greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

MEMO

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

1. Introduction

Schedule H of the Regional Plan: Working Document for Discussion (WDFD, GWRC 2013) included narrative and numeric outcomes for a range of values associated with lakes (Appendix 1). This memorandum outlines recommended changes to outcomes for lakes in Tables H2.1–H2.3 of the WDFD for inclusion in the draft Natural Resources Plan (dNRP). The changes take into account the National Objectives Framework (NOF) released in July 2014 under the National Policy Statement for Freshwater Management (NPS-FM, MfE 2014), stakeholder feedback on the WDFD and further external specialist advice.

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

1.1 National objectives framework (NOF)

The NOF under the NPS-FM (MfE 2014) identifies 'numeric attribute states' for a number of attributes relating to lake ecosystem health and contact recreation values. For each attribute, numeric and narrative states are identified that form the basis of four 'bands' ranging from A to D. The boundary between the C and D bands represents the 'national bottom line' or the minimum level at which the compulsory values are provided for.

The NOF attributes that apply to lakes are:

- Ecosystem health: chlorophyll *a*, total nitrogen, total phosphorus and ammonia toxicity
- Human health for recreation: *Escherichia coli (E. coli)* and planktonic cyanobacteria

These attributes, and their application to lakes in the Wellington region, are discussed further in Sections 2.1 and 3.1.

1.2 Stakeholder feedback

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

- Department of Conservation: Table H2.1 (Aquatic ecosystem health and mahinga kai) does not offer water quality outcomes for Lakes Kohangapiripiri, Kohangatera, and Pounui. Further information should be sought about these lakes in order for water quality outcomes to be set. Some definitions are needed for lake *vs* coastal lake *vs* estuary[1].
- Federated Farmers: Is the clarity outcome listed for Lake Wairarapa in Table H2.2 (Contact recreation and tangata whenua use) appropriate/realistic?

These comments are addressed in Sections 2 and 3. Responses to questions asked and other comments made during the stakeholder workshops are also included in these sections (eg, could LakeSPI data be generated for other lakes?). The original written feedback (verbatim) and abbreviated responses can be found in Appendix 2.

1.3 Expert workshop

In December 2013 a workshop was held at GWRC to discuss coastal lake ecosystem health monitoring and outcome setting for regional planning purposes. 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 provided in Milne et al. (2014) and key findings have been incorporated into the recommended changes set out in this memorandum.

2. Aquatic ecosystem health and mahinga kai

In Table H2.1 of the WDFD (GWRC 2013), the outcomes for the aquatic ecosystem health value centred around five attributes; nutrients (as represented by the trophic level index (TLI), submerged plant communities (LakeSPI scores), fish communities, phytoplankton communities and taonga species. Outcomes for nutrients and submerged plant communities were also only applied to selected lakes, whereas the remaining outcomes were applied to all six lakes listed: Kohangapiripiri, Kohangatera, Pounui, Onoke[2], Wairarapa and Waitawa (Appendix 1).

The attributes in Table H2.1 have been significantly re-worked following a workshop GWRC held with three shallow coastal lakes experts in December 2013 (documented in Milne et al. 2014), consideration of the NOF provisions for lakes and subsequent further discussions with Environmental Policy staff. The revised Table H2.1 attributes recommended for inclusion in the dNRP are outlined in Table 1. The key recommended changes to Schedule H2.1 (presented in Appendix 1) include:

- Reorganisation of the table columns and attributes to align with the equivalent tables for both rivers and streams (Greenfield 2014), and coastal waters (Oliver et al. 2014);
- The addition of narrative outcomes that address all of the key 'biological endpoints' of lake ecosystems – aquatic plants, invertebrates, fish and birds. This includes expanding the aquatic plant narrative to apply to all lakes (previously aquatic plant outcomes, expressed as LakeSPI scores, had only applied to selected lakes) and modification of the original phytoplankton narrative;

[1] Estuaries and intermittently closed and open lake or lagoons (ICOLL) are defined in Oliver et al. (2014).
[2] Lake Onoke was also (in the WDFD) included in the coastal table (Table H5.1) as it is an ICOLL and as such exhibits characteristics of both freshwater and estuarine environments.

