MEMO

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

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Recommended changes to Schedule H attributes and outcomes for the draft Natural Resources Plan: Coastal waters

1. Introduction

Schedule H of the Regional Plan: Working Document for Discussion (WDFD, GWRC 2013) included narrative and numeric outcomes for aquatic ecosystem health and mahinga kai as well as contact recreation and tangata whenua use values associated with coastal waters (Appendix 1). This memorandum sets out recommended changes to Tables H5.1–H5.2 of the WDFD for inclusion in the draft Natural Resources Plan (dNRP). The changes take into account stakeholder feedback on the provisions in the WDFD and further external specialist advice.

The final recommended changes to the Schedule H coastal water attributes and outcomes for the dNRP are provided in Appendix 1.

1.1 Stakeholder feedback

Feedback from stakeholders was received during and following GWRC workshops held in late 2013. Specific written comments relating to technical aspects of the Schedule H attributes and outcomes for coastal waters were received from:

- Department of Conservation (DoC), in relation to the need for definitions of estuary *vs* coastal lake *vs* lake (ie, Tables H4.1–2 vs Table H5.1–2);
- Friends of Taputeranga Marine Reserve Trust, in relation to the use of maximum-based statistics and the need for sediment and clarity targets (Table H5.2); and
- Regional Public Health (RPH), in relation to the suitability of the faecal coliform-based outcome to provide for safe shellfish gathering under the contact recreation value (Table H5.2).

These comments are addressed in Sections 2 and 3. The original feedback and abbreviated responses are tabulated in Appendix 2.

1.2 Expert advice

In December 2013 an expert workshop was held at GWRC to discuss monitoring and outcome setting for shallow coastal lakes, including Lake Onoke. Dr Marc Schallenberg (University of Otago), Dr Barry Robertson (Wriggle Coastal Management Ltd) and Keith Hamill (River Lake Ltd) were the external specialists that attended the workshop. A summary of the workshop is reported by Milne et al. (2014), with the primary point of interest to this memorandum being that Lake Onoke should be managed as an estuary except when its mouth is closed (see Section 2.1.1).

Dr Barry Robertson was also commissioned to provide technical advice on ecosystem health outcomes for estuaries in the Wellington region.

2. Aquatic ecosystem health and mahinga kai

2.1 Estuaries including Porirua Harbour, Lake Onoke (ICOLL) and Wellington Harbour

2.1.1 General changes

Table H5.1 has been revised to include more biological attributes relating to aquatic ecosystem health and provide greater consistency with the corresponding tables for rivers and lakes.

It is recommended that many of the numeric outcomes in Table H5.1 be replaced with narrative outcomes following external specialist advice (Robertson 2014); this largely reflects the absence of region-wide (or sufficient national) data against which robust, defensible numeric outcomes[1] (or limits) can be set[2]. Nationally, there is substantial work underway to address these information gaps. For example:

- Estuarine 'expert panel' workshops were held as part of the development of the National Objectives Framework (NOF) under the National Policy Statement for Freshwater Management (NPS-FM, MfE 2014);
- The current ANZECC (2000) water quality guidelines review has a specific project involving the review of existing New Zealand coastal water quality data-sets to assess whether they can be used to derive New Zealand-specific trigger values for aquatic ecosystem health; and
- An Envirolink Tools project (championed by the Coastal Special Interest Group of the regional councils) is now underway to develop an Estuarine Trophic Index (ETI) that should assist with the establishment of outcomes and limits for estuarine waters.

2.1.2 Definitions of estuaries and ICOLLS

In response to DoC's comments that clear definitions are required for an estuary and an intermittently closed and open lake or lagoon (ICOLL), these definitions are provided below (adapted from Robertson and Stevens 2007).

It should be noted that Lake Onoke has been removed from the lakes Schedule H tables (Tables H2.1–H2.3, see Perrie and Milne 2014) and is now only represented in the coastal table (Table H5.1). This is because Lake Onoke is an ICOLL and while it exhibits characteristics of both freshwater and estuarine environments, it represents an estuarine state the majority of the time (Milne et al. 2014).

[1] As outlined in Greenfield et al. (2013), the numeric outcomes for estuaries presented in Table H5.1 of the WDFD represent 'best estimates' of 'fair' to 'good' ecosystem health based on expert opinion (Robertson & Stevens 2012). These numeric values are still relevant and will, in the absence of any formal national guidelines, be incorporated into the Technical Guidance Document to Schedule H (Greenfield et al. in prep). This document will set out how Schedule H outcomes will be measured.

[2] It is this absence of nation- or region-wide data that precludes the addition of numeric narratives for sediment and water clarity as suggested in feedback from Friends of the Taputeranga Marine Reserve Trust.

Estuary	An estuary is a body of water formed where fresh water flowing from rivers and streams mixes with seawater. Although estuaries are influenced by tides and wind-driven currents, estuaries are typically low energy depositional environments. Estuaries may have extensive intertidal areas and are permanently open to the sea.
Intermittently closed and open lake or lagoon (ICOLL)	An ICOLL has a broad and shallow central basin and a sand or gravel barrier at the mouth that may naturally close periodically. The barrier constricts the entrance, reducing the exchange of water with the sea and results in poor flushing. Many ICOLLs are kept open artificially for flood and water quality management purposes.

