# Memo

| | |
|---|---|
| Date | 25 September 2017 |
| To | OTOP Zone Committee |
| CC | Dan Clark, Craig Davison, Peter Constantine |
| From | Shirley Hayward |

## Water quality objective and limits for the OTOP community outcomes

## PURPOSE:

The purpose of this paper is to:

a. Consider the water quality classes for the Opihi catchment (currently not included in the LWRP)
b. Provide the zone committee with options for establishing water quality outcomes in the zone

## INTRODUCTION

The Land and Water Regional Plan (LWRP) includes water quality objectives for ecosystem health, biodiversity, and aesthetic and recreational values. The LWRP water quality framework sets out region-wide default numeric water quality outcomes for indicators that were most relevant and available for the narrative objectives. The numeric outcomes were established for different river and lake types and are provided in Appendix 1.

The LWRP also provides the opportunity for sub-regional specific outcomes to be included in Chapters 6 -15 (sub-regional chapters). The zone committee has the option of reviewing water quality objectives and limits and recommending zone specific water quality objectives and limits for inclusion in Section 14 of the Land and Water Regional Plan (LWRP). This idea was introduced in the memo regarding water quality of the Timaru (Waitarakao/Washdyke and Levels Plains areas) locality (dated 18th August 2017), and several decisions regarding recommendations for water quality objectives and limits for groundwater, Waitarakao/Washdyke Lagoon and Timaru urban streams were made at the 21 August 2017 zone committee workshop.

This memo considers zone wide water quality objectives and limits for the OTOP zone in the context of the community outcomes.

## WATER QUALITY CLASSES FOR THE OPIHI AND TEMUKA FMU

The LWRP includes a classification of rivers and lakes for the purposes of referencing to water quality outcomes, limits and standards. The LWRP default water quality outcomes and river/lake classifications were carried over largely unchanged from the Natural Resources Regional Plan (NRRP). When the river and lake classification planning maps for the NRRP/LWRP where drawn and classified the Opihi, was not included because this area was covered by an existing catchment plan that sat outside the LWRP (Opihi River Regional Plan 2001). With the advent of a sub-regional planning process that includes the Opihi River catchment it has become apparent that a classified stream network is required. Recently, Environment Canterbury reviewed and proposed a river classification for the Opihi catchment that is consistent with the LWRP water quality classifications (Gray 2017). Figure 1 shows these proposed river classifications for the Opihi catchment.

Lake Opuha is the only freshwater lake in the Opihi catchment. Using the LWRP descriptions, Lake Opuha should be classified as an 'On-river artificial lake'.

In a recent NIWA report, the Opihi Lagoon (Milford Lagoon) is classified as a 'Hapua-type lagoon (Hume et al 2106). The LWRP does not establish water quality outcomes or limits for hapua-type lagoons. This is because of a paucity of information on indicators and criteria that provide for values of these systems. However, in setting water quality outcomes and limits in rivers, consideration of impacts on downstream environments (estuaries, hapuas) was given. More recently, a trophic level index has been developed for estuaries. Environment Canterbury is currently exploring the applicability of this index to our hapua systems.

**Key decision area**

**The zone committee recommends river and lake classifications as described above for the Opihi catchment are included in the LWRP**