- The addition of temperature, pH, dissolved oxygen, water clarity and toxicants as water quality attributes. These additions recognise that these physical and chemical properties are fundamental to lake ecosystem health;
- Modification of the nutrients outcome so that it no longer refers to trophic status (as measured by the TLI), applies to all lakes (previously it applied to selected lakes only) and more closely aligns with the NOF nutrient attributes;
- The addition of a range of narrative outcomes that recognise the importance of 'substrate quality' and the addition of narrative outcomes for lake water levels, riparian vegetation and 'connectivity[3]'. These additions recognise that substrate quality, lake water levels, lake margin riparian vegetation and connectivity are fundamental to lake ecosystem health; and
- The removal of individual lake names from the table. The attributes and outcomes are now recommended to apply to all 'natural'[4] lakes in the Wellington region. This change was made to recognise that there are a number of other lakes in the region (eg, Lake Waiorongomai on the Kapiti Coast) that were not previously covered by the original Table H2.1. It is also worth noting that Table H2.1 would only apply to Lake Onoke if the lake mouth was closed. Lake Onoke is an intermittently closed and open lake or lagoon (ICOLL) and so while it exhibits characteristics of both freshwater and estuarine environments, it is considered to primarily function as an estuary rather than a lake (as long as the lake mouth remains open – which it generally does (Milne et al. 2014)). Table H5.1, which covers (estuaries, harbours and open coast (see Oliver et al. 2014), will apply to Lake Onoke most of the time.

Table 1: Summary of aquatic ecosystem health attributes recommended for inclusion in Table H2.1

Attribute	Rationale
Biology	
Macrophytes	Macrophytes (aquatic plants) provide food, refuge and habitat for a range of invertebrate and fish species and also help stabilise lakebed sediments (reducing re-suspension of these sediments and any associated effects on water clarity) and recycle nutrients. Loss of macrophyte communities, which can occur through eutrophication, sedimentation, changes in lake water levels, etc., can be detrimental to shallow lake ecosystems. Some exotic macrophyte species have the potential to outcompete and smother native macrophytes, reducing biodiversity and habitat values (Vant 1987). A range of aquatic plant species of conservation interest are also present in lakes in the region (de Winton & Champion 2014).
Macroalgae and epiphytes	Macroalgae and epiphytes are a key part of lake ecosystems. However, when they reach nuisance levels they can smother aquatic plants and benthic substrate which can reduce the habitat value of these components to the wider ecosystem. Blooms of macroalgae and epiphytes are also typically a sign of eutrophication (Harlin 1995).
Phytoplankton	Phytoplankton are a critical part of lake food webs and in a balanced ecosystem they provide food for a wide range of aquatic life, including zooplankton and kakahi (freshwater mussel). When nutrient concentrations are too high phytoplankton blooms may occur. Blooms have the potential to cause ecological impacts through changes in water quality (eg, reduced water clarity) and food webs (ie, some bloom-forming species are unpalatable). Blooms of some types of phytoplankton (cyanobacteria) are also potentially toxic (de Winton & Champion 2-14; Vant 1987).

[3] Connectivity refers to both the connection between lakes and their marginal riparian vegetation but also between other aquatic habitats (eg, rivers, streams, wetland and the sea).

[4] In this sense natural is used to exclude lakes that have been artificially created.

