Appendix 3

horizons regional council

MEMORANDUM

FILE: OMS 10 17

DATE: 15 March 2010

TO: One Plan Hearings Chairperson

FROM: Kate McArthur, Dr John Zeldis, Dr Rob Davies-Colley, Max Gibbs and Graham McBride

SUBJECT: **MEMO TO THE WATER HEARING PANEL OUTLINING EXPERT AGREEMENT ON WATER QUALITY STANDARDS FOR RIVERS, ESTUARIES AND LAKES**

Dear Ms Allin,

Following the provision of expert evidence on behalf of Horizons regarding water quality standards, there remain some outstanding issues relating to standards for water clarity, faecal indicator bacteria and cyanobacterial toxins in lakes. The purpose of this memo is to provide an agreed recommendation to the Water Hearing Panel on the most appropriate water quality standards for these parameters, by consensus between the relevant technical experts (Table 1).

Table 1: Recommended water quality (WQ) standards for parameters subject to outstanding expert disagreement following the provision of evidence to the Water Hearing Panel, agreed through expert consensus.

WQ Parameter	Recommended (pink pages) value and reference	Agreed experts	Final value consensus
Lake minimum water visual clarity (black disc)	Deep lakes 2.8 m Shallow lakes 0.8 m	Dr Davies-Colley Max Gibbs	Deep lakes 2.1 m Shallow lakes 1.2 m
Estuary sub-zone water visual clarity (black disc)	No standard recommended	Dr Davies-Colley Dr John Zeldis	1.2 m
Estuary sub-zone faecal indicator bacteria (*E. coli* vs. *enterococci*)	260 *E. coli* at flows < median 550 *E. coli* at flows < 20th exceedence percentile	Dr Davies-Colley Dr John Zeldis Graham McBride	260 *E. coli* at flows < median 550 *E. coli* at flows < 20th exceedence percentile
Lake cyanobacterial toxin standard	No toxin standard recommended for any water body	Max Gibbs Kate McArthur	No standard for cyanobacterial toxins is recommended

Rationale for values recommended by consensus

Lake water clarity (black disc)

Dr Davies-Colley and Mr Gibbs have agreed that the minimum visual water clarity standard for lakes, measured using a black disc, should be 2.1 metres (c.f. 2.8 m recommended value) in deep lakes and 1.2 metres (c.f. 0.8 m recommended) in shallow lakes. In deep lakes a minimum visibility of 2.1 metres protects the visual environment for fish and birds, as well as for human recreation. In shallow lakes, which are frequently turbid because of wind-wave disturbance of bottom sediments and/or algal growth, a visibility of 1.2 metres is minimal for safe contact recreation.

Estuary sub-zone water clarity (black disc)

Dr Davies-Colley and Dr Zeldis have agreed that the minimum visual water clarity standard for estuary sub-zones should be 1.2 metres (c.f. no recommended standard) measured by black disc, being minimal for safe contact recreation. (Note that estuaries, like shallow lakes, are frequently turbid owing to wind-wave disturbance of bottom sediments.) Additionally, the experts recommend that the seawater visual clarity minimum is also measured using black disc to be consistent with all other clarity standards in the Proposed One Plan.

All references to Secchi depth should be removed from Schedules D and H. In practice, Secchi measurements might be continued operationally where valuable historical records exist (mainly in lakes) because Secchi depth and black disc visibility are approximately inter-convertible with Secchi depth typically about 25% greater than black disc visibility.

Estuary sub-zone faecal indicator bacteria

Dr Davies-Colley, Mr Gibbs and Mr McBride have agreed that the faecal indicator that should be used for estuary sub-zones standards is *Escherichia coli*, as recommended in the track changes (pink-pages) version of Schedule H. The values for this standard should be 260 *E. coli* / 100ml at flows less than the 50th flow exceedence percentile and 550 *E. coli* / 100ml at flows less than the 20th exceedence percentile. The standard should be considered to be exceeded when these indicator values are exceeded by the estuarine water quality. Further discussion on this matter is appended for reference (Appendix 1).