2.1.3 Summary of recommended changes

The revised Table H5.1 attributes recommended for inclusion in the dNRP are outlined in Table 1. The key recommended changes to Table H5.1 (presented in Appendix 1) include:

- Reorganisation of the table columns and attributes to align with the equivalent tables for rivers and lakes. In particular:
  - the addition of narrative outcomes that address all of the key 'biological endpoints' of coastal ecosystems – aquatic plants, invertebrates, fish and birds – as well as connectivity;
  - the addition of temperature, pH and dissolved oxygen as water quality attributes. These measures of water quality are fundamental to the assessment of aquatic ecosystem health;
- Replacement of the numeric sedimentation rate outcome with a narrative for all estuaries except Porirua Harbour which should retain the target sedimentation rate of <1 mm/yr by 2035 for consistency with the Porirua Harbour and Catchment Strategy and Action Plan; and
- Replacement of the numeric-based substrate quality attributes of mud content, sediment anoxia (referred to in existing Table H5.1 as Redox Potential Discontinuity) and organic carbon with narrative outcomes, as well as extension of these attributes (along with sedimentation rate) to Wellington Harbour (these attributes are considered relevant because the harbour is, by its semi-enclosed nature, a depositional environment).

Table 1: Summary of aquatic ecosystem health attributes recommended for inclusion in Table H5.1 for estuaries and harbours

Attribute	Rationale
Biology	
Saltmarsh	Saltmarsh cover is essential for healthy estuarine and harbour systems, providing essential food, refuge and nursery habitat for fish, invertebrates and birds. Saltmarsh also protects shorelines from erosion by buffering wave action and trapping sediments, reduces flooding by slowing and absorbing rainwater and protects water quality by filtering runoff and metabolising excess nutrients.
Macrophytes (including seagrass)	Macrophytes are an important component of all aquatic ecosystems, with seagrass a particularly important macrophyte in estuaries, where it stabilises bottom sediments and provides habitat for other species. However, mass blooms of green and red macroalgae, mainly of the genera *Ulva, Cladophora,* and *Gracilaria,* can present a significant nuisance problem, especially when loose mats accumulate and decompose. Algal blooms also have major ecological impacts on water and sediment quality, reducing water clarity and oxygen and smothering other resident species (Robertson & Stevens 2012).
Phytoplankton	Phytoplankton form the base of aquatic food webs. In a balanced ecosystem, they provide food for a wide range of sea life, including shrimp, snails and jellyfish. When too many nutrients are available, phytoplankton blooms may occur, with potential to cause major ecological impacts on water and sediment quality, such as reduced clarity, physical smothering, lack of oxygen, and the subsequent displacement of animals.

Attribute	Rationale
Invertebrates	Soft sediments provide a three-dimensional environment and invertebrates can burrow deep within the sediment column. The abundance, diversity and biomass of invertebrate communities living within and on the sediment can be used as indicators of changing environmental conditions.
Fish	Fish communities provide a number of important ecosystem services related to their movement, migration, feeding and breeding. A diverse fish community represented by multiple age and size classes represents a healthy ecosystem.
Birds	Shorebirds are found along the shores of estuaries, wetlands, beaches and rocky platforms where they can congregate in large flocks and feed on invertebrates. Estuaries, ICOLLs and harbours provide valuable and abundant feeding habitat at low tide. Each species of shorebird found in any given habitat has adapted to a particular niche within that environment and as such, the diversity of bird species can be an indicator of ecosystem health. Two examples of coastal waters in the Wellington region important for birds include the Otaki River Estuary (provides habitat for banded dotterel and Caspian tern) and the Whareama River Estuary (provides habitat for the variable oystercatcher, reef herons, banded dotterels, pied stilts and bar-tailed godwits).
Mahinga kai	See Royal and Barriball (2014).
Water quality	
Salinity, temperature and pH	Most aquatic organisms function optimally within a narrow range of salinity, temperature and pH. If these variables shift from the natural regime it can affect the distribution of plants, invertebrates and fish. Widely varying regimes can select for lower abundance and lower diversity communities.
Dissolved oxygen	Dissolved oxygen is essential for the survival of all aquatic organisms and also affects a wide range of other water quality indicators.
Clarity	Light is essential for plant growth and poor water clarity impedes light penetration and reduces the growth of important habitat-forming species such as seagrass. In addition, many fish species are visual predators and also rely on clear water to catch their prey.
Nutrients	While nutrients are essential for estuarine and harbour ecosystems, excessive nutrient inputs (principally nitrogen and phosphorus) can cause physical and chemical degradation of the near shore environment. Nutrient exchange between the water column and sediments influences the structure of biotic communities and the growth of algae.
Toxicants	Toxicants, such as metals, tend to accumulate in plants and animals, entering through body and respiratory surfaces as well as by ingestion of particles and water. Toxicants can impair function, metabolism, development and reproduction.
Substrate quality	
Sedimentation rate	Estuaries are a natural 'sink' for catchment-derived sediment but if sediment inputs are excessive, estuaries infill quickly with muds, reducing biodiversity and human values and uses. Muddy sediments have a higher tendency to become anoxic and anoxic sediments contain toxic sulphides and very little aquatic life. Elevated sedimentation rates are likely to lead to significant and detrimental ecological changes within estuary areas that could be very difficult to reverse (Robertson & Stevens 2012).
Mud content	
Sediment anoxia	Surface sediments need to be well oxygenated to support healthy invertebrate communities; anoxic sediments contain toxic sulphides and very little aquatic life (Robertson & Stevens 2012).
Organic carbon	Organic carbon is an important source of food and energy but too much organic content depletes sediment oxygen as it degrades and can result in anoxic sediments, adversely impacting biota.
Nutrients	When high nutrients inputs combine with suitable growing conditions, nuisance blooms of rapidly growing phytoplankton and macroalgae can occur. At nuisance levels such growths can deprive seagrass of light, causing its eventual decline, while decaying macroalgae can accumulate on shorelines causing localised depletion of sediment oxygen and displacing the animals that live there (Robertson & Stevens 2012).
Toxicants	Many chemicals discharged to estuaries and harbours via urban and rural runoff are toxic, even at very low concentrations. These chemicals can accumulate in sediments and bioaccumulate in fish and shellfish, causing health risks to people and marine life.