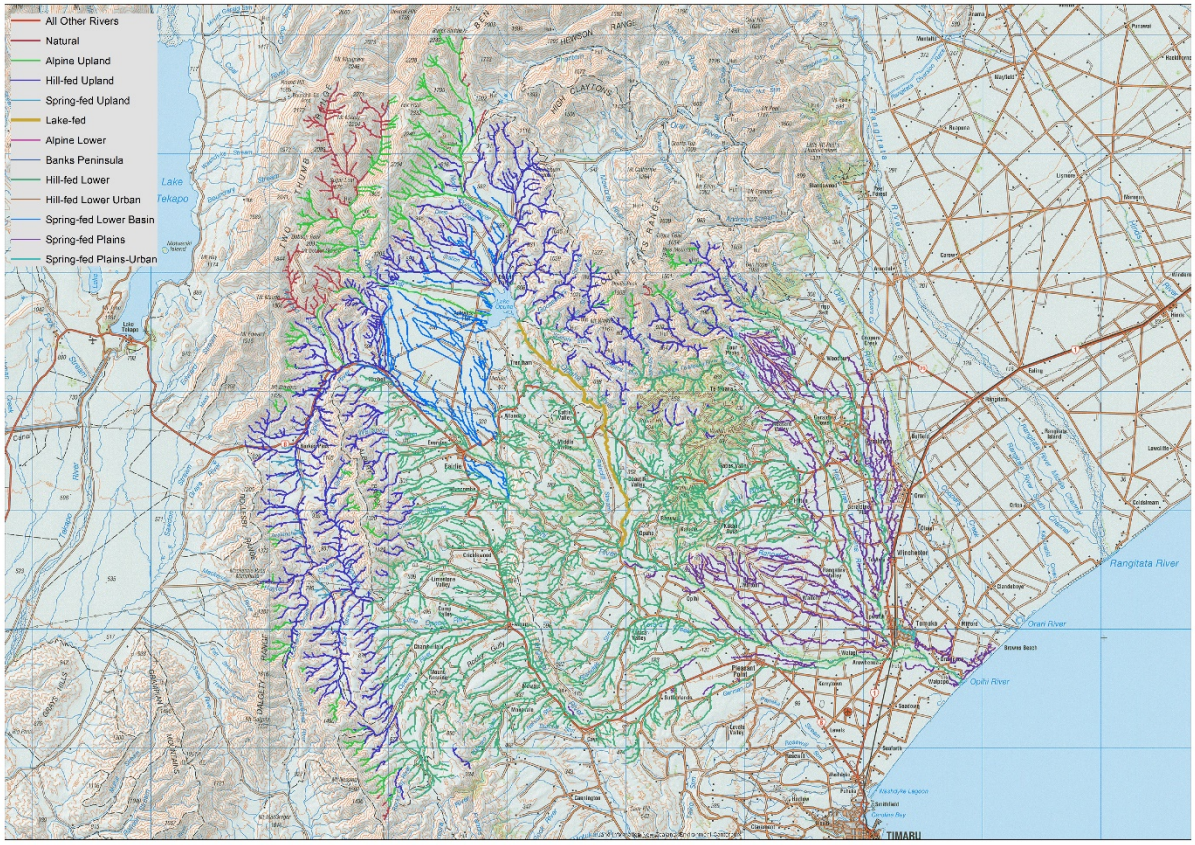


**Figure 1. Proposed river management unit classification for rivers in the Opihi catchment.**

## WATER QUALITY OUTCOMES OF THE LWRP, OTOP COMMUNITY OUCOMES AND NPSFM

The water quality outcomes in Tables 1a (rivers) and 1b (lakes) in the LWRP were developed as a set of numeric indicators that were considered appropriate and directly related to key freshwater values; namely healthy aquatic ecosystems, biodiversity, recreational and amenity values (Hayward et al., 2009). The numeric outcomes were set for the different river and lake types, reflecting different sensitivities, expectations and condition of these waterbodies. These freshwater outcomes were originally developed for the NRRP and were considered ambitious but generally achievable long term targets for most situations (Hayward et al, 2009). They were transferred largely unchanged into the LWRP as default freshwater quality outcomes that were to be achieved by 2030.

The National Policy Statement for Freshwater Management (NPSFM) 2014 included a national objectives framework for water quality objective setting that requires, as a minimum, objectives to be set for the compulsory national values; ecosystem health and human health for recreation. The NPSFM 2014 provided attribute states, and national bottom lines for relevant indicators. Amendments to the NPSFM in 2017 have further refined these attribute states. The only attribute in the outcomes tables that is directly related to attributes states is periphyton, although several attributes are indirectly related, specifically E. coli attributes, trophic indicators for lakes, toxicity indicators for rivers and lakes. Further amendments to the NPSFM 2017 have refined attributes, most notably the E. coli attribute for human health for recreation.

