direction of change in *E. coli* concentrations (lakes) under the different BSP scenarios in the part-FMUs where the TASs require the maintenance of this attribute (based on the Freshwater Panel's outputs for rivers in rural and mixed-rural part-FMUs (Greer *et al.*, 2022)). 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	
Lake Kōhangatera		*E. coli*	A	Maintain[1]	Improve[1]	Improve[1]	✓
Lake Kōhangapiripiri							
					↑ Provisions		

[1] Based on the freshwater panel results for rural rivers.

4.2.1.3 *Nitrogen in lakes*

Nitrogen concentrations in lakes are driven by internal cycling and external inputs (Schallenberg, 2019). Thus, in the absence of relevant modelling results, the only conclusion that can be drawn from the Freshwater Panel's assessment of the most relevant BSP scenario (Improved), is that the proposed provisions are unlikely to increase external (i.e., from rivers) nitrogen loads to Lake Kōhangatera and Lake Kōhangapiripiri. Hence, they also are unlikely to cause an in increase in total nitrogen (TN) or NH_4-N concentrations that would prevent these attributes being maintained (Table 40). However, as the internal nutrient cycling processes of these lakes are not fully understood, more detailed analysis would be needed to confirm that concentrations of these attributes will not increase for other reasons.

Table 40: The assumed direction of change in TN and NH_4-N concentrations (lakes) under the different BSP scenarios in the part-FMUs where the TASs require the maintenance of these attributes (based on the Freshwater Panel's outputs for nitrogen attributes in rivers in rural and mixed-rural part-FMUs (Greer *et al.*, 2022)). 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 consistent with the achievement of the TASs.

Part-FMU	Site	Attribute	Baseline state and TAS	Scenario results			Provisions consistent with the TAS?
				BAU	Improved	Water Sensitive	
Lake Kōhangatera		NH_4-N	A	Maintain[1]	Maintain[1]	Maintain[1]	✓
Lake Kōhangapiripiri							
Lake Kōhangatera		TN	B	Maintain[1]	Maintain[1]	Maintain[1]	
					↑ Provisions		

[1] Based on the freshwater panel results for rural rivers.

4.2.1.4 *Metals in coastal environments*

The proposed provisions require that stormwater network operators achieve the rivers Cu and Zn TASs through actions that may have to go beyond those assumed under the BSP Water Sensitive Scenario (see Section 3.1.6 and Table 36). Based on this and the outputs of the Coastal Panel, it is likely that the proposed provisions will result in sediment Cu and Zn concentrations at least being maintained where this is required by the coastal objectives (Table 41).

Table 41: The predicted direction of change in sediment Cu and Zn concentrations (coast) under the different BSP scenarios in the part-FMUs where the coastal objectives require the maintenance of these attributes (based on the outputs of Coastal Panel (Melidonis *et al.*, 2020)). 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 coastal objectives.

Part-FMU	Site	Attribute	Objective	Scenario results			Provisions likely to achieve objective?
				BAU	Improved	Water Sensitive	
Te Whanganui-a-Tara (Harbour and estuaries)		Sediment Cu	Maintain or improve	Degrade	Maintain	Improve	✓
Mākara Estuary							
Wainuiomata Estuary						Maintain	
Wai Tai						Improve	
Te Whanganui-a-Tara (Harbour and estuaries)		Sediment Zn	Maintain or improve	Degrade	Maintain	Improve	
Mākara Estuary							
Wainuiomata Estuary						Maintain	
Wai Tai						Improve	
						↑ Provisions	

4.2.1.5 *Dissolved oxygen*

Dissolved oxygen (DO) was not explicitly assessed by the Freshwater Panel (Greer *et al.*, 2022). However, given that primary production is major driver of DO (He *et al.*, 2011) it can be assumed that in rivers, 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 BSP scenarios assigned to that attribute (rural and mixed rural part-FMUs = BAU; urban part-FMUs = Water Sensitive). On that basis it is likely that the proposed provisions will maintain DO in all part-FMUs where that is required by the TASs (Table 42).

It is not possible to assign a BSP scenario to the proposed provisions for DO in lakes, as none of the Freshwater Panel outputs for rivers are directly transferable. Nevertheless, as the proposed provisions do not allow for an increase in external nutrient inputs that would increase primary productivity (Sections 4.2.1.3 and 4.2.2.2 (below)), it is unlikely that they will degrade DO in Lake Kōhangatera and Lake Kōhangapiripiri.

Table 42: The predicted direction of change in DO concentrations under the different BSP scenarios in the part-FMUs where the TASs require the maintenance of this attribute (based on the periphyton outputs of the Freshwater Panel (Greer *et al.*, 2022)). 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	
Small forested and forested mainstems	Whakatikei R. @ Riverstone	DO	A[1]	Maintain	Maintain	Maintain	✓
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott			Degrade			
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua				Improve	Improve	
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.				Maintain		
Wainuiomata urban streams	Black Ck @ Rowe Parade						
Wainuiomata rural streams	Wainuiomata River D/S of White Br.						
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels			Maintain	Improve		
Korokoro Stream	Korokoro S. @ Cornish St. Br.			Degrade	Improve		
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge			Maintain	Maintain		
Wellington urban	Karori S. @ Mākara Peak						
				↑ Provisions (rural part-FMUs)		↑ Provisions (urban part-FMUs)	

[1] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained.

