Assessments of the current state and derivation of numeric objectives and limits for Te Awarua-o-Porirua Whaitua Implementation Programme (WIP)

Introduction

The five freshwater and three coastal Water Management Units (WMU) in Te Awarua-o-Porirua each incorporate several mainstem catchments and numerous smaller tributary sub-catchments. This results in a degree of variability in water body type and environmental state within each WMU. Because of this, assigning an overall assessment of current state and appropriate numeric representation of the attribute state objectives chosen by the Whaitua Committee (i.e. A, B or C state) has required several technical considerations using both monitoring data and model outputs. The rationale for assignments differed for each attribute; this document describes that rationale for each of the:

- assessments of current state
- numeric objectives set
- limits and reduction targets set
- nutrient concentration criteria set.

The rationale in this document is designed to be read with reference to:

- The freshwater and coastal water objectives defined in attribute state terms (i.e. A, B or C state) in Tables 2 and 3 of the WIP
- The numeric freshwater and coastal water objectives defined in Appendix 2 to the WIP
- The Summary of Model and Monitoring Data from the Te Awarua-o-Porirua Collaborative Modelling Project

Further information on the monitoring and scenario modelling data drawn on in these assessments is available in:

- Freshwater Baseline Modelling Technical Report
- Freshwater Scenario Modelling Technical Report
- Te Awarua-o-Porirua Collaborative Modelling Project – Marine Receiving Environment technical report

LWP has also undertaken a review of these assignments of objectives and limits for Te Awarua-o-Porirua WIP.

Pathogens - *E. coli* and Enterococci

Basis for assessment of current state in each WMU

WMU name		Comments
Taupō		Model and monitoring data show a consistent classification of E attribute state at all monitoring points and all but two model reporting points. While some places within each WMU are likely to be better than indicated by the data, particularly in Rangituhi where some upper parts of catchments are in relatively natural conditions, the lower reaches are within residential areas and likely to be in E condition.
Rangituhi		
Pouewe		
Takapū		
Te Riu o Porirua		
Onepoto Arm	Intertidal	Model and monitoring data indicate D attribute state in the highest risk areas. Some areas are likely to be in better state.
	Subtidal	
Pauatahanui Inlet	Intertidal	Model data indicate D state in the highest risk areas. Some areas are likely to be in better state. Monitoring data shows a mix of C and A state, though these sites may not be in the highest risk areas
	Subtidal	
Coast		Largely based on monitoring estimates, with most outer harbour and coastal monitoring sites in the B or C state.

Basis for numeric objectives

All numeric objectives for *E. coli* and Enterococci set in Appendix 2 of the WIP are based on the upper thresholds of the Whaitua Committee-chosen objective state (i.e., A for Rangituhi, B for Taupō and Pouewe, C for Takapū and Te Riu o Porirua, C for Onepoto Arm, and B for Pauatahanui Arm and the coast), from the attribute tables described in Appendix 1 of the WIP.

Basis for limits and targets

The level of pathogens in the water at a given time are the basis for the risk of people contracting an infection. Therefore, the limits set in the WIP are based on maintaining the current state of *E.coli* concentration for each freshwater WMU and the targets are based on the objective state *E.coli* concentrations (Table 12 in Appendix 2 of the WIP) for each freshwater WMU.

Meeting the objectives, limits and targets in the freshwater WMUs is expected to support the achievement of the Enterococci objectives in the coastal WMUs.

Current state, objectives and targets for inclusion in WIP

E. coli		Water management unit				
		Taupō	Rangituhi	Pouewe	Takapū	Te Riu o Porirua
Estimated current state		E	E	E	E	E
Objective	Objective state chosen by Whaitua Committee	B	A	B	C	C
	% exceedances 540 cfu/100mL ≤	10%	5%	10%	20%	20%
	% exceedances 260 cfu/100mL ≤	30%	20%	30%	34%	34%
	Median concentration (*E. coli*/100mL) ≤	130	130	130	130	130
	95th percentile concentration (*E. coli*/100mL) ≤	1000	540	1000	1200	1200
	Objectives to be met by	2040	2040	2040	2040	2040

Enterococci		Water management unit		
		Onepoto Arm	Pauatahanui Arm	Coast
Estimated current state		D	D	B
Objective	Objective state chosen by Whaitua Committee	C	B	B
	% exceedances 500 cfu/100mL ≤	20%	10%	10%
	95th percentile concentration (Enterococci/100mL) ≤	500	200	200
	Objectives to be met by	2040	2040	Maintain