Attribute	Rationale
Invertebrates	Invertebrates are important components of lake ecosystems. As grazers they can influence phytoplankton and macrophyte biomass and they are in turn a critical component of the food web (ie, prey for fish). They inhabit a wide variety of habitat types within lakes (water column, benthic substrate and macrophyte beds).
Fish	Fish are a key component of lake ecosystems and a very useful indicator of ecosystem health because they respond to both local and catchment-scale impacts (David et al. 2010). Many of the native species found in the Wellington region are also of conservation interest (Goodman et al. 2014). The majority of native species are diadromous (migratory) so require connectivity to and from the sea. A healthy native fish community is also dependent on water quality and habitat quality. Some introduced fish species can negatively impact native fish communities (eg, through direct predation and competition and indirectly through affecting food webs, water quality and habitat) (McDowall 2000; McQueen & Morris 2013).
Birds	The lakes of the Wellington region provide a range of habitats for nationally and regionally significant populations of birds at several key stages of their life cycles. For example, the extensive mudflats on the eastern shoreline of Lake Wairarapa are unique in the region for supporting nationally significant non-breeding populations of up to 30 species of migratory wading birds, including both national and international migratory species (Robertson & Heather, 1999).
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. However, some of the region's lakes (eg, Onoke, Wairarapa, Kohangapiripiri and Kohangatera) are characterised by what can be considerable variation in salinity (caused by tidal movement, storm surges, salt spray, etc.). This variation is considered natural in these lakes and in these cases it is desirable as it provides a wide range of salinities/habitats for a wide range of flora and fauna.
Dissolved oxygen	Dissolved oxygen is essential for the survival of all aquatic organisms and where concentrations are too low, sensitive species may not thrive or may be absent. In lakes that stratify, deoxygenation of the lake bottom waters can occur and this is typically associated with eutrophication (Burns et al. 2000)
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 macrophytes. Additionally, many fish species are visual predators and rely on clear water to catch their prey.
Nutrients	Nutrients are essential for lake ecosystems but excessive nutrient inputs (principally nitrogen and phosphorus) can lead to nuisance blooms of phytoplankton, macro-algae/epiphytes and/or nuisance growths of macrophytes, all of which can alter the health of lake ecosystems by affecting water quality and habitat quality.
Toxicants	Toxicants, such as metals but also some nutrients at certain concentrations, can impair function, metabolism, development and reproduction of lake biota. In extreme cases toxicants can result in the death and/or exclusion of sensitive biota.
Substrate quality	
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	Total organic carbon (TOC) content 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	Nutrients (particularly phosphorus) are often bound-up with sediments and wind/wave re-suspension of these nutrients/sediments can release nutrients back into the water column where they can contribute to the overall nutrient inputs into a lake (Perrie & Milne 2012). Similarly, under anoxic conditions, nutrients can also be released from lakebed sediments and into the water column (Burns et al. 2000).
Toxicants	Toxicants, such as metals but also some nutrients at certain concentrations, can impair function, metabolism, development and reproduction of lake biota. In extreme cases toxicants could result in death and/or exclusion of sensitive biota from some lakes.

Riparian margin vegetation
Riparian margins around lakes can intercept and attenuate contaminants, such as nutrients and sediments, thus helping to mitigate the effects of landuse on lake water quality and ecological health (de Winton & Champion 2014; Vant 1987).
Water level
Water is a critical component of lake habitat for aquatic biota. Lake ecosystems can be expected to be at their healthiest when water levels are allowed to fluctuate within a range that they would normally experience in the absence of anthropogenic impacts (ie, diversions, barrage gates, water abstraction, etc.). Minimum lake water levels are addressed under a specific policy in the WDFD (Policy LW.P53).
Connectivity
Connectivity refers to the free movement of water, nutrients, sediment and biota between lakes and other waterbodies such as rivers, streams, wetlands and the sea , 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. For example, many of the native fish found in the region's lakes undertake migrations between freshwater environments and the sea to complete parts of their lifecycle and where these migrations cannot be undertaken (ie, due to an instream barrier) fish may be excluded from a lake. Fish communities in lakes are also likely to benefit from the occasional Inundation of marginal riparian vegetation by lake water levels as this can provide important foraging opportunities for a range of fish species and in some cases may also be important for providing suitable spawning areas.

2.1 NOF

The NOF (MfE 2014) establishes compulsory national 'bottom lines' for ecosystem health for chlorophyll *a* (Chl-*a*), total nitrogen (TN), total phosphorus (TP) and ammonia toxicity. It is considered that the attributes and outcomes recommended for Table H2.1 are consistent with the intent of NOF and that the recommended narrative outcomes reflect a level of ecosystem health above the NOF national bottom lines. However, at this stage it is not recommended to adopt the numeric attribute states provided in NOF for Table H2.1 for the following reasons:

- For many of the lakes in the region there is a deficiency of data and this precludes a robust assessment of the appropriateness of the NOF numerics for these lakes;
- The main lakes in the Wellington region are typically shallow (eg, Lake Wairarapa is mostly less than 2 m deep) and, as such, re-suspension of lakebed sediments (and associated nutrients) by wind/wave action are key drivers of lake water quality and ecosystem health. At this stage it is not clear how applicable the NOF numerics are for shallow lakes[5] and further discussion is required at a 'national level' around their appropriateness; and
- For some attributes (eg, total nitrogen), NOF provides different values for lakes that are either stratified or brackish and for lakes that are mixed (polymictic). Some lakes in the Wellington region can fall into either category (eg, Lake Wairarapa is a polymictic lake that is also at times brackish) and so it is unclear how the NOF attributes should be applied.