4.2.1.6 Plants in lakes and coastal environments

Melidonis *et al.* (2020) notes that in coastal environments macroalgae and phytoplankton respond to sediment and nutrient inputs. This means that the proposed provisions would be expected to achieve a similar outcome for those attributes as the BSP Improved scenario (the most applicable BSP scenario for the sediment, phosphorus and nitrogen attribute groups in rural and mixed-rural part-FMUs). On that basis, they are likely sufficient to meet the coastal objectives that require the maintenance of these attributes (Table 43).

As with DO, it is not possible to assign a BSP scenario to the proposed provisions for submerged plants or phytoplankton in lakes. However, as the proposed provisions do not allow for an increase in external nutrient inputs (Sections 4.2.1.3 and 4.2.2.2 (below)), they should not degrade these attributes where the TASs require they be maintained (Lake Kōhangatera = phytoplankton and submerged plants; Lake Kōhangapiripiri = submerged plants[18]). However, how these attributes will respond in the future to other factors, such as internal nutrient cycling or invasive plant species, is uncertain.

[18] The baseline state for both submerged plants attributes is C (Table 2) and does not meet the TASs. However, current state meets the relevant TASs (Greer *et al.*, 2023).

Table 43: The predicted direction of change in macroalgae and phytoplankton in the part-FMUs where coastal objectives require the maintenance of these attributes (based on the outputs of the Coastal Panel (Melidonis *et al.*, 2020)). 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 coastal objectives.

Part-FMU	Site	Attribute	Objective	Scenario results			Provisions likely to achieve objective?
				BAU	Improved	Water Sensitive	
Te Whanganui-a-Tara (Harbour and estuaries)		Macroalgae	Maintain or improve	Maintain	Maintain	Maintain	✓
Mākara Estuary						Improve	
Wainuiomata Estuary				Degrade		Maintain	
Wai Tai				Maintain			
Te Whanganui-a-Tara (Harbour and estuaries)		Phytoplankton	Maintain or improve	Maintain	Maintain	Maintain	
Mākara Estuary						Improve	
Wainuiomata Estuary				Degrade		Maintain	
Wai Tai				Maintain			
					↑ Provisions		

4.2.1.7 Fish and macroinvertebrates

The impacts of the proposed provisions on fish and macroinvertebrate communities in rural and mixed rural part-FMUs are likely to be most consistent with those predicted under BSP Improved scenario given they are expected to achieve similar or better outcomes for sediment (cited as an important stressor in the Freshwater and Coastal Panels' outputs (Greer *et al.*, 2022; Melidonis *et al.*, 2020)). However, in purely urban part-FMUs the proposed provisions will likely have a similar impact as the BSP Water Sensitive, which is the assigned scenario for sediment, metals, nitrogen, phosphorus and periphyton in those part-FMUs (Section 3.2).

Based on the Freshwater and Coastal Panels' assessment of the BSP Improved and Water Sensitive scenarios, it is likely that the proposed provisions will achieve those TASs and coastal objectives that require the maintenance of the following fish and macroinvertebrate attributes (Table 44 and Table 45) (Greer *et al.*, 2022; Melidonis *et al.*, 2020):

- Fish index of biotic integrity (F-IBI) (rivers);
- Fish community health[19] (rivers);
- Macroinvertebrate community index score and quantitative macroinvertebrate community index score Q/MCI (rivers); and
- Benthic marine invertebrate diversity (coast).

[19] Based on the Freshwater Panel's assessments for 'Ecosystem health'.

Table 44: The predicted direction of change in F-IBI and fish community health under the different BSP scenarios in the part-FMUs where the TASs require the maintenance of these attributes (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). The results presented for fish community health are based on the Freshwater Panel's assessment for 'Ecosystem health'. 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	
Small forested and forested mainstems	Whakatikei R. @ Riverstone	F-IBI	N/A[1]	Maintain	Maintain	Maintain	✓
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott						
Waiwhetū Stream	Waiwhetu S. @ Whites Line East						
Wainuiomata urban streams	Black Ck @ Rowe Parade						
Wainuiomata rural streams	Wainuiomata River D/S of White Br.						
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels						
Korokoro Stream	Korokoro S.						
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge						
Wellington urban	Karori S. @ Mākara Peak						
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.	Fish community health	N/A[1]	Degrade	Improve	Improve	
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels						
					↑ Provisions (rural part-FMUs)	↑ Provisions (urban part-FMUs)	

[1] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained.

Table 45: The predicted direction of change in Q/MCI (rivers), ASPM (rivers) and Benthic marine invertebrate diversity (coast) under the different BSP scenarios in the part-FMUs where the TASs and coastal objectives require the maintenance of these attributes (based on the outputs of the Freshwater and Coastal Panels (Greer *et al.*, 2022; Melidonis *et al.*, 2020)). 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 and TAS/ objective	Scenario results			Provisions likely to achieve TAS/ objective?
				BAU	Improved	Water Sensitive	
Small forested and forested mainstems	Whakatikei R. @ Riverstone	Q/MCI	A[1]	Maintain	Maintain	Maintain	✓
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.		N/A[2]	Degrade	Improve	Improve	
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels		C				
Small forested and forested mainstems	Whakatikei R. @ Riverstone	ASPM	A[1]	Maintain	Maintain	Maintain	
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott		B	Degrade			
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua			Maintain	Improve	Improve	
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.		N/A[2]	Degrade			
Parangārehu catchment streams and South-west coast rural streams	Mākara S. @ Kennels		B				
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge		C[3]				
Wellington urban	Karori S. @ Mākara Peak						
Te Whanganui-a-Tara (Harbour and estuaries)		Benthic marine invertebrate diversity	Maintain or improve	Maintain	Maintain	Maintain	
Mākara Estuary					Improve	Improve	
Wainuiomata Estuary				Degrade	Maintain		
Wai Tai				Maintain		Maintain	
					↑ Provisions (rural part-FMUs)	↑ Provisions (urban part-FMUs)	

[1] Baseline state is B. However, current state is A and trend analysis indicates it will remain so (GW, 2022).
[2] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained.
[3] Baseline state is D. However, current state is C and trend analysis indicates it will remain so (GW, 2022)..