Ammonia toxicity

Assessment of current state in each WMU

WMU name	Comments
Taupō	Model reporting points in A state after nominal pH adjustment, except for lowest point at mouth which is in B state. Majority of WMU likely to be similar to general rural conditions with low ammonia, though there is potential for the lower reaches to be in worse peak state due to wastewater overflows.
Rangituhi	Model reporting points in A state after nominal pH adjustment, except for Onepoto and Hukarito which are both in B state. Majority of WMU likely to be similar to natural conditions with low ammonia, though there is potential for the lower reaches to be in worse peak state due to wastewater overflows.
Pouewe	Model reporting points in A state after nominal pH adjustment and monitoring data is consistent with this.
Takapū	Model reporting points in A state after nominal pH adjustment and monitoring is consistent with this. There is potential for the lower reaches of Duck Creek to be in worse peak state due to wastewater overflows.
Te Riu o Porirua	Model reporting points in A state after nominal pH adjustment for median concentrations and this is consistent with monitoring results. Peak modelling indicates maximum concentrations in B or C state, with monitoring data also indicating maximum in B or C. Model may be more reliable than monitoring at estimating maximum concentrations in this case, with daily modelling estimates including wastewater overflows that are potentially missed in monitoring. Used more conservative estimate reflecting lower Porirua Stream main stem model results, and a conservative approach may be further supported by the observation that the pH of urban streams may be a little higher than the pH used in the nominal pH adjustment. The attribute state for median ammonia is estimated to be A state and the maximum concentration is estimated to be C state. The attribute state objective is to maintain the median concentration in A attribute state and the maximum concentration in C attribute state.

Nominal pH adjustment for scenario modelling results

The pH selected for pH adjustment was 7.3 as this seemed a good reflection of the typical pH in the monitored streams across the whaitua. There could be a suggestion to adopt a higher pH (eg, 7.5) for the urban streams in particular. Doing so places more of the urban reporting points in C state for peak ammonia concentrations.

Basis for numeric objectives

All numeric objectives for ammonia toxicity set in Appendix 2 of the WIP are based on the upper threshold of the Whaitua Committee-chosen objective state (i.e., A state for all WMUs except Te Riu o Porirua where the objective is A state for the median concentration and C state for maximum concentration) from the ammonia attribute tables in the NPS-FM.

While the estimates of current state concentrations from monitoring and modelling are lower than these NPS-FM attribute table threshold figures, the principle has been to use attribute state thresholds rather than specific estimates from monitoring or modelling. This principle has been selected because:

- The thresholds are effects-based and defensible with an independent basis for their derivation
- It reduces the risk of putting unwarranted confidence in the accuracy of the model and its ability to differentiate subtle differences between WMUs and catchments within each
- It reduces the risk of setting objectives that may require concentration reductions for little ecological gain if more detailed monitoring was undertaken

This approach does have the risk of allowing some limited increases in contaminant concentration (i.e., up to the relevant state band threshold). However, that risk is mitigated in part by the setting of harbour scale load limits (see below) and associated methods described in the WIP that collectively aim to maintain or reduce contaminant loads (including ammonia) entering the coastal WMUs.

Alternative approaches were considered, though all of these would introduce alternative sets of assumptions, judgements and risks. For example, setting objectives differently in each WMU based on the min/max/median/average of model reporting points implies a high degree of accuracy and confidence in the model predictions and increases the risk of requiring unintended reductions.

Another approach would be to use monitoring estimates to set 'maintain-at-current' numeric objectives. That is possibly a reasonably robust and defensible approach for those WMUs with monitoring sites and large datasets suitable for accurately estimating current state concentrations. However, there remains two WMUs with no monitoring sites so those would require a different approach to set objectives. In addition not all attributes are monitored at all sites, so some objectives for those WMUs would also need to be set with a different approach.

Basis for limits and targets

The concentration of ammonia in the water at a given time is the basis for the risk of ecological toxicity. Therefore, the limits set in the WIP are based on maintaining the current state for each freshwater WMU and the targets are based on the objective state concentrations (Table 13 in Appendix 2 of the WIP) for each freshwater WMU.

Current state, objectives and targets for inclusion in WIP

Ammonia (toxicity)		Water management unit				
		Taupō	Rangituhi	Pouewe	Takapū	Te Riu o Porirua
Estimated current state		A	A	A	A	A/C
Objective	Objective state chosen by Whaitua Committee	A	A	A	A	A/C
	Median concentration (mg/L) ≤	0.03	0.03	0.03	0.03	0.03
	Maximum concentration (mg/L) ≤	0.05	0.05	0.05	0.05	2.2
	Objectives to be met by	Maintain	Maintain	Maintain	Maintain	Maintain

The attribute state for median ammonia is estimated to be A state and the maximum is estimated to be C state. The attribute state objective is to maintain the median in A attribute state and the maximum in C attribute state.