Until the concerns around the appropriateness of the NOF numerics for shallow lakes have been addressed, it is not considered appropriate to use these as outcomes in the dNRP. Instead, it is recommended that these numerics be used only as guidance for interpreting lake ecosystem health (see Greenfield et al. in prep).

2.2 Stakeholder feedback

There was no stakeholder feedback requesting any specific changes to Table H2.1 in Schedule H of the WDFD. The inclusion of TLI-3 (ie, exclusion of clarity from the TLI calculation) as an attribute in Table H2.1 was queried at the Carterton stakeholder workshop (held in

[5] In particular in how they take into account the re-suspension of lakebed sediments which is common in shallow lakes.

December 2013). While use of the TLI-3 is a nationally accepted modification for 'optically challenged' lakes such as Lake Wairarapa (see Greenfield et al. 2013), the recommended reconfiguration of Table H2.1 following the lake expert panel workshop in December 2013 and the release of the NOF has resulted in the TLI-3 being removed as an attribute from Table H2.1.

The Department of Conservation suggested that further water quality information should be sought for Lakes Kohangapiripiri, Kohangatera and Pounui to enable the setting of water quality outcomes for these lakes. The recommended changes to the nutrient outcome in Table H2.1 (Appendix 1) do somewhat address this issue as the narrative provided is now applicable to all lakes (ie, it does not exclude Lakes Kohangapiripiri, Kohangatera and Pounui as it did previously). However, we acknowledge that obtaining more water quality information for Lakes Kohangapiripiri, Kohangatera and Pounui is desirable, as would the collection of further information on aquatic plant communities from additional lakes across the region.

3. Contact recreation and tangata whenua use

In Table H2.2 of the WDFD, outcomes for contact recreation and tangata whenua use consist of numeric and narrative outcomes for *E. coli*, planktonic cyanobacteria and clarity. A number of changes are recommended to these outcomes:

- Replace the 1.6 m minimum Secchi depth outcome for clarity with a narrative outcome that provides for safe boating (see Appendix 1). While the numerical outcome originally proposed is a national guideline for contact recreation, it was an oversight to apply it to shallow optically challenged lakes, particularly when these lakes are used for secondary contact uses (eg, boating).
- Add a different clarity narrative outcome for Lakes Kohangapiripiri and Kohangatera that recognises the importance of being able to view the lakebed (in the area immediate to the shore) for aesthetic values.
- Amend the numeric-based cyanobacteria outcome from the current 'surveillance' threshold of the MfE/MoH (2009) guidelines to the 'alert' threshold. This change aligns with the NOF (MfE 2014) 'bottom line' narrative state and equates to *"a low risk of health effects from exposure to cyanobacteria"*. This outcome is considered more appropriate than setting the risk exposure at a level equating to *"no different from natural conditions"* (ie, surveillance level) (K Hamill & S Wood[6], pers. comm. 2014).
- Rename the cyanobacteria attribute as 'phytoplankton' with the recommended narrative modified to recognise that other types of phytoplankton, in addition to cyanobacteria, can also be a nuisance to recreational users (eg, through reducing water clarity).
- Replace the existing MfE/MoH (2003) surveillance-based *E. coli* outcome with primary and secondary contact recreation outcomes that are consistent with the NOF (MfE 2014). This is discussed further in Section 3.1.