Riparian margin vegetation
Estuaries and harbours function best with healthy riparian margin vegetation. Loss of this habitat reduces ecological and aesthetic values, and reduces the ability of the estuary or harbour to deliver essential ecosystem services, such as flood and erosion protection and contaminant mitigation (Robertson & Stevens 2012).
Connectivity
Connectivity refers to the free movement of water, nutrients, sediment and biota between estuaries and harbours and other waterbodies such as rivers, streams, wetlands and the open coast as well as the connectivity with key (typically) terrestrial habitats such as riparian vegetation. This connectivity is critical for a range of ecosystem values and processes but is particularly so for the maintenance of native fish communities.

2.2 Open coast

The only recommended changes to open coastal waters are the inclusion of the wider suite of biological and water quality attributes outlined in Section 2.1. As previously outlined in Greenfield et al. (2013), the high energy nature of open coastal waters of the Wellington region means that sediment quality attributes such as nutrients and toxicants are of minor relevance.

3. Contact recreation and tangata whenua use

Outcomes in Schedule H of the WDFD to protect contact recreation and tangata whenua use values consist of numeric and narrative outcomes for a range of human health and aesthetic attributes. Human health outcomes relate to both primary contact recreation (enterococci and *E. coli* outcomes) and shellfish collection (faecal coliform outcomes).

Recommended changes to human health-related outcomes for the dNRP are discussed below, together with feedback from stakeholders which was focussed on outcomes for shellfish gathering.

3.1 Primary contact recreation

The numeric outcomes to protect human health in Schedule H of the WDFD are enterococci (coastal waters) or *E. coli* counts (estuarine waters) based on the surveillance thresholds of the MfE/MoH (2003) microbiological guidelines for marine and freshwater recreational areas (Appendix 1). Either the ‘alert’ or ‘action’ triggers are applied depending on the time of year.

There was no significant feedback received from stakeholders regarding the outcomes for primary contact recreation. However, in order to be consistent with recommended changes to outcomes for rivers and streams (see Greenfield 2014), it is proposed that the outcomes be based around enterococci/*E. coli* Microbiological Assessment Category (MAC) values provided in the MfE/MoH (2003) guidelines.

The MfE/MoH (2003) guidelines identify four MAC values ranging from A to D which are based on a 95^{th} percentile of faecal indicator bacteria counts (Tables 2 and 3). As MAC outcomes only apply to the summer bathing season (November to March inclusive) and it is known that coastal waters are still used, albeit to a lesser extent, outside of these months it is recommended that an additional enterococci/*E. coli* outcome be identified in the dNRP for the period outside of the bathing season. This outcome should also be an enterococci/*E. coli* 95^{th} percentile based on the appropriate MAC value rather than the surveillance-based threshold outcome recommended in Schedule H of the WDFD.

It is important to note that enterococci/*E. coli* 95th percentile outcomes should not be applied to coastal or estuarine waters that are impacted by a nearby point source discharge of treated wastewater without the relationship between indicator bacteria and pathogens in the discharge first being established. As stated in the MfE/MoH (2003) guidelines, the wastewater treatment process can alter the relationship between faecal indicator bacteria and pathogens (ie, treatment may remove indicator bacteria but not pathogens) meaning that the guidelines may not accurately represent the health risk to recreational users.