Nitrate toxicity

Assessment of current state in each WMU

WMU name	Comments
Taupō	The model median nitrate estimates for Taupō and Rangituhi WMUs are slightly higher than the modelled medians for Pouewe and Takapū WMUs but are within the range of model estimates for these latter WMUs. The model estimates and monitoring data in Te Riu o Porirua WMU tend to be higher. Consider the Horokiri and Pauatahanui monitoring site assessments are likely to be applicable in the Taupō and Rangituhi WMUs.
Rangituhi	
Pouewe	Consider the model may be over-estimating 95%tile concentrations when compared with the monitoring data 95%tiles. Used the attribute states based on monitoring sites to assign current state.
Takapū	
Te Riu o Porirua	

Basis for numeric objectives

All numeric objectives for nitrate toxicity set in Appendix 2 of the WIP are based on the upper threshold of the Whaitua Committee-chosen objective state (i.e., A state for all WMUs) from the nitrate toxicity attribute tables in the NPS-FM.

While some current state concentration estimates from monitoring and modelling are lower than these NPS-FM attribute table threshold figures, the principle has been to use attribute state thresholds rather than specific estimates from monitoring or modelling. The reasons for this approach are the same as described for ammonia toxicity in the previous section.

Basis for limits and targets

Limits and targets are not explicitly set for nitrate toxicity objectives. However, the DIN concentration criteria and limits and targets set for TN are expected to help achieve the nitrate toxicity objectives.

Current state and objectives for inclusion in WIP

Nitrate (toxicity)		Water management unit				
		Taupō	Rangituhi	Pouewe	Takapū	Te Riu o Porirua
Estimated current state		A	A	A	A	B
Objective	Objective state chosen by Whaitua Committee	A	A	A	A	A
	Median concentration (mg/L) ≤	1	1	1	1	1
	95th percentile concentration (mg/L) ≤	1.5	1.5	1.5	1.5	1.5
	Objectives to be met by	Maintain	Maintain	Maintain	Maintain	2040

Dissolved zinc toxicity and total zinc in sediment

Interpretation tables adopted for dissolved zinc

In the absence of a NPS-FM/NOF attribute table for zinc, the modelling leadership group has developed a framework for zinc that follows the same rationale as the toxicity attributes in the NPS-FM, that is, it includes two sets of state band thresholds for chronic and acute exposure (see dissolved zinc attribute table in Appendix 1 of the WIP). The chronic exposure thresholds adopt the figures for 99, 95 and 80% species protection given in the ANZECC (2000) guidelines.

The application of the framework is limited by not having a second set of toxicity data that enabled the acute thresholds to be derived for the NOF toxicity attributes. Instead, this table has adopted lower species protection thresholds for the A and B attribute states (ie, 95 and 90% for A and B states respectively), while the bottom of the C attribute state is defined from the USEPA acute toxicity threshold. Because these thresholds are uncertain proxies for acute toxicity thresholds, it is suggested to set objectives for 95th percentile concentrations rather than the more stringent maximum.

This framework has been used to interpret and present the modelling results to the Committee and help them choose attribute state objectives.

Interpretation tables adopted for total zinc in sediment

The adopted approach uses numeric thresholds representing fractions of the ANZECC (2000) interim sediment quality guideline (ISQG) (see total zinc in sediment attribute table in Appendix 1 of the WIP). This approach follows a risk framework to help indicate there is a changing risk that an effect might occur on animals living in the sediment.

The ISQG thresholds have been derived from a very limited international dataset, and there are few reliable New Zealand data on sediment toxicology. Uncertainty remains over the degree to which these thresholds protect New Zealand species. The adopted approach provides a precautionary approach to manage the risk of harm to aquatic species based on our current level of knowledge.

Assessment of current state in each WMU

There is no zinc monitoring data available for most WMUs, so the estimates of current state are largely driven by modelling results. However, it is noted that there was calibration data within the Te Riu o Porirua WMU only.