3.1 NOF

The NOF (MfE 2014) includes a set of numeric attribute states for both primary and secondary contact recreation. The secondary contact recreation value is identified as compulsory while

[6] Dr Susie Wood, Senior Freshwater Scientist, Cawthron Institute.

the primary contact recreational value is optional. As outlined in Greenfield et al. (2013), the region's lakes are not widely used for swimming or other forms of primary contact recreation – only Lake Waitawa has limited edge-based primary recreation. However, whether lakes are managed for primary or secondary contact recreation is a policy decision to be made by GWRC's Te Upoko Taiao – Natural Resources Committee (Te Upoko Taiao). Recommended outcomes for both primary and secondary contact recreation are provided below to inform this decision.

3.1.1 Primary contact recreation

Numeric attribute states for primary contact recreation in the NOF are 95th percentile values based on the Microbiological Assessment Category (MAC) values identified in the MfE/MoH (2003) guidelines. Band A of the NOF for primary contact recreation equates to the B MAC category and band B equates to the C MAC category (Table 2). The NOF band B is identified as the minimum acceptable state for primary contact recreation in rivers.

Table 2: NOF (MfE 2014) numeric attribute states for primary contact recreation in lakes and rivers. The numeric attribute state is a 95th percentile. Narrative attribute states give the risk of *Campylobacter* infection

Attribute state	Numeric attribute state (*E. coli*/100 mL)	Narrative attribute state
A	<260	People are exposed to a low risk of infection (up to 1% risk) when undertaking activities likely to involve full immersion.
B	260–540	People are exposed to a moderate risk of infection (less than 5% risk) when undertaking activities likely to involve full immersion.
Minimum acceptable state	**540**	

Determining which NOF band/MAC category is most suitable as an outcome for primary contact recreation in lakes is a policy decision to be made by Te Upoko Taiao. An important part of this decision is the acceptable level of infection risk to river users. The risk of *Campylobacter* infection associated with each MAC value is included in Table 2.

3.1.2 Secondary contact recreation

Numeric attribute states for secondary contact recreation identified by the NOF (MfE 2014) are based on analysis by McBride (2012) and consist of annual median *E. coli* counts (Table 3). Determining which NOF band is most suitable as an outcome for secondary contact recreation in lakes is a policy decision. An important part of this decision is the acceptable level of infection risk of *Campylobacter* infection associated with each NOF band. Another consideration is that the use of an annual median statistic as recommended by the NOF is less precautionary for safeguarding public health than the 95th percentile approach used in the MfE/MoH (2003) guidelines and recommended by World Health Organisation (2003). For this reason the New Zealand Freshwater Sciences Society (NZFSS) recommended in its submission on the proposed NOF that the secondary contact recreation numeric attribute state be based on a 95th percentile rather than a median.

Table 3: NOF (MfE 2014) numeric attribute states for secondary contact recreation in lakes and rivers. The numeric attribute state is an annual median. Narrative attribute states give the risk of *Campylobacter* infection

Attribute state	Numeric attribute state (*E. coli*/100 mL)	Narrative attribute state
A	<260	People are exposed to a very low risk of infection (less than 0.1% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating).
B	260–540	People are exposed to a low risk of infection (less than 1% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating).
C	540–1,000	People are exposed to a moderate risk of infection (less than 5% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating).
National Bottom Line	**1,000**	
D	>1,000	People are exposed to a high risk of infection (greater than 5% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating).

3.1.3 Planktonic cyanobacteria

The NOF does not differentiate between primary or secondary contact recreation for the planktonic cyanobacteria attribute in NOF. The recommended numeric outcome in Table H2.2 is the bottom of the 'alert' (amber) level of the existing national guidance for recreational waters (MfE/MoH 2009): ≤ 1.8 mm^3/L of potentially toxic cyanobacteria or ≤ 10 mm^3/L total biovolume of all cyanobacteria. This level of protection equates to Band C in the NOF (note NOF does not have a Band B for planktonic cyanobacteria).

3.2 Stakeholder feedback

Federated Farmers queried the 1.6 m minimum Secchi depth clarity outcome for Lake Wairarapa. This has been addressed through changing replacing the numeric outcome with a narrative one that provides for safe boating (see Appendix 1).