4.2.2 Improve TASs and coastal objectives

4.2.2.1 Sediment

Based on the Freshwater Panels assessment for the BSP Improved and Water Sensitive scenarios, the proposed provisions will likely reduce sediment loads throughout WTWT, and this may contribute to an improvement in DFS in those part-FMUs where the TASs require this (Table 46). However, as the Freshwater Panel did not explicitly assess DFS it not possible to determine whether the proposed provisions will be sufficient to ensure the achievement of these TASs on their own.

The Coastal Panel's assessments for the BSP Improved scenario suggest that, on their own, the proposed provisions may not be sufficient to improve muddiness and sediment rate in the Mākara Estuary

to the extent required by the coastal objectives (Table 46). Accordingly, additional non-regulatory actions may be needed such as those assumed under the BSP Water Sensitive scenario, e.g.:

- Planting 10-m riparian buffers on all second order and above streams on low slope (<15°) pastoral land; and
- Retiring all high erosion risk land.

Note: As the Freshwater Panel outputs fed into the Coastal Panel process, the impacts of climate change on sediment loads is factored into the muddiness and sediment rate assessments. National scale erosion modelling by Neverman et al. (2019) suggests that in the absence of any climate change impacts the assumptions of the Improved Scenario, and therefore the proposed provisions, may result in much greater sediment load reductions (55%) than were considered by the Coastal Panel (Table 30).

Table 46: The predicted direction of change in DFS (rivers) and the predicted state of muddiness (coast) and sedimentation rate (coast) under the different BSP scenarios in the part-FMUs where the TASs and coastal objectives require an improvement in these attributes (based on the outputs of the Freshwater and Coastal Panels (Greer *et al.*, 2022; Melidonis *et al.*, 2020)). 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.

<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/ objective</th><th colspan="3">Scenario results</th><th rowspan="2">Provisions consistent with TAS/ objective?</th></tr>
<tr><th>BAU</th><th>Improved</th><th>Water Sensitive</th></tr>
<tr><td>Waiwhetū Stream</td><td>Waiwhetu S. @ Whites Line East</td><td rowspan="3">DFS</td><td rowspan="2">D</td><td rowspan="2">C</td><td rowspan="3">Degrade</td><td>Maintain</td><td rowspan="3">Improve</td><td rowspan="3">✓</td></tr>
<tr><td>Parangārehu catchment streams and South-west coast rural streams</td><td>Mākara S. @ Kennels</td><td rowspan="2">Improve</td></tr>
<tr><td>Wellington urban</td><td>Karori S. @ Mākara Peak</td><td>C</td><td>B</td></tr>
<tr><td colspan="2" rowspan="3">Mākara Estuary</td><td>Muddiness (% area >50% mud)</td><td>5 – 15</td><td>≤5</td><td>>15</td><td>5 – 15</td><td>≤5</td><td rowspan="3">×</td></tr>
<tr><td>Muddiness (% of sample)</td><td>10 – 25</td><td><10</td><td>> 25</td><td>10 – 25</td><td><10</td></tr>
<tr><td>Sedimentation rate (C:N)</td><td>2– 5</td><td>≤2</td><td>>5</td><td>2– 5</td><td>≤2</td></tr>
<tr><td colspan="5"></td><td>↑ Provisions (rural part-FMUs)</td><td>↑ Provisions (urban part-FMUs)</td><td></td></tr>
</table>

4.2.2.2 *Nutrients, phytoplankton and cyanobacteria (lakes)*

The Freshwater Panel's assessment of the BSP Improved scenarios indicates that proposed provisions are unlikely to increase external (i.e., from rivers) nitrogen or phosphorus loads to Lake Kōhangatera and Lake Kōhangapiripiri and, consequently, should not cause an increase in TN or total phosphorus (TP) concentrations where the TASs require an improvement in these attributes (Table 47). Similarly, by not allowing for an increase in external nutrient inputs, the proposed provisions are unlikely to directly degrade phytoplankton or cyanobacteria concentrations where the TASs require they be improved (Lake Kōhangatera = phytoplankton and cyanobacteria; Lake Kōhangapiripiri = cyanobacteria). Nonetheless, it is not possible to confirm that the proposed provisions will result in an improvement in any of these attributes due to uncertainties around baseline state and internal nutrient cycling.

Note: It is not possible to assign a BSP scenario to the proposed provisions for phytoplankton and cyanobacteria in lakes.

Table 47: The assumed direction of change in TN and TP concentrations under the different BSP scenarios in the part-FMUs where the TASs require the improvement of these attributes (based on the Freshwater Panel's outputs for rivers in rural and mixed-rural part-FMUs (Greer *et al.*, 2022)). 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.