The NPSFM 2014 set out freshwater objectives that included the requirement to maintain and improve the overall quality of freshwater within a region. The NPSFM 2017 amendments have refined the spatial scale for setting overall 'maintain and improve' at the freshwater management unit (FMU) level rather than at the regional level. Furthermore, the 2017 amendments have indicated that maintaining water quality means that for attributes listed, they must not be set an attribute state lower than the current state. This means for example, that water quality cannot be allowed to deteriorate from attribute state A to B, or B to C, etc. This is also interpreted to mean that some variation within an attribute state band may be acceptable.

It is reasonable to expect that meeting the outcomes set out in Tables 1a and 1b will be consistent with, and make a significant contribution to, achieving the OTOP community outcomes that relate to water quality, cultural and biodiversity outcomes. There may be, however, some specific outcomes that the zone committee may want to refine for the OTOP zone, particularly where this provides consistency with the NPSFM 2017 or addresses locally important issues. These are discussed below and options for consideration by the zone committee are provided.

The current state OTOP water quality and ecology report included an assessment of key water quality indicators against the OTOP community outcomes (Hayward et al. 2016). This memo draws on that analysis to explore the relevance and achievability of these key indicators as set in the LWRP for the OTOP zone. This memo refers to figures in the current state water quality/ecology report, and rather than replicating these details in this memo, the specific figures or tables are referenced.

**Indicators for human health (E. coli)**

The LWRP included indicators for microbial water quality based on the 'Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas' (MfE/MoH 2003). Suitability for Recreation Grades (SFRG) of Good to Fair were set for most river and lake classes, but no values were set for spring-fed plain streams or coastal lakes.

The NPSFM 2017 has set an objective that the quality of freshwater will be suitable for primary contact more often, and has set a national target of making 90% of rivers and lakes swimmable by 2040. It specifically targets streams sized of fourth order or larger, and lakes with a perimeter of 1.5 km or larger. Many small headwater tributaries and spring-fed streams will not meet this fourth order criteria, however it is recognised that in order to achieve the national targets, contributing tributaries will need improvements as well (Appendix 2). The NPSFM 2017 also requires regional councils to identify primary contact sites (any size river or lake that is considered important for primary contact recreation), and monitor and report on these sites. There are currently 11 sites in the OTOP zone that are identified as popular swimming sites in Environment Canterbury's summertime contact recreational monitoring programme. These sites have been selected over several years based on community discussions, local knowledge and agreements with the relevant district councils and district health boards. A new site has been added to the 2017 summertime programme in response to the Waihi catchment group request to monitor E. coli levels in the Waihi River along the walkway in Geraldine.

The current state water quality/ecology report showed that nearly all of the sites currently identified and monitored for primary contact recreation meet the MoH/MfE criteria for suitability for swimming (grade Fair or better) (see Figure 7-1 of Hayward et al. 2016). The one exception was the Waihi Gorge

site, which was graded Poor, but recent improvements to this site have resulted in the grading improving to Fair.

Implementation of Plan Change 5, particularly the industry agreed good management practices (GMPs) required through farm environment plans, is likely to result in improvements to the microbial quality in many of our rivers and lakes. Key GMPs such as managing stock access to waterways, critical source areas and effluent will reduce faecal inputs to waterways. This will contribute to the regional and national targets for improvements in suitability of freshwaters for primary contact recreation.

There may be areas and certain streams where the microbial quality adversely affects values other than primary contact recreation. In particular, the quality of waterways valued and used for cultural purposes including mahinga kai gathering is critically important to iwi. The current state water quality report indicated that the microbial quality of spring-fed streams was often particularly poor (see Figures 3-10, 4-20, 4-21 in Hayward et al. 2016). The current pathways scenario indicated while some improvement in these waterways is expected through PC5, this may not be sufficient to achieve OTOP community outcomes for cultural values.