4. Stock watering

The only recommended changes to Table H2.3 are to amend the cyanobacteria outcome to align with the recommended change in Section 3 and include the following narrative to support the toxicants/irritants numeric-based attribute:

> *"Concentrations of toxicants or irritants do not harm stock"*

5. Additional comments

A number of species of introduced fish that are potentially valued as sports or coarse fish are present in lakes in the Wellington region. There are currently no attributes/outcomes in Schedule H that identify lakes as having these values and discussion with Fish and Game may be warranted to better understand whether any of the region's lakes support fisheries that require attributes/outcomes to be provided in dNRP.

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Appendix 1: Recommended changes to Schedule H2: Lakes

Table H2.1: Aquatic ecosystem health and mahinga kai

<table>
<tr><td>Water type</td><td colspan="5">Lakes</td></tr>
<tr><td>Value</td><td colspan="5">Aquatic ecosystem health and mahinga kai</td></tr>
<tr><td>Broad outcome</td><td colspan="5">Lake water quality, quantity and habitat safeguards healthy aquatic ecosystems and supports mahinga kai</td></tr>
<tr><td rowspan="9">Outcome</td><td></td><td>Water quality</td><td colspan="3">Biological</td></tr>
<tr><td></td><td>Nutrients</td><td>LakeSPI</td><td>Fish</td><td>Phytoplankton</td><td>Taonga species</td></tr>
<tr><td>Kohangapiripiri</td><td rowspan="3">NA</td><td>≥63</td><td rowspan="6">Fish communities are healthy and the structure, composition, diversity, resilience and abundance is within an acceptable range of that found under natural conditions</td><td rowspan="6">The lake is free of algal blooms</td><td rowspan="6">Taonga species are present in quantities, sizes and of a quality that is appropriate for the area</td></tr>
<tr><td>Kohangatera</td><td>≥88</td></tr>
<tr><td>Pounui</td><td>≥56</td></tr>
<tr><td>Onoke[1]</td><td rowspan="3">Trophic status shall be in the eutrophic range or better</td><td rowspan="3">NA</td></tr>
<tr><td>Wairarapa</td></tr>
<tr><td>Waitawa</td></tr>
<tr><td>Limit</td><td colspan="5">Relevant resource use limits to be defined</td></tr>
</table>

[1] Lake Onoke is an intermittently closed and open lake (ICOL), exhibiting ecological characteristics of both a lake and estuary. It is therefore considered as both a lake and an estuary for the purposes of aquatic ecosystem health and mahinga kai values. See the Coastal aquatic ecosystem health and mahinga kai table H5.2 for other relevant outcomes.

~~Interpretation of Table H2.1~~

~~Interpretation of lakes aquatic ecosystem health and mahinga kai Table H2.1~~					
~~Attribute~~		~~Unit~~	~~Direction~~	~~Narrative~~	~~Notes~~
~~Trophic status~~	~~Nutrients~~		~~Range~~	~~The trophic status shall be in the eutrophic range~~	~~The eutrophic range for lakes using Trophic Level Index (TLI) is between 4 and 4.99~~ ~~The TLI for Lakes Wairarapa and Onoke is calculated using TLI3.~~
~~LakeSPI~~	~~Lake Submerged Plant Indicator~~		~~≥~~	~~The Lake Submerged Plant Indicator value is equal to or greater than ….~~	~~See monitoring manual~~ ~~http://www.niwa.co.nz/sites/default/files/import/attachments/lakespi_manual.pdf~~

Table H2.1: Aquatic ecosystem health and mahinga kai

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

Water type	Lakes							
Value	Aquatic ecosystem health and mahinga kai							
Broad outcome	Lake water quality, quantity and habitat safeguards healthy aquatic ecosystems and supports mahinga kai							
Outcome	**Lake**	**Biology**						
		Aquatic plants			**Invertebrates**	**Fish**	**Birds**	**Mahinga kai**
		Macrophytes	**Macro-algae and epiphytes**	**Phytoplankton**				
	All lakes	Macrophyte (submerged and emergent) communities are resilient and occupy at least one third of the lake bed that is naturally available for macrophytes, and are dominated by native species. For lakes Kohangapiripiri Kohangatera, and Pounui this equates to LakeSPI scores ≥63, ≥88, ≥56, respectively	The macrophyte and epiphyte communities are balanced and there is a low frequency of nuisance blooms of opportunistic macroalgae or epiphytes	Phytoplankton communities are balanced and there is a low frequency of blooms	Native macroinvertebrate (including zooplankton) communities are resilient and their structure, composition and diversity are balanced	Native fish communities are resilient and their structure, composition and diversity are balanced	Lake dependant bird communities are resilient and their structure, composition and diversity are balanced	Taonga species are present in quantities, size and of a quality that is appropriate for the area, and are safe to eat
Limit	Relevant resource use limits to be defined							