Lake cyanobacterial toxin standards

Mr Gibbs and Mrs McArthur have agreed that it is appropriate for cyanobacterial toxins to remain absent from the lakes water quality standards (as recommended in the pink pages version of Schedule D) because reducing the adverse effect of toxins on lake water body values can only feasibly be achieved by reducing cyanobacterial blooms themselves.

Mr Gibbs has recommended standards for chlorophyll *a* for lakes (included in the pink pages track changes version of Schedule D). These standards provide the most adequate targets for the protection of water body values from adverse effects relating to nuisance blooms of any kind and are specific to the type of lake (ie. deep or shallow).

The interim National Guidelines for cyanobacteria in recreational fresh waters (MfE/MoH, 2009) provide guidance in relation to recreational risk from cyanobacterial toxins (included here as Appendix 2). One of the key recommendations of the guidelines is the use of cell bio-volumes of cyanobacterial species in mm^3/L to determine risk alert levels. Cell counts of various potential toxic species should be retained as monitoring records because this information is also extremely useful from a management perspective. Direct measures of cyanobacterial toxins themselves are recommended as an alternative 'situation' by the guidelines, but are not recommended until the red alert level is reached and public notification of the risk is deemed necessary. At this alert stage, effects on values are already occurring; therefore the toxin levels recommended by the guidelines are not appropriate as lake water quality standards to provide for values such as Contact Recreation.

The original cyanobacterial toxin standard for lakes in the Proposed One Plan (20 mg/m^3) is higher than the guideline recommendation for microcystin toxins for the red alert level ($\geq$ 12 $\mu g/L$ (equivalent to mg/m^3)). Therefore the cyanobacterial toxin standard set out in the Proposed One Plan will not adequately provide for the water body values and may also be too high to account for publicly notifiable risk to water users. However, both experts note that the toxin standards set in the National Guidelines are extremely conservative and should be considered pragmatically.

Agreed experts:

Kate McArthur
Horizons Senior Scientist – Water Quality

Dr Rob Davies-Colley
NIWA Principal Scientist – Aquatic Pollution

Mr Max Gibbs
NIWA Scientist – Limnologist and Environmental Chemist

Mr Graham McBride
NIWA Principal Scientist

Dr John Zeldis

NIWA Principle Scientist – Marine Group Manager

Appendix 1

One Plan Water Hearing: End of Hearing Report:

Agreed position on choice of Faecal Indicator Standard for the One Plan Estuary Sub-zones

Mr McBride and Drs Davies-Colley and Zeldis (NIWA) recommend that the faecal indicator standard that should be used for estuary sub-zones in Horizon's One Plan standard is *Escherichia coli* (*E. coli*) alone, ie. not including enterococci. We are comfortable with the single-sample limit values for the concentrations of this health risk indictor proposed by the Regional Council (less than 260 *E. coli* per 100 mL at river flows less than median and less than 550 *E. coli* per 100 mL at flows less than the 20th exceedence percentile). The standard should be considered breached when these indicator values are exceeded in the sub-zone.

Nonetheless, because the choice of *E. coli* is in some conflict with the relevant National Guidelines (MfE/MoH 2003) it may be wise to conduct parallel analyses of *E. coli* and enterococci in the first year or two of sampling, and reassess the choice of standard at that time. Relevant experts should assist the interpretation of the results of such analyses at the end of that period.

Explanatory information (for the choice of *E. coli* versus enterococci)

At first sight it would appear that the preferred indicator in estuaries should be enterococci. This is because the Guidelines (MfE/MoH 2003) say that combined measurement of *E. coli* and enterococci is the default for estuaries (first bullet on page C2). Indeed, footnote 5 (and associated text) on page D1 of the Guidelines implies that performing only enterococci measurements may be satisfactory in some circumstances.[1]

However, any faecal material in estuaries that have short residence times (such as the Manawatu) would probably have spent most of its life outside its host in freshwater, and so *E. coli* could be expected to be more long-lasting than enterococci, even if the sample was taken from saline estuarine waters (Sinton *et al*. 1999, 2002).