**Key decision areas**

1. **The zone committee supports the current sites identified and monitored in the OTOP zone as primary contact sites:**
   - **Orari River Gorge**
   - **Waihi River Gorge**
   - **Hae Hae Te Moana River Gorge**
   - **Lake Opuha at Recreation Reserve**
   - **Lake Opuha at Ewarts Corner Boat ramp**
   - **Opihi River – at Saleyards Bridge, at SH1, and at Waipopo Huts**
   - **Temuka River at SH1**
   - **Pareora River at Evans Crossing and at the Pareora Huts**
   - **Waihi Rivera at Geraldine (new site in 2017)**

2. **The zone committee supports implementation of industry good management practices, which will contribute to improvements in the quality of freshwater so that it is suitable for swimming more often.**

3. **The zone committee would like consideration of further measures for improving the microbial quality of sites of cultural importance.**

## Periphyton and nutrients

The water quality outcomes for periphyton in Table 1a include a total periphyton biomass measure (measure of chlorophyll a per square metre cover of the stream bed) and a measure of the percentage cover of the stream bed by nuisance algae (long filamentous algae). The thresholds were based on the NZ Periphyton guidelines (Biggs 2000). The NPSFM 2014 (and amended 2017) have set periphyton as a compulsory attribute for ecosystem health of rivers. The relationships between the LWRP outcomes table and the NPSFM attributes are shown below (Table 1). The periphyton thresholds set in the LWRP can be considered consistent with the NPSFM attribute states. In the upland reaches of all river types it is reasonable to expect that low periphyton biomass can be maintained. This provides a high level of protection for aquatic ecosystems in these areas. In the open, shallower, unshaded lower reaches of rivers we would naturally expect higher periphyton biomass to occur, although this is often exacerbated by nutrient inputs and abstractive pressures on summertime flows.

**Table 1 Relationship between LWRP outcomes for Periphyton and NPS Periphyton Attribute States**

| NPS Attribute States for periphyton | Numeric attribute state (mg chl-a/$m^2$) Default class - Exceeded no more than 8% of samples | LWRP periphyton biomass objectives per river class | Narrative Attribute State |
|---|---|---|---|
| A | ≤50 | Alpine, Hill-fed, Spring-fed upland | Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat. |
| B | >50 - ≤120 | Alpine - lower, Banks Peninsula | Occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat. |
| C | >120 - ≤200 | Hill-fed lower + urban, lake-fed spring-fed lower basin, spring-fed plains | Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or alteration of the natural flow regime or habitat. |
| National Bottom line<br>D | 200<br>>200 | | Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat. |

The NPSFM 2017 requires regional councils to set instream concentrations of dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) in rivers to help them achieve their freshwater objectives for periphyton, where conspicuous periphyton is likely to occur. For rivers or streams where conspicuous periphyton is not likely to occur, instream nutrient concentrations (or loads) may be set for other values (eg for macrophyte growths in spring-fed streams).

Establishing relationships between instream nutrient concentrations and risks of periphyton growths has been fraught. The NZ periphyton guidelines (Biggs 2000) provided national models for establishing periphyton/nutrient relationships in gravel bottomed, hill-fed rivers. However, these models have been shown to be highly conservative and often poor predictors in a wider range of river types (Matheson et al 2012, Kilroy and Wech 2016). Environment Canterbury attempted to develop regional specific periphyton/nutrient relationships and while this has also proven difficult, some promising

relationships have been established (Kilroy and Wech 2016). However, the Canterbury specific work is not at the stage yet where it can be used to establish region-wide instream nutrient criteria for periphyton for all relevant river types. Matheson et al (2012) provided some useful categories and nutrient thresholds which were used to assess and compare the nutrient status of OTOP waterways in the current state water quality/ecology report, but this is a very generic national approach.

The approach taken in previous sub-region planning processes to establish instream nutrient concentration limits has been to take as a starting point the current nutrient status of waterways as the first step in setting limits (except in the Waitaki sub-region section where a small increase in N concentrations was permitted). This makes sense in the context of the NPSFM to maintain or improve water quality. However, it is also reasonable to require that where periphyton indicators currently do not meet water quality outcomes, some reductions in nutrient concentrations are required (possibly along with other interventions such as flow regimes, riparian shading).

Environment Canterbury currently has little quantitative measurements of periphyton biomass. Regular recorded observations of periphyton cover indicate that some OTOP waterways would likely currently meet the LWRP periphyton outcomes, while others may not. The current state water quality/ecology report indicated that the lower reaches of rivers such as the Pareora, Hae Hae Te Moana, and Opuha may not meet their respective periphyton outcomes.