WMU name	Comments
Taupō	While much of the Taupō WMU is rural land cover with low risk of zinc contamination, it also has some high-risk zinc sources that may give rise to higher zinc concentrations in some places, including near SH1 and urban, commercial and industrial activities in the lower reaches below Taupō Swamp. The current C state assessment based on modelling reflects the influence of these sources, though there is no monitoring data and the actual current state is uncertain.
Rangituhi	The current D state assessment is largely driven by the modelled D state result around Elsdon/Urukahika Stream. However, that modelled state is uncertain due to uncertainty around storm water drainage and how much of the runoff from the commercial and industrial areas there reaches the stream. The current state may be better than estimated if there is separation,

	retention and treatment of storm water from these higher risk areas.
Pouewe	Most model reporting points are in A state and there are few high-risk activities in the WMU.
Takapū	Most model reporting points are in A state and there are few high-risk activities in the WMU.
Te Riu o Porirua	This WMU has monitoring data to draw on, and the D state assessment reflects the lower Porirua Stream monitoring result.
Onepoto Arm	Assessments are all based on monitoring data, showing B state for Onepoto Arm Intertidal and Pauatahanui Arm Subtidal WMUs, C state for Onepoto Arm Subtidal, and A state for Pauatahanui Arm Intertidal. There is reasonable consistency in monitoring sites across the baseline period and within the sample replicates at each site.
Pauatahanui Inlet	

Basis for numeric objectives

All numeric objectives for dissolved zinc set in Table 13 of Appendix 2 of the WIP are based on the upper threshold of the Whaitua Committee-chosen objective state (i.e., A state for all WMUs except Te Riu o Porirua where the objective is C state) from the adopted dissolved zinc toxicity attribute table in Appendix 1 of the WIP.

All numeric objectives for total zinc in sediment set in Table 15 of Appendix 2 of the WIP are based on the upper threshold of the Whaitua Committee-chosen objective state (i.e., A state for Pauatahanui Arm Intertidal WMU, B state for Pauatahanui Arm Subtidal and Onepoto Arm Intertidal, and C state for Onepoto Arm Subtidal) from the adopted total zinc in sediment attribute table in Appendix 1 of the WIP.

While some current state zinc concentration estimates from monitoring and modelling are lower than these attribute table threshold figures, the principle has been to use attribute state thresholds rather than specific estimates from monitoring or modelling. The reasons for this approach are similar to those described for ammonia toxicity in the earlier section above.

Basis for limits and targets

To achieve the zinc objectives in the Onepoto Arm and Pauathaunui Inlet WMUs, a reduction in total zinc and copper load is required to match the reduction in sediment load sought for those WMUs. This is in order to ensure harbour sediment zinc and copper concentrations do not increase as a result of the reduced dilution afforded by lower sediment loads.

The sediment load reduction targets require a 40% reduction in total sediment. Therefore, the limit set in Table 6 of the WIP is to maintain the current total zinc load, and the target is for a 40% reduction in the incoming total zinc loads to each harbour arm.

Setting total zinc load reduction targets entering each harbour arm is also likely to support the achievement of the in-stream dissolved zinc objectives, provided that significant amounts of the load reduction occurs during peak flows and rainfall periods, particularly from streams in the Taupō, Rangituhi and Te Riu o Porirua WMUs.

Current state, objectives and limits for inclusion in WIP

Dissolved zinc (toxicity)		Water management unit				
		Taupō	Rangituhi	Pouewe	Takapū	Te Riu o Porirua
Estimated current state		C	D	A	A	D
Objective	Objective state chosen by Whaitua Committee	A	A	A	A	C
	Median concentration (mg/L) ≤	0.0024	0.0024	0.0024	0.0024	0.031
	95th percentile concentration (mg/L) ≤	0.008	0.008	0.008	0.008	0.042
	Objectives to be met by	2040	2040	Maintain	Maintain	2040

Total zinc in sediment (toxicity)		Water management unit			
		Onepoto Arm		Pautahanui Inlet	
		Intertidal	Subtidal	Intertidal	Subtidal
Estimated current state		B	C	A	B
Objective	Objective state chosen by Whaitua Committee	B	C	A	B
	Total zinc in sediment (mg Zn/Kg) ≤	100	200	40	100
	Objectives to be met by	Maintain	Maintain	Maintain	Maintain

Annual average total zinc load (kg/yr)	Baseline estimate	Limit	Target
Onepoto Arm	2,600	No increase from baseline estimate	40% reduction from baseline estimate
Pautahanui Inlet	580	No increase from baseline estimate	40% reduction from baseline estimate

Dissolved copper toxicity and total copper in sediment

Interpretation tables adopted for dissolved copper and total copper in sediment

The same rationale and approach described for both dissolved zinc and total zinc in sediment was followed for these copper objectives.

Assessment of current state in each WMU

There is no copper monitoring data available for most WMUs, so the estimates of current state are largely driven by modelling results. However, it is noted that there was calibration data within the Te Riu o Porirua WMU only.