Table 2: Guideline values for microbiological water quality of marine recreational waters. Note AFRI = acute febrile respiratory illness

Source: Adapted from pp. H25, MfE/MoH (2003)

95th percentile value of enterococci/100mL	MAC value	Estimated risk of infection
≤40	A	<1% gastroenteritis risk, <0.3% AFRI risk
41–200	B	1–5% gastroenteritis risk, 0.3–<1.9% AFRI risk
200–500	C	5–10% gastroenteritis risk, 1.9–3.9% AFRI risk
>500	D	>10% gastroenteritis risk, >3.9% AFRI risk

Table 3: Guideline values for microbiological water quality of estuarine recreational waters

Source: Adapted from pp. H26, MfE/MoH (2003)

95th percentile value of *E. coli*/100mL	MAC value	Estimated risk of *Campylobacter* infection
≤130	A	<0.1% occurrence. This relates to less than one case of *Campylobacter* infection in every 1000 exposures.
131–260	B	0.1–1% occurrence. The upper 95th percentile value of 260 relates to an average probability of one case of *Campylobacter* infection in every 100 exposures.
261–550	C	1–5% occurrence. This range of 95th percentiles represents a probability of 1in 100 to 5 in 100 of *Campylobacter* infection.
>550	D	>5% occurrence. The upper 95th percentile value of 550 represents a greater than 1 in 20 chance of *Campylobacter* infection.

Unlike rivers and streams it is not recommended that 95th percentiles are modified to exclude rainfall-related results. The key reason for modifying the 95th percentiles for rivers and streams is that they are significantly affected by results recorded during or shortly after heavy rainfall and as such are not indicative of conditions when primary contact recreation is generally undertaken. In the coastal environment, although heavy rainfall clearly does affect faecal indicator bacteria counts at recreational sites (eg, Morar & Greenfield 2013, Greenfield et al. 2012b), the relationship between the two is not as strong as that between flow and *E. coli* counts in rivers. Assessment of exceedances of the ‘action’ trigger of the MfE/MoH (2003) guidelines during weekly summer-time monitoring at 77 coastal sites between 2005/06 and 2009/10 showed that just over 60% of ‘action’ exceedances occurred following ≥ 5mm of rainfall in the 72 hours prior to sampling (Figure 1). Thirty five percent of action exceedances coincided with little or no rainfall prior to sampling. The weaker relationship between faecal indicator bacteria and rainfall in the coastal environment may be due to the greater dilution of runoff at coastal sites (further aided by tidal exchange) and also the less direct nature of rainfall as a parameter compared to the use of flow in rivers.

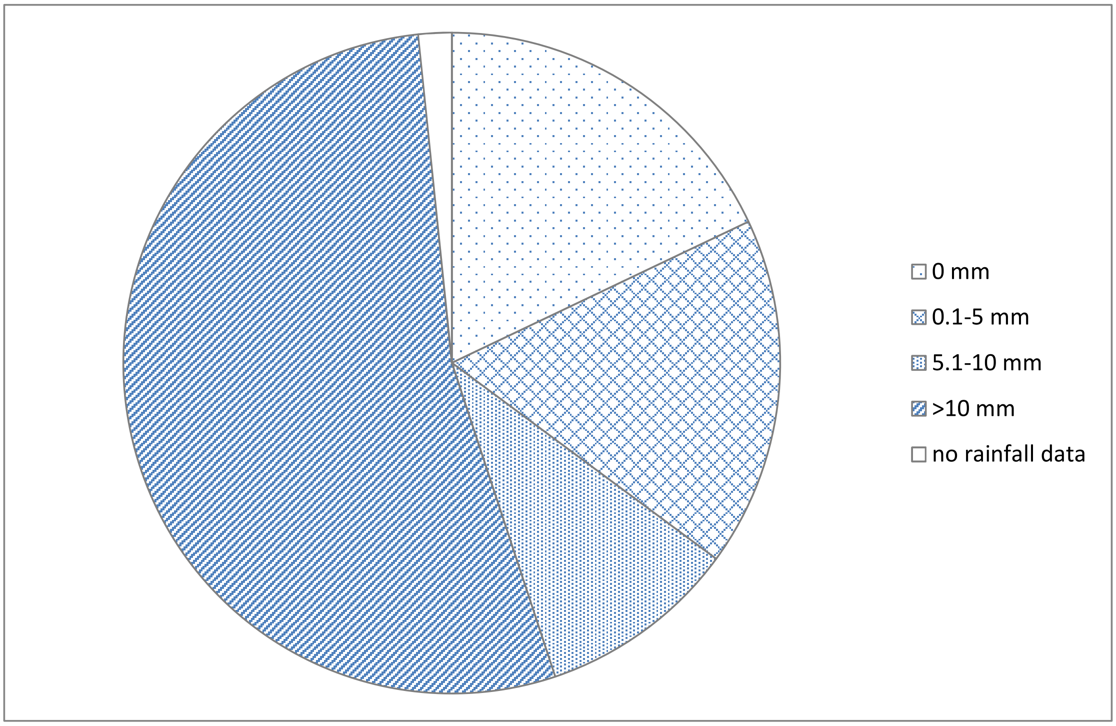

Figure 1: Proportion of exceedances of the MfE/MoH (2003) 'action' guideline within different categories of rainfall within the 72 hours prior to sampling. Data are from 77 coastal sites monitored weekly over the bathing season between 2005/06 and 2009/10

(Source: data from Greenfield et al. 2012b)

In addition to the weaker relationship between rainfall and faecal indicator bacteria, the coastal environment tends to be more heavily used at times of heavy or prolonged rainfall for activities such as surfing.