**Key decision areas**

**Periphyton**

**Option 1 Periphyton outcomes are set at levels appropriate and consistent with the NPSFM 2017, and do not deteriorate from current levels.**

**Option 2 – some variations of Option 1**

**Instream nutrient concentrations**

**Option 1 Instream nutrient concentrations are set at least at current levels, and where periphyton outcomes are not met, are reduced over time until periphyton outcomes are met.**

**Option 2 Instream nutrient concentrations are set at current levels, and are not allowed to deteriorate below those levels.**

## Lake trophic indicators

Opuha Water Limited (OWL) has proposed a Trophic Level Index (TLI)[1] for Lake Opuha of 4, which is based on the upper range of the annual average values recorded from its monitoring of the lake (see the OWL paper presented to the zone committee in August 2017). The LWRP outcome for lakes such as Opuha (artificial on-river lakes) set a TLI of 3. The main justification for this default threshold was

[1] Trophic Level Index (TLI) is an indicator of lake water quality specifically developed for NZ lakes. The index is calculated from the combined measures of chlorophyll a (phytoplankton biomass), total nitrogen, total phosphorus and water clarity. Higher TLI values indicate greater nutrient enrichment, more phytoplankton (algal) biomass and lower water clarity. The TLI can be calculated by omitting water clarity, where this is not available.

based on consideration of the impact of the nutrient status on downstream river environments (Hayward et al., 2009). A conservative TLI threshold of 3 (at the boundary of unenriched/moderately enriched states) was used for the default objective.

The NPSFM 2017 does not include TLI as an attribute state for lakes. Rather, it includes attributes for the three major components of TLI; phytoplankton (chlorophyll a), total nitrogen (TN), and total phosphorus (TP). Figure 2 shows the components of the TLI for Lake Opuha and how they relate to the NPSFM 2017 attribute states. First, it is clear there is a lot of annual variability. Second, the various components fall into differing states, with TN values falling largely in the Attribute State C, TP varying between A and B and chlorophyll a largely falling within Attribute State B. No values have exceeded the national bottom line. The key question is whether the current trophic state is acceptable in terms of both the condition of the lake and its various values and whether the trophic status of the lake adversely impacts on the downstream environment.

In terms of Lake Opuha's values as a reservoir for irrigation water, and a local recreational/amenity resource, the current trophic condition may well be accepted by users. The lake does not produce unsightly or toxic algal blooms, although it does not have high water clarity.

In regards to the discharge from the lake into the Opuha River, when the lake was first commissioned, significant stratification events occurred causing severe deoxygenation of the deep waters in the lake, resulting in the release of soluble forms of phosphorus and metals (iron, manganese) from the lake bed that were discharged from the lake into the Opuha River. The installation of an aeration system has reduced these effects, but at times the lake can still stratify and potentially result in release of these minerals and metals. The management of the aeration system has a major part to play in these processes, rather than control of nutrient inputs to the lake per se. Despite issues with lake stratification, the Opuha River below Lake Opuha maintains generally low phosphorus concentrations and moderate nitrogen concentrations (Hayward et al., 2016). The Opuha River is generally less enriched than the upper Opihi River, and therefore, provides some dilution of nutrients to the lower Opihi system. On this basis, while it remains important that the nutrient levels in the lake do not increase, the current trophic status could be maintained without compromising the downstream environment.

**Key decision areas**

**Option 1: Maintain the trophic status of Lake Opuha at current levels (within current attribute states) and with the maximum annual TLI to not exceed 4**