Part-FMU	Site	Attribute	Baseline state	TAS	Scenario results			Provisions consistent with TAS?
					BAU	Improved	Water Sensitive	
Lake Kōhangatera		TP	C	B	Degrade[1]	Maintain[1]	Maintain[1]	✓
Lake Kōhangapiripiri		TN	C	B	Maintain[1]	Maintain[1]	Maintain[1]	
						↑ Provisions		

[1] Based on the freshwater panel results for rural rivers.

4.2.2.3 *Dissolved oxygen*

The Waiwhetū Stream is only part-FMU where the default TAS requires an improvement in DO. However, as a macrophyte dominated system, DO is driven by those plants rather than periphyton Consequently, it is not possible to use the Freshwater Panel's periphyton assessments to determine whether the provisions will improve DO in this part-FMU.

4.2.2.4 *Fish and macroinvertebrates*

Based on the Freshwater Panel's assessment of the BSP Improved and Water Sensitive scenarios (Greer *et al.*, 2022), the proposed provisions:

- Are unlikely to achieve or contribute to the improvements in the F-IBI required by the TASs (Table 48);
- Will likely contribute to the achievement of the TASs that require an improvement in fish community health (Table 48), except in:
    - The Small forested and forested mainstems part-FMU; and
    - The Te Awa Kairangi lower mainstem part-FMU.
- Are unlikely to achieve those Q/MCI and ASPM TASs that require an improvement except in (Table 49):
    - The Waiwhetū Stream part-FMU; and
    - The Wellington urban part-FMU.

The Freshwater Panel's outputs indicate that additional non-regulatory actions like those assumed under the BSP Water Sensitive Scenario may achieve some of the macroinvertebrate and fish community health TASs that will not be met through the proposed provisions; i.e.:

- Planting 10-m riparian buffers on all second order and above streams on low slope (<15°) pastoral land; and
- Retiring all high erosion risk land.

However, it is possible that even with those mitigations the following macroinvertebrate TASs may not be met (Table 49):

- Te Awa Kairangi lower mainstem (Q/MCI); and
- Kaiwharawhara Stream (ASPM).

Furthermore, improving the F-IBI requires the introduction of one or more species which, based on the Freshwater Panel's outputs, is unlikely to be achieved by GW unless remediable fish passage barriers are present (i.e., not a single action assumed under the BSP scenarios was predicted to improve this attribute in any part-FMU). Similarly, the fish community health TAS for the 'Small forested and forested mainstems' part-FMU is unlikely to be met through the actions of GW given this area is in reference condition (i.e., natural state).

Table 48: The predicted direction of change in F-IBI and fish community health under the different BSP scenarios in the part-FMUs where the TASs require an improvement in this attribute (based on the Freshwater Panel's 'Ecosystem health' assessments (Greer *et al.*, 2022)). 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	
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua	F-IBI	N/A[1]	A	Maintain	Maintain	Maintain	×
Te Awa Kairangi urban streams	Hulls Ck adj. Reynolds Bach Dr.							
Small forested and forested mainstems	Whakatikei R. @ Riverstone	Fish community health	N/A[1]	A	Maintain	Maintain	Maintain	
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott			B	Degrade			
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua				Maintain	Improve	Improve	✓
Waiwhetū Stream	Waiwhetu S. @ Whites Line East			C	Degrade			
Wainuiomata urban streams	Black Ck @ Rowe Parade							
Wainuiomata rural streams	Wainuiomata River D/S of White Br.			B				
Korokoro Stream	Korokoro S. @ Cornish St. Br.			A				
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge			C				
Wellington urban	Karori S. @ Mākara Peak							
						↑ Provisions (rural part-FMUs)	↑ Provisions (urban part-FMUs)	

[1] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained.

Table 49: The predicted state of Q/MCI (rivers) and ASPM under the different BSP scenarios in the part-FMUs where the TASs require an improvement in these attributes (based on the outputs of the Freshwater Panel (Greer *et al.*, 2022)). The results presented for fish community health are based on the Freshwater Panel's assessment for 'Ecosystem health'. 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.

Part-FMU	Site	Attribute	Baseline state	TAS	Scenario results			Assigned scenario consistent with TAS
					BAU	Improved	Water Sensitive	
Te Awa Kairangi lower mainstem	Hutt R. @ Boulcott	Q/MCI	C	B	C	C	C	×
Te Awa Kairangi rural streams and mainstems	Mangaroa R. @ Te Marua						A	
Waiwhetū Stream	Waiwhetu S. @ Whites Line East		D[1]	C	D	D	C	✓
Wainuiomata urban streams	Black Ck @ Rowe Parade		N/A[2]	C	Degrade	Improve	Improve	?
Wainuiomata rural streams	Wainuiomata River D/S of White Br.		C	B	C	C	B	×
Korokoro Stream	Korokoro S. @ Cornish St. Br.		N/A[2]	A	Degrade	Improve	Improve	?
Kaiwharawhara Stream	Kaiwharawhara S. @ Ngaio Gorge		D[1]	C	D	D	D	×
Wellington urban	Karori S. @ Mākara Peak						C	✓
Waiwhetū Stream	Waiwhetu S. @ Whites Line East	ASPM	D	C	D	D	C	
Wainuiomata urban streams	Black Ck @ Rowe Parade		N/A[2]		Degrade	Improve	Improve	?
Wainuiomata rural streams	Wainuiomata River D/S of White Br.		B	A	B	B	A	×
Korokoro Stream	Korokoro S. @ Cornish St. Br.		N/A[2]		Degrade	Improve	Improve	?
						↑ Provisions (rural part-FMUs)	↑ Provisions (urban part-FMUs)	

[1] Assessed as B in Greer *et al.* (2022); the states presented for WSP scenarios are based on the baseline state in Table 3 and the Freshwater Panels 'change' assessments.
[2] Baseline state unknown; further monitoring needed to determine whether the attribute needs to be improved to the TAS or maintained.