Table H2.1: Aquatic ecosystem health and mahinga kai *continued…*

Water type	Lakes							
Value	Aquatic ecosystem health and mahinga kai							
Broad outcome	Lake water quality, quantity and habitat safeguards healthy aquatic ecosystems and supports mahinga kai							
Outcome	**Lake**	**Water quality**						
	All lakes	**Dissolved oxygen**	**Salinity, temperature and pH**	**Clarity**	**Nutrients**	**Nitrate toxicity**	**Ammonia toxicity**	**Other toxicants**
		Dissolved oxygen varies within a range that sustains aquatic plant, invertebrate and fish communities	Salinity, temperature and pH 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	Nitrate concentrations do not cause unacceptable effects on aquatic plant, invertebrate or fish communities	Ammonia concentrations do not cause unacceptable effects on aquatic plant, invertebrate or fish communities	Concentrations do not cause unacceptable effects on aquatic plant, invertebrate or fish communities
Limit	Relevant resource use limits to be defined							

Table H2.1: Aquatic ecosystem health and mahinga kai *continued…*

Water type	Lakes							
Value	Aquatic ecosystem health and mahinga kai							
Broad outcome	Lake water quality, quantity and habitat safeguards healthy aquatic ecosystems and supports mahinga kai							
Outcome	**Lake**	**Substrate quality**				**Water level**	**Riparian margin vegetation**	**Connectivity**
	All lakes	**Sediment anoxia**	**Nutrients**	**Toxicants**	**Organic carbon**			
		There is low incidence of sediment anoxia with no gross anoxic areas and/or nuisance conditions	Nutrient concentrations do not cause an imbalance in aquatic plant, invertebrate or fish communities	Concentrations do not cause unacceptable effects on aquatic plant, invertebrate or fish communities	Organic carbon concentrations do not cause an imbalance in aquatic plant, invertebrate or fish communities	Lake water levels sustain plant, invertebrate, fish and bird communities, and water levels are met in accordance with policy LW.P53	Vegetation cover and composition sustain plant, invertebrate, fish and bird communities	The connectivity between lakes, their riparian margins and other waterbodies sustains plant, invertebrate, fish and lake dependant bird communities
Limit	Relevant resource use limits to be defined							

Table H2.2: Contact recreation and tangata whenua use

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

<table>
<tr><td>Water type</td><td colspan="5">Lakes</td></tr>
<tr><td>Values</td><td colspan="5">Contact recreation and tangata whenua use</td></tr>
<tr><td>Broad outcome</td><td colspan="5">The quantity and quality of water in lakes are suitable for swimming and other types of recreation and amenity, and support tangata whenua use and their relationship with water.</td></tr>
<tr><td rowspan="4">Outcome</td><td></td><td>E. coli</td><td>Aquatic plants</td><td>Phytoplankton ~~Cyanobacteria~~</td><td>Clarity</td><td>Tangata whenua use</td></tr>
<tr><td>Kohangapiripiri</td><td rowspan="3">TBC</td><td rowspan="3">Growth of aquatic plants does not cause a nuisance or pose a threat to safety of lake users</td><td rowspan="3">~~Cyanobacteria counts do not exceed Alert 1 ('safe' green mode)~~
There is low frequency of phytoplankton blooms and cyanobacteria biovolumes do not exceed the Alert (amber) mode</td><td rowspan="2">~~≥1.6m Secchi depth~~
Water clarity is sufficient so that the lakebed immediate to the lake edge is visible</td><td rowspan="3">Lake waters are safe for primary contact and ~~ceremonial use~~ support tangata whenua use</td></tr>
<tr><td>Kohangatera</td></tr>
<tr><td>~~Pounui~~
~~Onoke~~[1]
~~Wairarapa~~
~~Waitawa~~
Other lakes</td><td>~~≥1.6m Secchi depth~~
Water clarity is sufficient to provide for safe boat launching and use</td></tr>
<tr><td>Limit</td><td colspan="5">Relevant resource use limits to be defined</td></tr>
</table>