**Option 2: Set the TLI for the lake at 3 and NPS attributes at State A - B**

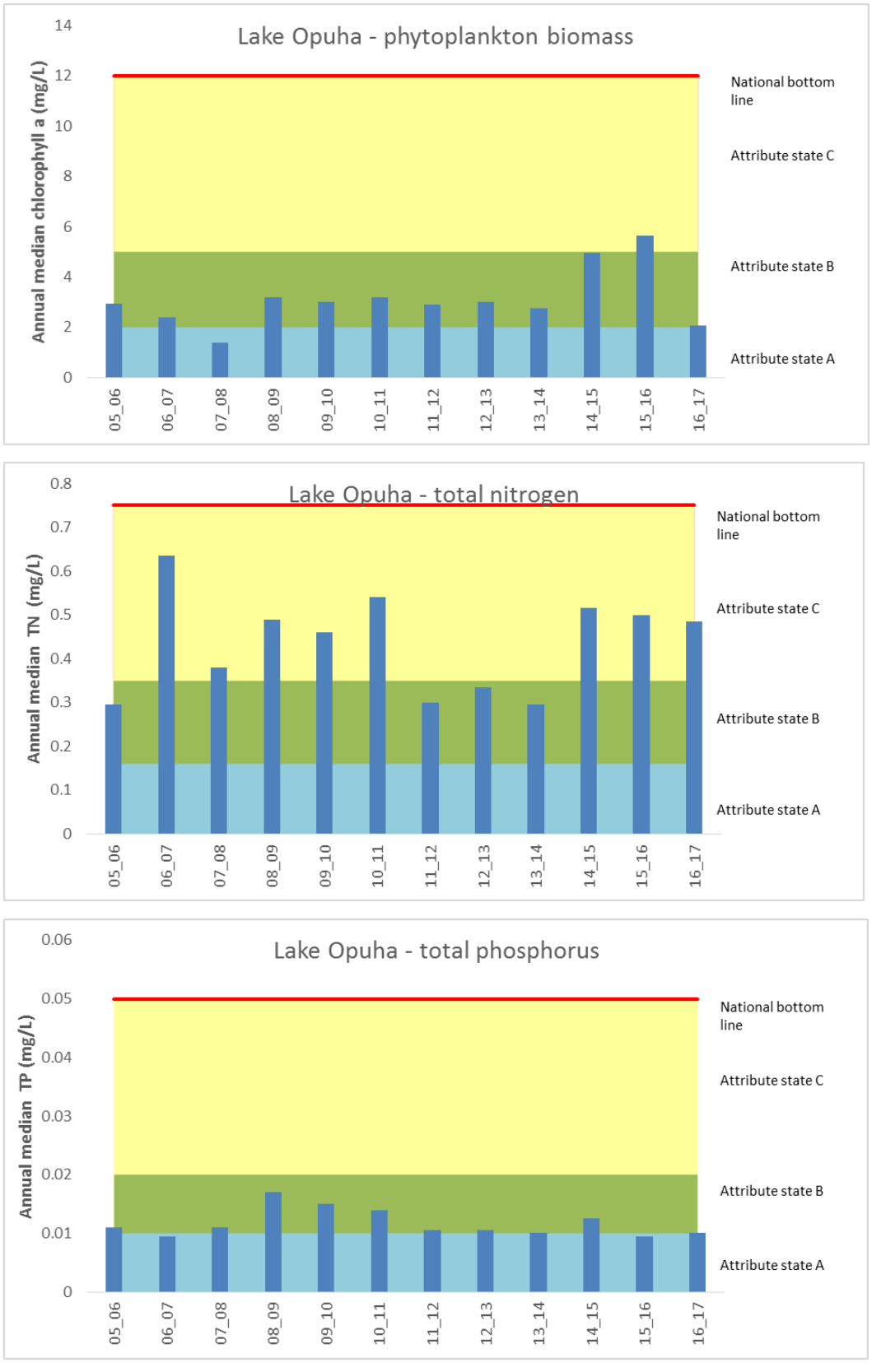


**Figure 2 Assessment of water quality attributes against NPS attributes states for Lake Opuha**

## GROUNDWATER QUALITY (NITRATES)

Previous workshops have considered and addressed specific issues relating to nitrate hotspots in the OTOP zone (Orari and Levels Plains). These workshops addressed areas where groundwater quality did not meet the drinking water standards for nitrates, and surface waterways did not meet national bottom lines for nitrate toxicity. In the current state groundwater report, Ashwick Flat was also identified as an area where drinking-water quality standards for nitrates were not being met in some shallow groundwater monitoring bores. Furthermore, long-term trends of increasing nitrogen in the Opihi and Opuha rivers was noted in the current state water quality/ecology report.