Unlike rivers and streams it is not considered appropriate to identify separate outcomes for primary and secondary contact recreation because exposures may not be as separable between these two categories as they seem to be for freshwaters (McBride[3], pers. comm. 2014, citing the New Zealand coastal swimmers study (McBride et al. 1998); this study found that the highest risk category was for respiratory effects among 'paddlers' in the near-shore area who didn't immerse their heads but inhaled aerosolised sea water).

3.1.1 Recommended outcome

Deciding what MAC category is most suitable as an outcome for primary contact recreation in coastal waters is a policy decision. An important part of this decision is the acceptable level of infection risk to users. The risk of infection associated with each MAC value is listed in Tables 2 and 3.

3.2 Recreational shellfish collection

Schedule H of the WDFD includes numeric outcomes for shellfish gathering taken directly from the existing national microbiological water quality guidelines (MfE/MoH 2003). It is recommended that these numeric outcomes are replaced with a narrative outcome for the

[3] Dr Graham McBride, Principal Scientist – Water Quality, NIWA.

dNRP. This is because, as outlined in the feedback from Regional Public Health (RPH) and identified in a recent regional council discussion paper on the limitations of the existing national guidelines (Bolton-Ritchie et al. 2013), compliance with the national guidelines alone does not guarantee that shellfish in recreational waters will be safe for human consumption. This lack of guarantee relates to both microbiological contaminants (which the guidelines specifically address) and a wider contaminants point of view (which the guidelines and Schedule H current do not address)[4]. RPH notes:

> "*The guidelines apply to waters in a catchment where a prior sanitary survey has shown that there are no point sources of pollution of public health concern. The guidelines are solely a management tool to measure any change from the conditions prevailing at the time of assessment. These guidelines should be applied in conjunction with a sanitary survey. There may be situations where bacteriological levels suggest that waters are safe, but a sanitary survey may indicate that there is an unacceptable level of risk.*"

Further to RPH's comments, there is already evidence from monitoring studies in several regions of New Zealand (eg, Environment Bay of Plenty 2009, Taranaki Regional Council 2014a&b) demonstrating that there is no clear relationship between indicator bacteria levels in the water column and indicator or pathogen/virus content (eg, norovirus) in shellfish flesh – at least for low levels of faecal contamination that are generally typical in coastal waters. Similar findings were recorded in a survey of shellfish from Wellington Harbour carried out in 2013 in relation to discharges from Hutt City Council's Seaview Wastewater Treatment Plant (Cameron 2013); in this instance norovirus was consistently recorded in sea water (and wastewater) samples while indicator bacteria counts in the same samples were at times relatively low.

There is currently no widely accepted microbiological indicator of the suitability of shellfish for consumption. Although the norovirus test is the most commonly used assay it is expensive (hence the wide use of indicator bacteria tests) and *"does not distinguish between viruses that are viable (infectious) and those that have been inactivated by treatment processes such as UV irradiation"* (Cameron 2013, p13). This suggests that since *"neither indicator bacteria nor norovirus provide a reliable indicator of infection risk"*, the only conservative way to protect human health is to assume that any positive norovirus test result indicates shellfish are unsuitable for human consumption (since NZFSA recommends a zero tolerance for noroviruses in shellfish).

Inclusion of numeric objectives may be possible in the future if the planned review of the MfE/MoH (2003) microbiological water quality guidelines proceeds. At this stage it is unclear if or when this central government-initiated review will proceed. See Bolton-Ritchie et al. (2013) for commentary on what the review of the shellfish-related provisions should include.

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[4] As noted in MfE/MoH (2003) and in GWRC's annual recreational water quality monitoring reports (eg, Morar & Greenfield 2013), the national guidelines for recreational shellfish-gathering waters only cover microbiological contamination. They do not cover marine biotoxins, which in certain places and locations can pose a significant risk to recreational shellfish gatherers. Similarly, other contaminants, such as heavy metals, may pose a risk to the quality of some (filter feeding) shellfish. Other shortcomings with the MfE/MoH (2003) guidelines documented in Bolton-Ritchie et al. (2013) include compliance being based only on seasonal results with no clear definition in the guidelines of what constitutes a season, and a lack of technical explanation for the correlation between indicator bacteria in surrounding waters and public health risk.

3.2.1 Recommended outcome

Overall, Cameron (2013, p13) concluded that aside from planned maintenance WWTP discharges, due to the frequency of periodic wet weather sewer or contaminated stormwater overflows in the harbour catchment and the longevity of norovirus (which means shellfish collection should not occur for at least a month following the cessation of a discharge), it is not safe to collect shellfish for much of the year. This conclusion is consistent with the general advice from RPH and NZFSA not to collect shellfish near urban areas which are generally the subject of ongoing stormwater and sewage-related contamination.