WMU name	Comments
Taupō	While much of the Taupō WMU is rural land cover with low risk of copper contamination, it also has some high risk copper sources that may give rise to copper concentrations in some places, including near SH1 and urban, commercial and industrial activities in the lower reaches below the swamp. The current D state assessment based on modelling reflects the influence of these sources, though there is no monitoring data and the actual current state is uncertain
Rangituhi	The current D state assessment is largely driven by the modelled D state result around Elsdon/Urukahika Stream. However, that modelled state is uncertain due to uncertainty around storm water drainage and how much of the runoff from the commercial and industrial areas there reaches the stream. The current state may be better than estimated if there is separation, retention and treatment of this storm water.
Pouewe	Most model reporting points are in A state and there are few high-risk activities in the WMU.
Takapū	Most model reporting points are in A state and there are few high risk activities in the WMU.
Te Riu o Porirua	This WMU has monitoring data to draw on, and the D state assessment reflects the Porirua Stream monitoring result.
Onepoto Arm	Assessments are all based on monitoring data, showing A state for Pauatahanui Arm (both Subtidal and Intertidal) and Onepoto Arm Intertidal, but B state for Onepoto Arm Subtidal. There is reasonable consistency in monitoring sites across the baseline period and within the sample replicates at each site.
Pauatahanui Inlet	

Basis for numeric objectives

All numeric objectives for dissolved copper set in Table 13 of Appendix 2 of the WIP are based on the upper threshold of the Whaitua Committee-chosen objective state (i.e., A state for most WMUs except for C state in Te Riu o Porirua and B state in Taupō WMU) from the adopted dissolved copper toxicity attribute table in Appendix 1 of the WIP.

All numeric objectives for total copper in sediment set in Table 15 of Appendix 2 of the WIP are based on the upper threshold of the Whaitua Committee-chosen objective state (i.e., A state for Pauatahanui Arm (both Subtidal and Intertidal) and Onepoto Arm Intertidal, but B state for Onepoto Arm Subtidal) from the adopted total copper in sediment attribute table in Appendix 1 of the WIP.

While some current state copper concentration estimates from monitoring and modelling are lower than these attribute table threshold figures, the principle has been to use attribute state thresholds rather than specific estimates from monitoring or modelling. The reasons for this approach are similar to those described for ammonia toxicity in the earlier section above.

Basis for limits and targets

The same rationale and approach described above for both dissolved zinc and total zinc in sediment was followed for limits and targets to help achieve these copper objectives.

Current state, objectives and limits for inclusion in WIP

Dissolved copper (toxicity)		Water management unit				
		Taupō	Rangituhi	Pouewe	Takapū	Te Riu o Porirua
Estimated current state		D	D	A	A	D
Objective	Objective state chosen by Whaitua Committee	B	A	A	A	C
	Median concentration (mg/L) ≤	0.0014	0.001	0.001	0.001	0.0025
	95th percentile concentration (mg/L) ≤	0.0018	0.0014	0.0014	0.0014	0.0043
	Objectives to be met by	2040	2040	Maintain	Maintain	2040

Total copper in sediment (toxicity)		Water management unit			
		Onepoto Arm		Pautahanui Inlet	
		Intertidal	Subtidal	Intertidal	Subtidal
Estimated current state		A	B	A	A
Objective	Objective state	A	B	A	A
	Total copper in sediment (mg Zn/Kg) ≤	13	32	13	13
	Objectives to be met by	Maintain	Maintain	Maintain	Maintain

Annual average total copper load (kg/yr)	Baseline estimate	Limit	Target
Onepoto Arm	240	No increase from baseline estimate	40% reduction from baseline estimate
Pautahanui Inlet	70	No increase from baseline estimate	40% reduction from baseline estimate

Periphyton

Assessment of current state in each WMU

There is limited periphyton monitoring data available for most WMUs, so the estimates of periphyton current state for all WMUs are taken from expert assessments.

Basis for numeric objectives

All numeric objectives for periphyton set in Table 14 of Appendix 2 of the WIP are based on the upper threshold of the Whaitua Committee-chosen objective state (i.e., B state for all WMUs except Rangituhi where the objective is A state) from the periphyton attribute table in the NPS-FM.

Basis for DIN concentration criteria

Nutrient concentration criteria are one tool to help avoid large and frequent blooms of periphyton growth. These focus on managing median nutrient concentrations rather than short-term peak concentrations, because it is the former rather than latter that most influences periphyton growth.

The periphyton objectives seek an improvement in most WMUs. The approach to setting the DIN concentration criteria in Table 9 of the WIP has been based on the current estimated DIN concentration with a reduction factor applied based on the average modelled 'improved' scenario reduction of approximately 10% off median concentrations.

The modelled 'improved' scenario reduction was used as scenario modelling indicated most reduction in DIN occurred in the ‘improved’ scenario, with limited additional reduction in the modelled ‘water sensitive’ scenario. Additionally, expert assessment considered that most improvements in periphyton levels were likely to occur under the 'improved' scenario, with little additional improvement expected in the ’water sensitive’ scenario.