5 Conclusions

The results of this assessment suggest that the proposed provisions of PC1 require outcomes and actions that are likely to achieve most (~85%) of the WTWT TASs and coastal objectives. However, there are a number that are unlikely to be met through the proposed provisions alone. In most cases it is likely that the 'gap' between the consequences of the proposed provisions and these TASs and coastal objectives can be filled through non-regulatory actions like those assumed under the BSP Water Sensitive scenario; e.g.:

- Planting 10-m riparian buffers on all second order and above streams on low slope (<15°) pastoral land; and
- Retiring all high erosion risk land.

Nonetheless, some TASs may not be met unless action planning includes even greater non-regulatory actions than those described above, or land use is changed.

The TASs and coastal objectives that have been identified as inconsistent with the proposed provisions are set out below in Table 50.

Table 50: 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 BSP scenario assumptions.

Part-FMU	Attribute	Attribute type	Possible non-regulatory actions to plug 'gap' between provisions and TAS/objective
Wainuiomata rural streams	Periphyton biomass	2A	Planting of five metre riparian buffers on all second order and above streams on pastoral land less than 10 degrees. *Note: This is likely only necessary to offset the effects of climate change at 2090. This attribute should be maintained by the proposed provisions at 2040.*
Korokoro Stream			
Wainuiomata rural streams	SFS		• Planting of 10 metre riparian buffers on all second order and above streams on pastoral land less than 15 degrees; and • Retirement of all high risk erosion land
Parangārehu catchment streams and South-west coast rural streams	DRP		
Wainuiomata rural streams			
Parangārehu catchment streams and South-west coast rural streams	*E. coli*		
Te Awa Kairangi rural streams and mainstems			
Te Whanganui-a-Tara (Harbour and estuaries)	Enterococci		
Mākara Estuary	Muddiness (% area >50% mud)	2B	
	Muddiness (% of sample)		
	Sedimentation rate		
Te Awa Kairangi rural streams and mainstems	Q/MCI		
Wainuiomata rural streams			
	ASPM		
Te Awa Kairangi lower mainstem	SFS	2A	• Planting of 10 metre riparian buffers on all second order and above streams on pastoral land less than 15 degrees; • Retirement of all high risk erosion land; and • Additional mitigations not considered in BSP scenarios or land-use change.
Small forested and forested mainstems	DRP		
Kaiwharawhara Stream			• Additional urban mitigations not considered in BSP scenarios.
Waiwhetū Stream			
Wellington urban	*E. coli*		
Wainuiomata urban streams			
	NH_4-N		
Te Awa Kairangi rural streams and mainstems	Periphyton biomass		• Planting of 10 metre riparian buffers on all second order and above streams on pastoral land less than 15 degrees; • Retirement of all high risk erosion land; and • Additional mitigations not considered in BSP scenarios or land-use change.
Te Awa Kairangi lower mainstem	Fish community health	2B	
Kaiwharawhara Stream	Q/MCI		
Te Awa Kairangi lower mainstem			
Small forested and forested mainstems	Fish community health		Unlikely to be achieved through action planning (i.e., outside of GW's control).
Te Awa Kairangi rural streams and mainstems	F-IBI		
Te Awa Kairangi urban streams			

6 References

Auckland Regional Council (ARC), 2004. The Use of Flocculants and Coagulants to Aid the Settlement of Suspended Sediment in Earthworks Runoff : Trials, Methodology and Design (Technical Publication No. No. 227). Auckland Regional Council, Auckland, New Zealand.

Blyth, J., 2020. Whaitua Te Whanganui-a-Tara Expert Panel Proxy Modelling Catchment Assessment (Greater Wellington Regional Council Publication No. GW/ESCI-T-19/123). Greater Wellington Regional Council, Wellington, New Zealand.

Dymond, J.R., Betts, H.D., Schierlitz, C.S., 2010. An erosion model for evaluating regional land-use scenarios. Environ. Model. Softw. 25, 289–298.

Easton, S., Cetin, L., 2020. dSedNet model development and results (Jacobs Memorandum No. IZ130500). Jacobs New Zealand Ltd, Wellington, New Zealand.

Easton, S., Hopkinson, O., 2020. Contaminant Load Model development (Jacobs Memorandum No. IZ130500). Jacobs New Zealand Ltd, Wellington, New Zealand.

Easton, S., Shrestha, M., Cetin, L., Blyth, J., Sands, M., 2019a. Porirua Whaitua Collaborative Modelling Project. Baseline Modelling Technical Report (Jacobs Report No. IZ080700). Jacobs New Zealand Ltd, Wellington, New Zealand.

Easton, S., Shrestha, M., Cetin, L., Sands, M., 2019b. Porirua Whaitua Collaborative Modelling Project. Scenario Modelling Technical Report (Jacobs Report No. IZ080700). Jacobs New Zealand Ltd, Wellington, New Zealand.