Given that much access of the Wellington region's coastline for recreational shellfish gathering is known to occur in areas that receive urban (as well as rural) runoff, identifying an acceptable outcome that is achievable is very difficult at the regional scale. It is likely that no real progress can be made in this area until the issue can be considered by the respective whaitua committees. In the interim, the following narrative outcome is recommended for inclusion in Schedule H of the dNRP:

> *"Concentrations of contaminants, including pathogens, are sufficiently low for shellfish to be safe to collect and consume where appropriate"*

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Appendix 1: Recommended changes to Schedule H5: Coastal Water

Table H5.1: Aquatic ecosystem health and mahinga kai

Water type	Open coast, harbours and estuaries													
Value	Aquatic ecosystem health and mahinga kai													
Broad outcome	Harbours, estuaries and open coastal waters safeguard healthy aquatic ecosystems and support mahinga kai													
Outcome			Sediment quality						Water quality				Mahinga kai	Habitat
			Mud content	**Sedimentation rate**	**Redox potential depth**	**Total C**	**Toxicants – sediment**	**Macroalgal growth**	**Salinity**	**Toxicants – water column**	**Clarity**	**Nutrients**		
	Estuaries[1]		5*	5**	3	2	ISQG-low	There is no nuisance odours or sediment anoxia arising from nuisance macroalgal growth	The natural salinity regime is maintained	95%	Water clarity is suitable for healthy marine ecosystems	The concentration of plant available nutrients does not cause nuisance algal blooms	Taonga species are present in quantities, size and of a quality that is appropriate for the area	The extent and condition of existing seagrass beds and saltmarsh are maintained or enhanced
	Porirua Harbour	**Inter-tidal flats**[2]	5	-	3	2								
		Harbour-wide	-	1 by 2035	-	-								
	Wellington Harbour		NA				ISQG-low	NA	NA					NA
	Open coast		NA											
Limit	Relevant resource use limits to be defined													

Interpretation of Table H5.1

1 Includes the Lake Onoke inter-tidal flats. Lake Onoke is an intermittently closed and open lake (ICOL), exhibiting characteristics of both a lake and estuary. It is therefore considered as both a lake and an estuary for the purposes of ecosystem health and mahinga kai values. See the Lakes aquatic ecosystem health and mahinga kai table for other relevant outcomes.
2 Inter-tidal flats are defined as those areas of the harbour which is covered at high tide and uncovered at low tide.
The delineation of the coastal marine area where rivers meet the coast is delineated in Map 18.1 to 18.25.

Interpretation of harbours, estuaries and open coastal aquatic ecosystem health and mahinga kai table H5.1					
Attribute		Unit	Direction	Narrative	Notes
	Mud content of surface sediments	%	≤	The mud content of surface sediments is at or less than …%, except where it can be proved that natural background levels are higher than this.	* indicates that this outcome does not apply where it can be proved that natural background levels are higher than this, particularly in eastern Wairarapa estuaries draining erosion-prone soft rock catchments (eg. Whareama)
	Sedimentation rate	mm/year	≤	The sedimentation rate is at or is less than …%, except where it can be proved that natural background levels are higher than this.	** indicates that this outcome does not apply where it can be proved that natural background levels are higher than this, particularly in eastern Wairarapa estuaries draining erosion-prone soft rock catchments (eg. Whareama)
	Redox potential depth	cm	≥	The redox potential depth is greater than …cm.	
Total C	Total organic carbon content of surface sediments	%	≤	The total organic carbon content of surface sediment does not exceed … %	
	Toxicants – sediment		≤	Toxicant concentrations in sediments do not exceed the ISQG-low interim sediment quality guideline values.	ISQG-low interim sediment quality guidelines, ANZECC (2000). http://www.environment.gov.au/water/publications/quality/pubs/nwqms-guidelines-4-vol1.pdf
	Toxicants – water column		≤	Toxicants concentrations in the water column do not exceed the trigger values identified in the ANZECC (2000) guidelines for the level of protection of …% of species	95th percentile protection level in ANZECC (2000) http://www.environment.gov.au/water/publications/quality/pubs/nwqms-guidelines-4-vol1.pdf

Table H5.1: Aquatic ecosystem health and mahinga kai

Note: See Royal and Barriball (2014) for commentary on changes to the mahinga kai outcome

<table>
<tr><td>Water type</td><td colspan="8">Estuaries, harbours and open coast</td></tr>
<tr><td>Value</td><td colspan="8">Aquatic ecosystem health and mahinga kai</td></tr>
<tr><td>Broad outcome</td><td colspan="8">Estuarine, harbour and open coastal waters safeguard healthy aquatic ecosystems and support mahinga kai</td></tr>
<tr><td rowspan="5">Outcome</td><td rowspan="3"></td><td colspan="7">Biology</td></tr>
<tr><td colspan="3">Aquatic plants</td><td rowspan="2">Invertebrates</td><td rowspan="2">Fish</td><td rowspan="2">Birds</td><td rowspan="2">Mahinga kai</td></tr>
<tr><td>Saltmarsh</td><td>Macrophytes</td><td>Phytoplankton</td></tr>
<tr><td>Estuaries including Porirua Harbour, Lake Onoke (ICOLL) and Wellington Harbour</td><td>Saltmarsh communities are resilient and diverse and their cover is sufficient to support invertebrate and fish communities</td><td rowspan="2">The macrophyte community, including seagrass, is balanced with low frequency of nuisance blooms of opportunistic macroalgae and epiphyte cover</td><td rowspan="2">The phytoplankton community is balanced with a low frequency of blooms</td><td rowspan="2">Invertebrate communities are resilient and their structure, composition and diversity are balanced</td><td rowspan="2">Native fish communities are resilient and their structure, composition and diversity are balanced</td><td rowspan="2">Shorebird communities are resilient and their structure, composition and diversity are balanced</td><td rowspan="2">Taonga species are present in quantities, size and of a quality that is appropriate for the area, and are safe to eat</td></tr>
<tr><td>Open Coast</td><td>NA</td></tr>
<tr><td colspan="9">Relevant resource use limits to be defined</td></tr>
</table>