The basis of current state DIN concentration estimates for each WMU is described below, from which the 10% reduction was made.

WMU name	Comments
Taupō	The model estimates for Taupō and Rangituhi WMUs are higher than the Pouewe and Takapū WMU model estimates, though not as high as many of the Te Riu o Porirua WMU model estimates. Using Horokiri monitoring DIN concentration as a pragmatic proxy for current state in both of these unmonitored WMUs is likely to help avoid DIN concentrations being problematic for nuisance periphyton, while also reducing the risk of requiring DIN reductions in other catchments should monitoring occur in these catchments in the future.
Rangituhi	
Pouewe	Model estimates suggest there is variation in DIN between catchments within these WMUs, but no clear distinction on reporting points in one WMU being consistently higher or lower than the other. Monitoring shows the Pauatahanui site tends to have lower DIN concentrations than Horokiri. Both monitoring site DIN concentrations are not considered likely to be limiting periphyton growth. Using Horokiri monitoring DIN concentration as a pragmatic proxy for current state in both of these unmonitored WMUs is likely to help avoid DIN concentrations being problematic for nuisance periphyton, while also reducing the risk of requiring DIN reductions in other catchments should
Takapū	

	monitoring occur in those catchments in the future.
Te Riu o Porirua	Relatively consistent DIN estimates across model reporting points within the WMU. Therefore the Porirua monitoring site median DIN concentration has been used as an estimate of current state for this WMU.

Using this approach the DIN concentration criteria set in Table 9 of the WIP are higher than national guidelines to limit periphyton growth using nutrient limitation alone, and other measures will be required to achieve the periphyton objectives as described in the WIP.

Basis for DRP concentration criteria

The same rationale and approach described for DIN concentration criteria was followed for the DRP concentration criteria set in Table 9 of the WIP.

The percent reduction factor applied to the current median DRP concentration was 30%, reflecting the modelled 'improved' scenario result. This 30% reduction was taken off current state DRP estimates derived for each WMU on the basis described below.

WMU name	Comments
Taupō	The modelled DRP estimates for Taupō and Rangituhi WMUs are not clearly different from either the Pouewe, Takapū or Te Riu o Porirua WMU model estimates. DRP is not monitored in either of these WMUs. To be consistent with the DIN approach the DRP estimate for the Pouewe and Takapū WMUs (see below) has also been used for the Taupō and Rangituhi WMUs.
Rangituhi	
Pouewe	Model estimates suggest there is variation in DRP between catchments within these WMUs, with Takapū perhaps being slightly higher than Pouewe. Monitoring shows the Pauatahanui site tends to have slightly higher concentrations than Horokiri. Concentrations at both monitoring sites are unlikely to be limiting periphyton growth and may be at levels sufficient to stimulate periphyton growth. Using Pauatahanui monitoring DRP concentration as a pragmatic proxy for current state in both of these WMUs is likely to reduce the risk of requiring greater than anticipated reductions in other catchments should monitoring occur in those catchments in the future.
Takapū	
Te Riu o Porirua	Relatively consistent DRP estimates across model reporting points within the WMU. Therefore the Porirua monitoring site median DRP concentration has been used as an estimate of current state in this WMU.

Using this approach the DRP concentration criteria set in Table 9 of the WIP are higher than national guidelines to limit periphyton growth using nutrient limitation alone, and other measures will be required to achieve the periphyton objectives, as described in the WIP.

Current state, objectives and nutrient concentration criteria for inclusion in WIP

Periphyton		Water management unit				
		Taupō	Rangituhi	Pouewe	Takapū	Te Riu o Porirua
Estimated current state		C	A	C	C	C/B
Objective	Objective state chosen by Whaitua Committee	B	A	B	B	B
	No more than 8% of samples with mg chl-a/m2 ≤	-	50	120	120	120
	No more than 17% of samples with mg chl-a/m2 ≤	120	-	-	-	-
	Objectives to be met by	2040	Maintain	2040	2040	2040

The Taupō WMU is predominantly in the 'Productive Class' defined by the NPS-PM periphyton attribute, meaning no more than 17% of samples may exceed the objective threshold

Water management unit	Dissolved inorganic nitrogen	Dissolved reactive phosphorus
	Median concentration (mg/L) ≤	Median concentration (mg/L) ≤
Taupō	0.6	0.01
Rangituhi	0.6	0.01
Pouewe	0.6	0.01
Takapū	0.6	0.01
Te Riu o Porirua	0.8	0.013

Macroinvertebrate Community Index

Assessment of current state in each WMU

There is limited Macroinvertebrate Community Index (MCI) monitoring data available for most WMUs, so the estimates of MCI current state are taken from expert assessments that utilise both the available monitoring data and model-predicted MCI at multiple reporting points, as summarised below.