Average groundwater nitrate concentrations in the Ashwick Flat area were 6.2 mg/L based on Environment Canterbury's current monitoring programme, which is 9% higher than the limit in the LWRP of 5.65 mg/L (half MAV NZ Drinking Water Standards). The current pathways scenario assessment indicated that implementation of PC5 will result in improvements in nitrate concentrations in the shallow groundwater, and will likely result in meeting the LWRP groundwater limits of half MAV. However, the zone committee may want to be explicit in ensuring such a limit is achieved. The LWRP region-wide limits for groundwater quality are set at an average nitrate concentration of half MAV and maximum concentration not exceeding the MAV (11.3 mg/L nitrate nitrogen). Most other groundwater zones are currently better than this state, which gives the options of accepting the limits as currently written in the LWRP for groundwater, or setting limits that maintain groundwater quality where it is currently better than the LWRP limits.

**Key decision area**

**Option 1 Average nitrate concentrations in the shallow groundwater in Ashwick Flat shall not exceed half the drinking water standards MAV of 5.65 mg/L**

**Option 2 Average nitrate concentrations are maintained at current levels.**

**For all other areas (not previously identified as nitrate hotspots)**

**Option 1 Average nitrate concentrations in the shallow groundwater zones shall not exceed half the drinking water standards MAV of 5.65 mg/L**

**Option 2 Where groundwater nitrate concentrations in groundwater are better than the limits set in the LWRP, they shall be maintained at the current level or better.**

## REFERENCES


Biggs, B.J.F. 2000. New Zealand Periphyton Guideline: Detecting, Monitoring and Managing Enrichment of Streams. Ministry for the Environment, Wellington, New Zealand. June 2000.

Gray, D. 2017: Memorandum detailing river water quality classification approach for the Opihi catchment. Dated 25 July 2017.

Hayward S, Meredith A, Stevenson M, 2009. Review of proposed NRRP water quality objectives and standards for rivers and lakes in the Canterbury region. Environment Canterbury technical report R09/16.

Hayward, S., Clarke, G., Dynes, K., Barnden, A., Arthur, J., Barbour, S., 2016. Orari, Temuka, Opihi and Pareora Zone: state and trends in water quality and aquatic ecology. Draft Environment Canterbury Report No. R16/63

Hume, T., Gerbeaux, P., Hart, D., Kettles, H., Neale, D., 2016: A classification of New Zealand's coastal hydrosystems. NIWA client report for the Ministry for the Environment, HAM2016-062.

Kilroy, C. Wech, J. 2016: Analysis of a three-year data set of periphyton biomass and cover in Canterbury Rivers. Draft NIWA report for Environment Canterbury, Client report No. 2017085CH.

Matheson, F., Quinn, J. and Hickey, C. 2012. Review of the New Zealand instream plant and nutrient guidelines and development of an extended decision making framework; Phases 1 and 2 Final report. Report prepared for the Ministry of Science and Innovation, Envirolink Fund.

## Appendix 1 LWRP Freshwater outcomes tables

**Table 1a Freshwater Outcomes for Canterbury Rivers**

| Management unit | Sub-unit | Ecological health indicators | | | Macrophyte indicators | | Periphyton Indicators[1] | | | Siltation indicator[1] | Microbiological indicator |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | QMCI*[1] [min score] | Dissolved oxygen [min saturation] (%) | Temperature [max] (°C) | Emergent macrophytes [max cover of bed] (%) | Total macrophytes [max cover of bed] (%) | Chlorophyll a [max biomass] (mg/m²) | Filamentous algae >20 mm [max cover of bed] (%) | Cyanobacteria mat cover (%) | Fine sediment <2 mm diameter [max cover of bed] (%) | Suitability for contact recreation [SFRG*] |
| Natural state waterbodies[2] | Rivers are maintained in a natural state | | | | | | | | | | |
| Alpine - upland | | 6 | 90 | 20 | No value set | No value set | 50 | 10 | 20 | 10 | Good |
| Alpine - lower | | | | | | | 120 | 20 | 30 | | Good to Fair |
| Hill-fed - upland | | | | | | | 50 | 10 | 20 | 15 | Good |
| Hill-fed - lower | | | | | | | 200 | 30 | 50 | | Good to Fair |
| | Urban | 3.5 | | | | | | | | 20 | No value set |
| Lake-fed | | 6 | | | | | 200 | 30 | 50 | 10 | Good |
| Banks Peninsula | | 5 | | | | | 120 | 20 | 30 | 20 | No value set |
| Spring-fed -upland | | 6 | | | 20 | 30 | 50 | 10 | 20 | 10 | Good |
| Spring-fed - lower basins | | 5 | | | 30 | 30 | 200 | 30 | 50 | | Fair |
| Spring-fed -plains | | 5 | 70 | | 30 | 50 | 200 | 30 | 50 | 20 | No value set |
| | Urban | 3.5 | | | 30 | 60 | 200 | 30 | 50 | 30 | No value set |