Greater Wellington (GW), 2022. 2021/22 River water quality and ecology monitoring (Greater Wellington Publication). Greater Wellington, Wellington, New Zealand.

Greer, M.J.C., 2023. 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 (Torlesse Environmental Report No. 2023–007). Torlesse Environmental Ltd, Christchurch, New Zealand.

Greer, M.J.C., Ausseil, O., 2018. Whaitua Te Whanganui-a-Tara: River and stream water quality and ecology (Technical report prepared by Aquanet Consulting Limited for Greater Wellington Regional Council). Aquanet Consulting Ltd., Wellington, New Zealand.

Greer, M.J.C., Ausseil, O., Clapcott, J.E., Farrant, S., Heath, M.W., Norton, N., 2022. Whaitua Te Whanganui-a-Tara water quality and ecology scenario assessment (Aquanet Report). Aquanet Consulting Limited, Wellington, New Zealand.

Greer, M.J.C., Blyth, J., Easton, S., Gadd, J., King, B., Nation, T., Oliver, M., Perrie, A., 2023. Technical assessments undertaken to inform the target attribute state framework of proposed Plan Change 1 to the Natural Resources Plan for the Wellington Region (Torlesse Environmental Report No. 2023–006). Torlesse Environmental Ltd, Christchurch, New Zealand.

He, J., Chu, A., Ryan, M.C., Valeo, C., Zaitlin, B., 2011. Abiotic influences on dissolved oxygen in a riverine environment. Ecol. Eng. 37, 1804–1814.

Leersnyder, H., Parsonson, M., Bunting, K., Stewart, C., 2021. Erosion and sediment control guide for land disturbing activities in the Wellington Region (Greater Wellington Publication). Greater Wellington, Wellington, New Zealand.

Melidonis, M., Oliver, M., Stevens, L., Conwell, C., 2020. Whaitua Te-Whanganui-a-Tara Coastal Assessment Report (Greater Wellington Publication No. GW/ESCI-T-21/16). Greater Wellington, Wellington, New Zealand.

Neverman, A.J., Djanibekov, U., Soliman, T., Walsh, P., Speikermann, R., Basher, L., 2019. Impact testing of a proposed suspended sediment attribute: identifying erosion and sediment control mitigations to meet proposed sediment attribute bottom lines and the costs and benefits of those mitigations (Contract Report No. LC3574).

Phillips, C.J., Basher, L., Spiekermann, R., 2020. Biophysical performance of erosion and sediment control techniques in New Zealand: a review (Contract Report No. LC3761). Manaaki Whenua – Landcare Research.

Schallenberg, M., 2019. Determining reference conditions for New Zealand lakes. Sci. Conserv. 334, 1–46.

Semadenis-Davies, A., Haddadchi, A., Booker, D.J., 2020. Modelling the impacts of the Draft Stock Exclusion Section 360 Regulations on river water quality: E. coli and Sediment (NIWA Client Report No. 2020052AK). NIWA, Auckland, New Zealand.

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).

Table 13: Attribute states for phytoplankton (trophic state) taken from Appendix 2A of the NPS-FM 2020.

Value	Ecosystem health		
Freshwater Body Type	Lakes		
Attribute	**Phytoplankton (Trophic state)**		
Attribute Unit	mg chl-a/m^3 (milligrams chlorophyll-a per cubic metre)		
Attribute State	**Numeric Attribute State**		**Narrative Attribute State**
	Annual median	**Annual maximum**	
A	≤2	≤10	Lake ecological communities are healthy and resilient, similar to natural reference conditions
B	>2 and ≤5	>10 and ≤25	Lake ecological communities are slightly impacted by additional algal and/or plant growth arising from nutrient levels that are elevated above natural reference conditions.
C	>5 and ≤12	>25 and ≤60	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions. Reduced water clarity is likely to affect habitat available for native macrophytes.
National Bottom Line	**12**	**60**	
D	>12	>60	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state (without native macrophyte/seagrass cover), due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.

For lakes and lagoons that are intermittently open to the sea, monitoring data should be analysed separately for closed periods and open periods.

Table 14: Attribute states for total nitrogen (trophic state) taken from Appendix 2A of the NPS-FM 2020.

Value	Ecosystem health		
Freshwater Body Type	Lakes		
Attribute	**Total nitrogen (Trophic state)**		
Attribute Unit	mg/m^3 (milligrams per cubic metre)		
Attribute State	**Numeric Attribute State**		**Narrative Attribute State**
	Annual median	**Annual median**	
	Seasonally stratified and brackish	Polymictic	
A	≤160	≤300	Lake ecological communities are healthy and resilient, similar to natural reference conditions
B	>160 and ≤350	>300 and ≤500	Lake ecological communities are slightly impacted by additional algal and/or plant growth arising from nutrient levels that are elevated above natural reference conditions.
C	>350 and ≤750	>500 and ≤800	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions
National Bottom Line	**750**	**800**	
D	>750	>800	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state (without native macrophyte/seagrass cover), due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.

For lakes and lagoons that are intermittently open to the sea, monitoring data should be analysed separately for closed periods and open periods.

Table 15: Attribute states for total phosphorus (trophic state) taken from Appendix 2A of the NPS-FM 2020.