WMU name	Comments
Taupō	Currently C state based on expert assessment.
Rangituhi	Currently C state based on expert assessment and modelling predictions showing C state at most reporting points within the WMU. However it is noted that model predictions and expert assessment suggest a currently better state (B or even A) at some locations such as parts of the Rangituhi and Mahinawa streams.
Pouewe	Currently between B and C state, based on expert assessment of model predictions that show C state throughout the WMU and monitoring of the Horokiri site being within or close to B state.
Takapū	Currently between B and C state, based on expert assessment of model predictions that show C state throughout the WMU and monitoring of the Pauatahanui site being within or close to B.
Te Riu o Porirua	Currently C state based on expert assessment of model predictions showing C state throughout the WMU and this being consistent with C state shown in monitoring data at the Porirua Stream site.

Basis for numeric objectives

All numeric objectives for MCI set in Table 14 of Appendix 2 of the WIP are based on the upper threshold of the Whaitua Committee-chosen objective state (i.e., A state for Rangituhi and Pouewe, B state for Taupō and Takapū, and C state for Te Riu o Porirua) from the adopted MCI attribute table in Appendix 1 of the WIP.

Current state and objectives for inclusion in WIP

Macroinvertebrate community index		Water management unit				
		Taupō	Rangituhi	Pouewe	Takapū	Te Riu o Porirua
Estimated current state		C	C	C/B	C/B	C
Objective	Objective state chosen by Whaitua Committee	B	A	A	B	C
	River class 2 MCI ≥	105	130	130	105	80
	River class 6 MCI ≥	100	120	120	100	80
	Objectives to be met by	2040	2040	2040	2040	Maintain

Macroalgae

Assessment of current state in each WMU

Regular monitoring of macroalgae in the Onepoto Arm and Pauatahanui Inlet indicated the overall Environmental Quality Rating (EQR) across all intertidal areas of Te Awarua-o-Porirua was 0.61 (on a scale from zero to one) in 2016, which equates to a B state using the adopted macroalgae attribute table in Appendix 1 of the WIP. This was a slight improvement from 2015.

Monitoring since 2008 has not recorded any significant 'gross eutrophic zones' in the estuary, but highlights that localised nuisance conditions (e.g. rotting algae, poorly oxygenated and sulphide-rich sediments) do occur when there are dense accumulations (>50% cover) of macroalgae.

Basis for numeric objectives

Numeric objectives for macroalgae set in Table 15 of Appendix 2 of the WIP are based on the upper threshold of the Whaitua Committee-chosen objective state (i.e., B state for the intertidal areas of both Onepoto Arm and Pauatahanui Inlet) from the adopted macroalgae attribute table in Appendix 1 of the WIP.

Basis for limits and targets

Setting limits for the load of total nitrogen (TN) and total phosphorus (TP) entering each harbour arm is intended to support the achievement of the macroalgae objectives in the Onepoto Arm and Pauatahanui Inlet WMUs.

Those objectives are seeking to maintain macroalgae at current levels, therefore the limits and targets are also recommended to at least maintain no greater than current nutrient loads entering those WMUs. It is expected that the limits for DIN and DRP concentrations in streams described earlier will help maintain and likely actually reduce current nutrient loads to each harbour arm.

Current state, objectives and limits for inclusion in WIP

Macroalgae		Water management unit			
		Onepoto Arm		Pautahanui Inlet	
		Intertidal	Subtidal	Intertidal	Subtidal
Estimated current state		B	N/A	B	N/A
Objective	Objective state chosen by Whaitua Committee	B		B	
	Ecological quality rating ≥	0.6		0.6	
	Objectives to be met by	Maintain		Maintain	

Annual average total nitrogen load (tonnes/yr)	Baseline estimate	Limit	Target
Onepoto Arm	59	No increase from baseline estimate	No increase from baseline estimate
Pautahanui Inlet	84	No increase from baseline estimate	No increase from baseline estimate
Annual average total phosphorus load (kg/yr)	Baseline estimate	Limit	Target
Onepoto Arm	3,300	No increase from baseline estimate	No increase from baseline estimate
Pautahanui Inlet	4,500	No increase from baseline estimate	No increase from baseline estimate

Sedimentation rate and muddiness

Assessment of current state in each WMU

The current sedimentation rates given in section 4.4 of the WIP are 4.7mm/year for Pauatahanui Inlet and 4.1mm/year for Onepoto Arm) and these were taken from the modelling results. This is reflected in the results of the 2010 full year model run and a number of rain 'event' model runs. This is intended to represent the longer-term average sedimentation rate, incorporating both the 'average' incoming sediment and the pulses of sediment that come into the harbour during significant rainfall events.