Graham McBride, John Zeldis, Rob Davies-Colley, NIWA, 4 March 2010

[1] There is a caveat (last paragraph on page D1 of the Guidelines) that *E. coli* should be used where the primary faecal source is waste stabilisation ponds. However, that does not appear to be relevant here.

References

MfE/MoH (2003). Microbiological Water Quality Guidelines for Marine And Freshwater Recreational Areas. Ministry for the Environment and Ministry of Health, Wellington (published by MfE).

Sinton, L.W., Finlay, R.K. and Lynch, P.A. (1999). Sunlight inactivation of fecal bacteriophages and bacteria in sewage-polluted seawater. *Applied and Environmental Microbiology* **65**(8): 3605-3613.

Sinton, L.W., Hall, C.H., Lynch, P.A. and Davies-Colley, R.J. (2002). Sunlight inactivation of fecal indicator bacteria and bacteriophages from waste stabilization pond effluent in fresh and saline waters. *Applied and Environmental Microbiology* **68**(3): 1122–1131.

Appendix 2:

3.2 Alert-level framework: planktonic (lake) cyanobacteria

Decision Chart 1: Alert-level framework for planktonic (lake) cyanobacteria

Alert level	Actions
	(See section 2.4 for the recommended framework for roles and responsibilities relating to actions, and the text box at the beginning of Section 3 for advice on interpreting the guidance in this table.)
Surveillance (green mode) *Situation 1:* The cell concentration of total cyanobacteria does not exceed 500 cells/mL.[a] *Situation 2:* The biovolume equivalent for the combined total of all cyanobacteria does not exceed 0.5 mm^3/L.	• Undertake weekly or fortnightly visual inspection[b] and sampling of water bodies where cyanobacteria are known to proliferate between spring and autumn.
Alert (amber mode) *Situation 1:* Biovolume equivalent of 0.5 to < 1.8 mm^3/L of potentially toxic cyanobacteria (see Tables 1 and 2); **or** *Situation 2[c]:* 0.5 to < 10 mm^3/L total biovolume of all cyanobacterial material.	• Increase sampling frequency to at least weekly. • Notify the public health unit. • Multiple sites should be inspected and sampled.
Action (red mode) *Situation 1:* ≥ 12 µg/L total microcystins; **or** biovolume equivalent of ≥ 1.8 mm^3/L of potentially toxic cyanobacteria (see Tables 1 and 2); **or** *Situation 2[c]:* ≥ 10 mm^3/L total biovolume of all cyanobacterial material; **or** *Situation 3[e]:* cyanobacterial scums consistently present.	• Continue monitoring as for alert (amber mode).[d] • If potentially toxic taxa are present (see Table 1), then consider testing samples for cyanotoxins.[f] • Notify the public of a potential risk to health.

a) A cell count threshold is included at this level because many samples may contain very low concentrations of cyanobacteria and it is not necessary to convert these to a biovolume estimate.

b) In high concentrations planktonic cyanobacteria are often visible as buoyant green globules, which can accumulate along shorelines, forming thick scums (see Appendix 3). In these instances, visual inspections of water bodies can provide some distribution data. However, not all species form visible blooms or scums; for example, dense concentrations of *Cylindrospermopsis raciborskii* and *Aphanizomenon issatschenkoi* are not visible to the naked eye (see Appendix 3).

c) This applies where high cell densities or scums of 'non-toxigenic' cyanobacteria taxa are present (ie. where the cyanobacterial population has been tested and shown not to contain known toxins).

d) Bloom characteristics are known to change rapidly in some water bodies, hence the recommended weekly sampling regime. However, there may be circumstances (eg, if good historical data/knowledge is available) when bloom conditions are sufficiently predictable that longer interval sampling is satisfactory.

e) This refers to the situation where scums occur at the recreation site for more than several days in a row.

f) Cyanotoxin testing is useful to: provide further confidence on potential health risks when a health alert is being considered; enable the use of the action level 10 mm3/L biovolume threshold (ie. show that no toxins are present; and show that residual cyanotoxins are not present when a bloom subsides).