Value	Ecosystem health	
Freshwater Body Type	Lakes	
Attribute	**Total phosphorus (Trophic state)**	
Attribute Unit	mg/m^3 (milligrams per cubic metre)	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	Annual median	
A	≤10	Lake ecological communities are healthy and resilient, similar to natural reference conditions
B	>10 and ≤20	Lake ecological communities are slightly impacted by additional algal and/or plant growth arising from nutrient levels that are elevated above natural reference conditions.
C	>20 and ≤50	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions
National Bottom Line	**50**	
D	>50	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state (without native macrophyte/seagrass cover), due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.

Table 16: Attribute states for cyanobacteria (planktonic) taken from Appendix 2A of the NPS-FM 2020.

Value	Human contact		
Freshwater Body Type	Lakes and lake fed rivers		
Attribute	**Cyanobacteria (planktonic)**		
Attribute Unit	Biovolume mm^3/L (cubic millimetres per litre)		
Attribute State	**Numeric Attribute State**		**Narrative Attribute State**
	80th percentile	**80th percentile**	
	biovolume equivalent for the combined total of all cyanobacteria	biovolume equivalent of potentially toxic cyanobacteria	
A	≤0.5	≤0.5	Risk exposure from cyanobacteria is no different to that in natural conditions (from any contact with freshwater).
B	>0.5 and ≤1.0	>0.5 and ≤1.0	Low risk of health effects from exposure to cyanobacteria (from any contact with freshwater).
C	>1.0 and ≤10	>1 and ≤1.8	Moderate risk of health effects from exposure to cyanobacteria (from any contact with freshwater).
National Bottom Line	**10**	**1.8**	
D	>10	>1.8	High health risks (for example, respiratory, irritation and allergy symptoms) exist from exposure to cyanobacteria (from any contact with freshwater).

The 80th percentile must be determined using a minimum of 12 samples collected over 3 years. Thirty samples collected over 3 years is recommended.

Table 17: Attribute states for submerged plants (natives) taken from Appendix 2B of the NPS-FM 2020.

Value	Ecosystem health	
Freshwater Body Type	Lakes	
Attribute	**Submerged plants (natives)**	
Attribute Unit	Lake Submerged Plant (Native Condition Index)	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	(% of maximum potential score)	
A	>75%	Excellent ecological condition. Native submerged plant communities are almost completely intact.
B	>50 and ≤75%	High ecological condition. Native submerged plant communities are largely intact.
C	≥20 and ≤50%	Moderate ecological condition. Native submerged plant communities are moderately impacted.
National Bottom Line	**20%**	
D	<20%	Poor ecological condition. Native submerged plant communities are largely degraded or absent.

Monitoring to be conducted, and numeric attribute state to be determined, following the method described in Clayton J, and Edwards T. 2006. LakeSPI: A method for monitoring ecological condition in New Zealand lakes. User Manual Version 2. National Institute of Water & Atmospheric Research: Hamilton, New Zealand. (see clause 1.8)

Lakes in a devegetated state receive scores of 0.

Table 18: Attribute states for submerged plants (invasive species) taken from Appendix 2B of the NPS-FM 2020.

Value	Ecosystem health	
Freshwater Body Type	Lakes	
Attribute	**Submerged plants (invasive species)**	
Attribute Unit	Lake Submerged Plant (Invasive Impact Index))	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	(% of maximum potential score)	
A	0%	No invasive plants present in the lake. Native plant communities remain intact.
B	>1 and ≤25%	Invasive plants having only a minor impact on native vegetation. Invasive plants will be patchy in nature co-existing with native vegetation. Often major weed species not present or in early stages of invasion.
C	>25 and ≤90%	Invasive plants having a moderate to high impact on native vegetation. Native plant communities likely displaced by invasive weed beds particularly in the 2 – 8 m depth range.
National Bottom Line	**90%**	
D	>90%	Tall dense weed beds exclude native vegetation and dominate entire depth range of plant growth. The species concerned are likely hornwort and Egeria.

Monitoring to be conducted, and numeric attribute state to be determined, following the method described in Clayton J, and Edwards T. 2006. LakeSPI: A method for monitoring ecological condition in New Zealand lakes. User Manual Version 2. National Institute of Water & Atmospheric Research: Hamilton, New Zealand. (see clause 1.8).

Table 19: Attribute states for lake-bottom dissolved oxygen taken from Appendix 2B of the NPS-FM 2020.

Value	Ecosystem health	
Freshwater Body Type	Lakes	
Attribute	**Lake-bottom dissolved oxygen**	
Attribute Unit	mg/L (milligrams per litre)	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	Measured or estimated annual minimum	
A	≥7.5	No risk from lake-bottom dissolved oxygen of biogeochemical conditions causing nutrient release from sediments.
B	≥2.0 and <7.5	Minimal risk from lake-bottom dissolved oxygen of biogeochemical conditions causing nutrient release from sediments
C	≥0.5 and <2.0	Risk from lake-bottom dissolved oxygen of biogeochemical conditions causing nutrient release from sediments.
National Bottom Line	**0.5**	
D	<0.5%	Likelihood from lake-bottom dissolved oxygen of biogeochemical conditions resulting in nutrient release from sediments..

To be measured less than 1 metre above sediment surface at the deepest part of the lake using either continuous monitoring sensors or discrete dissolved oxygen profiles.