Monitoring results dating back to 2004, show a consistent trend of increasing mean sediment mud content at intertidal and subtidal sites in both arms. Current levels of mud content in the harbour are around 20% for the intertidal and 80% for the subtidal areas. There is also evidence that the spatial extent of muddy sediment in the intertidal is increasing both shoreward and toward the subtidal basins.

Basis for numeric objectives

The numeric objectives set in Table 3 of the WIP for sedimentation rate (<1mm/year in Onepoto Intertidal; <2mm/year in Pauatahanui Intertidal) and muddiness (sediment mud content <20% in intertidal sediments of both harbour arms) have not been developed following an 'attribute state' approach. The basis of these objectives is described in the technical paper supporting the Committee's discussions.

Basis for limits and targets

The average sediment load reduction targets set in Table 8 of the WIP (i.e. 40% reduction from current load in both Onepoto and Pauatahanui arms) were derived based on modelled scenario changes in the 2010 annual load. The modelled scenario load changes were plotted against the modelled scenario changes in sedimentation rate, the latter being based on the 2010 annual model run plus consideration of a number of significant rain events. This provided a relationship between percent load reduction and average sedimentation rate that could then be analysed to derive the percent load reduction necessary to achieve the Whaitua Committee's chosen sedimentation rate objectives.

This approach does not account for the observation that modelled scenario sediment load change for some rain events was greater than the 2010 annual change. The following analysis and resulting 40% reduction target for both harbour arms therefore represents the average reduction required: reductions in short term peak loads may need to be greater than this target to achieve the sedimentation rate objectives.

The average reduction target of 40% for Pauatahanui Inlet reflects considerations of:

- Harbour modelling indicating that a sediment reduction of around 45% is estimated to result in a sedimentation rate of around 2mm/yr.
- The bulk of sediment reductions in catchments draining to the Pauatahanui Inlet are estimated to come through the mitigations associated with the modelled 'improved' scenario. This produced a load reduction of around 40%.
- While additional sediment reductions were made in the modelled 'water sensitive' scenario, the additional cost for these was significant.

The average reduction target of 40% for Onepoto Arm reflects considerations of:

- Over 95% of Onepoto arm deposition originates from catchments draining to Onepoto.

- Harbour modelling indicating that a sediment reduction in Onepoto source loads of between 15 and 58% estimated to result in a sedimentation rate of between 2.5 and 0.3mm/yr.
- Simple linear interpolation between these points suggests a load reduction of 40-45% may approximate to a sedimentation rate of around 1mm/yr.
- The bulk of sediment reductions in catchments draining to the Onepoto Arm are estimated to come through the mitigations associated with the modelled 'improved' scenario with small additional reductions in the modelled 'water sensitive' scenario. The 'improved' scenario produced a load reduction of around 45%.

Current state, objectives and limits for inclusion in WIP

Sedimentation rate		Water management unit			
		Onepoto Arm		Pautahanui Inlet	
		Intertidal	Subtidal	Intertidal	Subtidal
Estimated current state (mm/yr)		4.1		4.7	
Objective	Objective state chosen by Whaitua Committee	Net average sedimentation rate is less than 1mm/year in Onepoto Arm (rolling average over the most recent 5 years of data)		Net average sedimentation rate is less than 2mm/year in Pautahanui Inlet (rolling average over the most recent 5 years of data)	
	Objectives to be met by	Maintain		Maintain	

Muddiness		Water management unit			
		Onepoto Arm		Pautahanui Inlet	
		Intertidal	Subtidal	Intertidal	Subtidal
Objective	Objective state chosen by Whaitua Committee	Sediment mud content will not exceed 20% in intertidal sediments/ no increase from current state		Sediment mud content will not exceed 20% in intertidal sediments/ no increase from current state	
	Objective state chosen by Whaitua Committee	Spatial extent of soft mud will not exceed 15% of available intertidal area/no increase in soft mud area from current		Spatial extent of soft mud will not exceed 15% of available intertidal area/no increase in soft mud area from current	
	Objectives to be met by	Maintain		Maintain	

Annual average sediment load (tonnes/yr)	Baseline estimate	Limit	Target
Onepoto Arm	2,800	No increase from baseline estimate	40% reduction from baseline estimate
Pautahanui Inlet	5,200	No increase from baseline estimate	40% reduction from baseline estimate