1. These indicators only apply to wadeable areas of wetted riverbed. For the purposes of this table, wadeable areas are derined as reaches of the river up to 600mm in depth.
2. Rivers within land that is administgered for conservation purposes by the Department of Conservation.

*Key:

QMCI = quantitative macroinvertebrate community index
SFRG = Suitability for Recreation Grade from Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas, Ministry for the Environment, June 2003

**Table 1b Freshwater Outcomes for Canterbury Lakes**

<table>
<tr><th rowspan="2">Management unit</th><th colspan="4">Ecological health indicators</th><th>Eutrophication indicator</th><th>Visual quality indicator</th><th>Microbiological indicator</th></tr>
<tr><th colspan="2">Dissolved Oxygen [min] (%)</th><th>Temp [max] (ºC)</th><th>Lake SPI* [min grade]</th><th>Trophic Level Index (TLI)* [max score]</th><th>Colour</th><th>Suitability for contact recreation [SFRG]*</th></tr>
<tr><th>Hypo-limnion</th><th>Epilimnion</th><th></th><th></th><th></th><th></th><th></th></tr>
<tr><td>Natural state waterbodies[1]</td><td colspan="7">Lakes are maintained in a natural state</td></tr>
<tr><td>Large high country lakes</td><td rowspan="5">70</td><td rowspan="5">90</td><td rowspan="5">19</td><td>Excellent</td><td>2</td><td rowspan="6">The natural colour of the lake is not degraded by more than five Munsell Units[(a)]</td><td>Good</td></tr>
<tr><td rowspan="2">Small to medium sized high country lakes</td><td rowspan="2">High</td><td>Māori Lakes and Lakes Emily and Georgina<br>4</td><td rowspan="2">Good</td></tr>
<tr><td>All other small to medium sized high country lakes<br>3</td></tr>
<tr><td rowspan="2">Coastal lakes</td><td rowspan="2">Moderate</td><td>Coopers Lagoon/Muriwai<br>4</td><td rowspan="2">No value set</td></tr>
<tr><td>All other coastal lakes<br>6</td></tr>
<tr><td>Artificial lakes - on-river</td><td>High</td><td>3</td><td>Good</td></tr>
<tr><td>Artificial lakes – others</td><td>20</td><td colspan="3">Suitable for the purpose of the lake</td><td>4</td><td>Suitable for the purpose of the lake</td></tr>
</table>

(a) Explanatory Note: In respect of Lake Coleridge the natural colour of the lake is the colour of the lake as measured monthly in the period 1 August 2014 to 31 July 2015.

1. Lakes within land that is administered for conservation purposes by the Department of Conservation.

*Key:

Lake SPI = Lake Submerged Plant Indicators from Clayton J, Edwards T, (2002) LakeSPI: a method for monitoring ecological condition in New Zealand lakes (Technical report version 1 Report by NIWA)

TLI = Trophic Level Index from: Protocol for Monitoring Trophic Levels of New Zealand Lakes and Reservoirs (Report by Lakes Consulting, March 2000)

SFRG = Suitability for Recreation Grade from: Microbiological Water Quality Guidelines for Marine and Freshwater Recreational

## Appendix 2

The River Environment Classification (REC) network, highlighting streams fourth order or greater.