Table H5.1: Aquatic ecosystem health and mahinga kai *continued…*

Water quality					Substrate quality						Riparian margin vegetation	Connectivity
Salinity, temperature, pH	**Dissolved oxygen**	**Clarity**	**Nutrients**	**Toxicants**	**Sedimentation rate**	**Mud content**	**Sediment anoxia**	**Organic carbon**	**Nutrients**	**Toxicants**		
Salinity, temperature and pH vary within a range that sustains aquatic plant, invertebrate and fish communities, with the exception of estuaries with approved managed openings (eg, Lake Onoke)	Dissolved oxygen concentrations vary within a range that sustains aquatic plant, invertebrate and fish communities	Water clarity sustains aquatic plant, invertebrate and fish communities	Nutrient concentrations do not cause an imbalance in aquatic plant, invertebrate or fish communities	95% Toxicant concentrations do not cause unacceptable effects on aquatic plant, invertebrate or fish communities	Sedimentation rates do not cause an imbalance in aquatic plant, invertebrate or fish communities (for Porirua Harbour the areal rate is 1 mm/yr by 2035) NA	The mud content and areal extent of soft mud habitats is within a range that sustains aquatic plant, invertebrate and fish communities NA	There is low incidence of sediment anoxia with no gross anoxic areas and/or nuisance conditions NA	Total organic carbon content does not cause an imbalance in aquatic plant, invertebrate or fish communities NA	Nutrient concentrations do not cause an imbalance in aquatic plant, invertebrate or fish communities NA	ISQG Low Toxicant concentrations do not cause unacceptable effects on aquatic plant, invertebrate or fish communities NA	Vegetation cover and composition sustain plant, invertebrate, fish and bird communities	The connectivity between estuarine and coastal waters, their riparian margins and other waterbodies sustains plant, invertebrate, fish and lake dependant bird communities
Relevant resource use limits to be defined												

Interpretation of Table H5.1

Interpretation of harbours, estuaries and open coastal aquatic ecosystem health and mahinga kai table H5.1				
Attribute	Unit	Direction	Narrative	Notes
Water quality – toxicants		≤	Toxicants concentrations in the water column do not exceed the trigger values identified in the ANZECC (2000) guidelines for the level of protection of …% of species	95th percentile protection level in ANZECC (2000) http://www.environment.gov.au/water/publications/quality/pubs/nwqms-guidelines-4-vol1.pdf
Substrate quality – toxicants		≤	Toxicant concentrations in sediments do not exceed the ISQG-low interim sediment quality guideline values	ISQG-low interim sediment quality guidelines, ANZECC (2000). http://www.environment.gov.au/water/publications/quality/pubs/nwqms-guidelines-4-vol1.pdf

Table H5.2: Contact recreation and tangata whenua use

Water type	Open coast, harbours and estuaries						
Value	Contact recreation and tangata whenua use						
Broad outcome	Open coastal waters, harbours and estuaries are suitable for contact recreation, shellfish gathering and amenity, and support tangata whenua use and their relationship with water						
Outcome		**Enterococci**	***E. coli***	**Faecal coliforms**	**Clarity**	**Macroalgae**	**Tangata whenua use**
	Estuaries[1]	NA	**Bathing season:** 260 **Non-bathing season:** 550	43/14	Water is of a clarity that provides for a good swimming experience during the bathing season	There are no nuisance odours from sediment anoxia and macroalgal growth	Coastal waters and estuaries are safe for primary contact and ceremonial use
	Porirua Harbour	**Bathing season:** 140 **Non-bathing season:** 280	NA				
	Wellington Harbour – **Outside Port Area**	**Bathing season:** 140 **Non-bathing season:** 280	NA				
	Wellington Harbour – **Port Area**	The delineated Port Area is not managed for contact recreation					
	Open coast	**Bathing season:** 140 **Non-bathing season:** 280	NA	43/14	Water is of a clarity that provides for a good swimming experience during the bathing season months	NA	Coastal waters and estuaries are safe for primary contact and ceremonial use
Limit	Relevant resource use limits to be defined						

Interpretation of Table H5.2

[1] Excludes Lake Onoke. For contact recreation and tangata whenua use outcomes, Lake Onoke is treated as a Lake and not as an estuary.
The delineation of Port Areas is in accordance with the Commercial Port Areas shown in Map 15A, 15B and 15C.