TBC To be confirmed (requires a policy decision)

Interpretation of Table H2.2

~~[1] Lake Onoke is an intermittently closed and open lake (ICOL), exhibiting characteristics of both lakes and estuaries. For the purposes of contact recreation and tangata whenua use values, Lake Onoke is considered as a lake.~~

Interpretation of lakes contact recreation and tangata whenua use Table H2.2					
Attribute		**Unit**	**Direction**	**Narrative**	**Notes**
E. coli	*Escherichia coli*	cfu/100mL	≤	The concentration of *E. coli* does not exceed …cfu/100mL.	Applies as a 95th percentile for primary contact recreation with a bathing season from November to March inclusive. Non-bathing season is April to October inclusive. Applies as a median for secondary contact recreation and applies at all times of year.
	~~Secchi depth~~	~~m~~	~~≥~~	~~The Secchi depth is …m.~~	
	Phytoplankton		≤	Cyanobacteria biovolumes do not exceed 'alert amber' mode.	Ministry for the Environment/Ministry of Health (2009) interim national Guidelines for cyanobacteria

Table H2.3: Stock watering

Water type	Lakes				
Broad outcome	Lake water quality is suitable for stock watering				
Outcome	***E. coli* (cfu/100mL)**	**Cyanobacteria**	**pH**	**Toxicants/irritants**	
	≤550	~~Cyanobacteria counts do not exceed Alert 1 ('safe' green mode)~~ Cyanobacteria biovolumes do not exceed the Alert (amber) mode	6.0-9.0	Concentrations of toxicants or irritants do not harm stock	Refer to Table 5.2.3 in ANZECC 2000
Limit	Relevant resource use limits to be defined				

Interpretation of Table H2.3

Interpretation of lakes stock watering Table H2.3				
Attribute	**Unit**	**Direction**	**Narrative**	**Notes**
E. coli *Escherichia coli*	cfu/100mL	≤	The concentration of *E. coli* does not exceed …cfu/100mL	
Cyanobacteria			~~Cyanobacteria counts do not exceed Alert 1 ('safe' green mode)~~ Cyanobacteria biovolumes do not exceed the Alert (amber) mode.	Ministry for the Environment/Ministry of Health (2009) interim national Guidelines for cyanobacteria
pH	pH units	Range	The pH of the water is between … and ….	
Toxicants/irritants		≤	Concentrations of toxicants/irritants do not exceed those specified in tables 5.2.3 and 5.2.4 of ANZECC 2000.	http://www.environment.gov.au/water/publications/quality/pubs/nwqms-guidelines-4-vol1.pdf

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

Stakeholder	Relevant value	Feedback	Comments from GWRC
DoC	*Aquatic Ecosystem health*	*Further water quality information should be sought for Lakes Kohangapiripiri, Kohangatera, and Pounui to enable the setting of water quality outcomes for these lakes.*	The recommended changes to the nutrient attribute/outcome in Table H2.1 somewhat addresses this since the narrative provided is now applicable to all lakes. We do acknowledge that further water quality information for lakes Kohangapiripiri, Kohangatera, and Pounui is desirable but obtaining access to these lakes for regular water quality sampling is a challenge (eg, Pounui is in private ownership).
DoC	*Aquatic Ecosystem health*	*Definitions are needed for "estuary" and "coastal lake" along with consistent use of "lake" and "coastal lake".*	Recommended definitions for estuary and ICOLL are included in Oliver et al. (2014). 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 both Tables H2.1 and H5.1 should remove any confusion around terminology.
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 (Greenfield et al. in prep).
Federated Farmers	*Contact recreation*	*Is the clarity outcome for Lake Wairarapa appropriate/realistic?*	As outlined in Section 3, the numeric outcome recommended in the WDFD was an error and a narrative outcome around safe launching of boats is recommended for inclusion in Table H2.2 of the draft Natural Resources Plan.