Appendix B – Detailed BSP scenario assumptions

BAU scenario

- No storm water capture or treatment.
- Numbers of additional dwellings are from the overall supply of realisable residential capacity from the Wellington City Council, Hutt City Council and Upper Hutt City Council housing and business development capacity assessments. These projections aim to represent the realisable new dwellings to accommodate residential population growth over the 30 years from 2017-2047.
- The resulting areas for development are calculated based on an assumed density of 15 additional dwellings/ha for standalone and 7.5 additional dwellings/ha (ha) for terraced housing (giving a total density of 20 dwellings/ha).
- Assumed new development form for dwellings within existing residential zones is 43% urban grassland and parks, 15% roads, 17% paved, 25% roofs. For greenfield development zones it is 36% urban grassland and parks, 20% roads, 14% paved, 30% roofs.
- Standalone houses and greenfield development replace forest and pasture, while terrace style housing replaces urban grass and parks and residential impervious cover.
- The wastewater network condition does not change, and additional dwellings and population do not increase the wastewater overflows.
- Livestock exclusion in all REC streams in identified 'Category 1 or 2' areas of the Natural Resources Plan (NRP).

Improved scenario

- Numbers of additional dwellings, development form and land cover replacement for are the same as for BAU.
- 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%
- Rain tanks retrofitted to 10% existing residential roofs to reduce total flow from these by 1%.
- 50% of runoff from 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 10 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 existing 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.
- 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 commercial and industrial roofs and existing residential roofs are replaced/treated with low zinc yielding materials.
- 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 is undertaken on all REC order 2 or greater streams with grassland land cover and catchment slope less than 15 degrees. However, all areas of exclusion receive 10 meters of riparian planting following the GW planting guidance.
- Retirement of LUC classes 6e, 7e and 8e land with existing grassland land cover.

Assumed riparian management under the different scenarios

- Under BAU stock exclusion entails a simple one metre fencing setback with no riparian planting;

- Under Improved a five-metre setback is assumed with riparian planting carried in accordance with existing guidance documents from Greater Wellington[20] (see Figure 1 for the type of riparian planting assumed); and
- Under Water Sensitive a 10-metre setback with riparian planting is assumed (Figure 1).

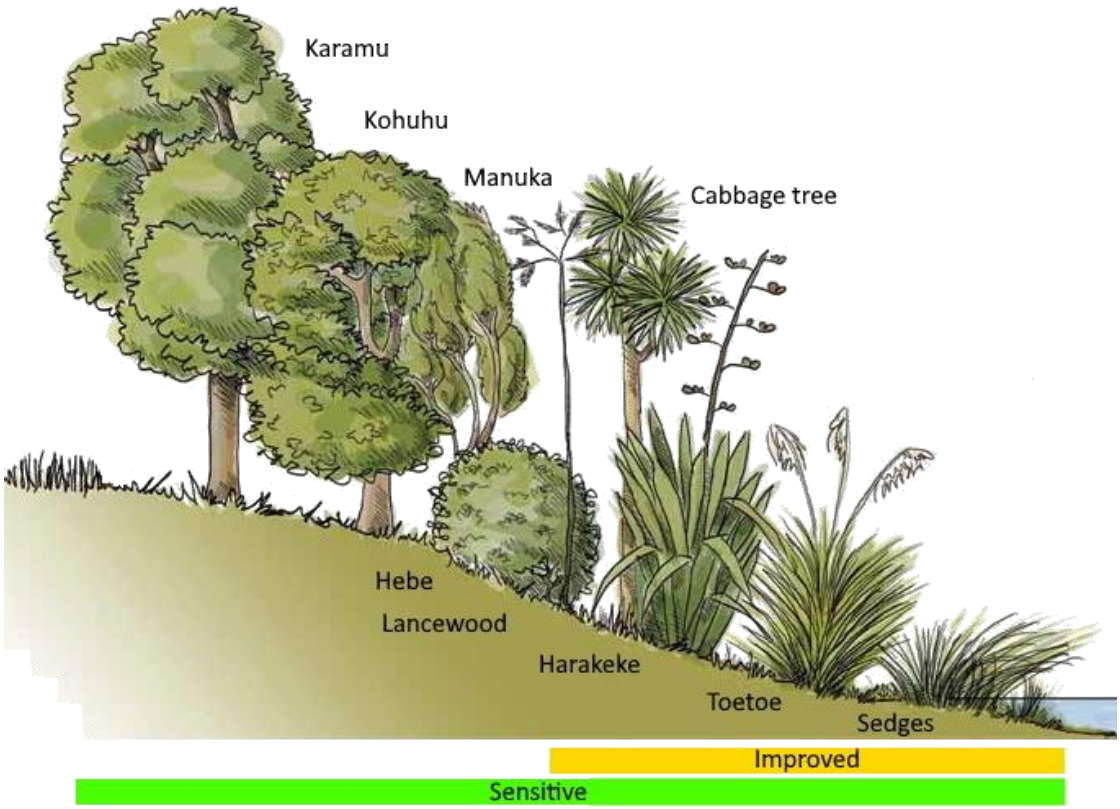


Figure 1: Assumed level of riparian planting under the Improved and Water Sensitive scenarios.

[20] Greater Wellington Regional Council, 2009: Mind the Stream – A guide to looking after streams in the Wellington Region. Wellington. http://www.gw.govt.nz/assets/council-publications/Mind%20the%20stream%20booklet%20Full.pdf

TORLESSE
ENVIRONMENTAL LTD