Interpretation open coast, harbours and estuaries contact recreation and tangata whenua use Table H5.2					
Attribute		**Unit**	**Direction**	**Narrative**	**Notes**
	Enterococci	cfu/100mL	≤	The Enterococci count does not exceed …cfu/100mL between 1 November and 31 March (inclusive). The Enterococci count does not exceed …cfu/100mL between 1 April and 31 October (inclusive).	Bathing season is November to March inclusive. Non-bathing season is April to October inclusive.
E. coli	*Escherichia coli*	cfu/100mL	≤	The concentration of E. coli does not exceed …cfu/100mL	
	Faecal coliforms	MPN/100mL	≤	The 90th percentile of faecal coliform count does not exceed …MPN/100mL and the median faecal coliform count does not exceed …MPN/100mL.	The 90th percentile and median values from the Ministry for the Environment/Ministry of Health (2003) microbiological water quality guidelines http://www.mfe.govt.nz/publications/water/microbiological-quality-jun03/microbiological-quality-jun03.pdf

Table H5.2: Contact recreation and tangata whenua use

Note: See Royal and Barriball (2014) for commentary on changes to the tangata whenua use outcome

Water type	Open coast, harbours and estuaries					
Value	Contact recreation and tangata whenua use					
Broad outcome	Open coastal waters, harbours and estuaries are suitable for contact recreation, shellfish gathering and amenity, and support tangata whenua use and their relationship with water					
Attribute	**Water type**	**Indicator bacteria**	**Shellfish**	**Clarity**	**Macroalgae**	**Tangata whenua use**
Outcome	Estuaries (excluding Porirua Harbour) and Lake Onoke	**Bathing season:** The 95th percentile *E. coli* count does not exceed *** cfu/100mL between November and March inclusive **Non-bathing season:** The 95th percentile *E. coli* count does not exceed *** cfu/100mL between April and October inclusive	Concentrations of contaminants, including pathogens, are sufficiently low for shellfish to be safe to collect and consume where appropriate	Water is of a clarity that provides for a safe swimming, fishing and boating experience during the bathing season	There are no nuisance odours from sediment anoxia and macroalgal growth	Coastal waters and estuaries are safe for primary contact and support tangata whenua use
	Wellington Harbour[1], Porirua Harbour and Open Coast	**Bathing season:** The 95th percentile enterococci count does not exceed *** cfu/100mL between November and March inclusive **Non-bathing season:** The 95th percentile enterococci count does not exceed *** cfu/100mL between April and October inclusive				
Limit	Relevant resource use limits to be defined					

[1] Excludes the Port Area which is not managed for contact recreation. The delineation of Port Areas is in accordance with the Commercial Port Areas shown in Map 15A, 15B and 15C.

*** Outcome to be determined by GWRC's Environmental Policy Department/Te Upoko Taiao.

Appendix 2: Stakeholder feedback related to Schedule H coastal waters and GWRC response

Stakeholder	Relevant value	Feedback	Comments from GWRC
DoC	*Aquatic Ecosystem health*	*Definitions are needed for "estuary" and "coastal lake" along with consistent use of "lake" and "coastal lake". Table H5.1 of Schedule H should define intertidal flats using MHWS and MLWS rather than "high tide" and "low tide". Also "inter-tidal" should be replaced with "intertidal".*	Recommended definitions for estuary and ICOLL are included in Section 2.1. Also Perrie and Milne (2012) explain that many of the recognised lakes in the Wellington region are classified as "coastal lakes" due to their proximity to the coast. Recommended changes to Tables H2.1 and H5.1 should remove any confusion around terminology (particularly in relation to defining Lake Onoke) and mean that references to intertidal flats are no longer required.
Friends of Taputeranga Marine Reserve Trust	*Aquatic Ecosystem health*	*Maximum etc is misleading if there's only been one point. See general comments about statistical robustness and replicates etc*	There are no longer any references to maximum concentrations in Schedule H. Details on attribute measurements and statistics will be provided in a separate Schedule H Technical Guidance Document.
	Aquatic Ecosystem health	*Table H5.1* *Should have targets for C4 schedule (marine areas) with sediment and clarity targets at least.*	Outcomes for these attributes are not included because there isn't the region-wide (or national) data on which to base numeric outcomes. See Section 2.1 for comment on current national initiatives underway to address existing data/information gaps.
	Mahinga Kai	*"Taonga species are present in quantities, size and of a quality that is appropriate for the area": how are you going to define these, monitor these, and have any impact on these? Catch limit is of MPI resort, and is the most important factor for quantity and size. Quality could indeed include pollution etc which the Council might have an impact on…*	This matter is addressed separately by Royal and Barriball (2014).
	Contact recreation	*Should have pathogen markers for where there is likely wastewater treatment contamination, since they treat for e-coli but might not treat other pathogens which pose a human health risk*	
	Contact recreation	*E-coli limits (and pathogens): add in shellfish too?*	It is assumed that this feedback relates to setting outcomes for *E. coli* (and possibly pathogens) in actual shellfish flesh. To do so would be moving into the domain of food safety which is outside the jurisdiction of regional councils.
RPH	*Contact recreation*	Suitability of faecal coliforms outcome in providing for safe shellfish gathering; Recommendation to add a statement for interpretation of Table H5.2 (suggested text is given in doc attached to #1288402)	
		Faecal coliforms, H5.2, p290; Acknowledging additional changes likely to be recommended re shellfish, comment is sought on whether this additional guidance is required.	