Technical report advising Proposed Plan Change 6A 'Officer's Report of Decisions Requested'

Schedule 16
Recommended discharge limits for water quality

Four analytes are considered for discharge limits, as set out in Table 1. This subset of water quality parameters keeps analysis to a minimum, but provides a series of indicators which shows the levels of nutrients and bacteria. This section discusses the limits for each analyte.

Changes from notified Plan

Area 1 and 2 limits for NNN, DRP and E. coli

Schedule 16 - Discharge limits for water quality

Accrual days	Nitrate-nitrite nitrogen (mg/l)	Dissolved reactive phosphorus (mg/l)	Ammoniacal nitrogen (mg/l)	Escherichia coli (cfu/100ml)
Area 1 (more flushing flows)	***2.0***	***0.045***	0.1	***260***
Area 2 (fewer flushing flows)	***0.5***	***0.035***	0.1	***260***
Area 3 (Wanaka, Wakatipu, Hawea)	0.08	0.006	0.1	126

1 Nutrients

Nitrogen and phosphorus are essential nutrients for the growth of aquatic plants and algae that form an important part of any healthy stream ecosystem. However, excessive in-stream concentrations can lead to proliferations of algae (eg, rock slime) and macrophtyes (aquatic plants), which in turn may compromise a range of in-stream values such as amenity, native fish conservation and recreation (Biggs, 2000).

Measuring nitrogen and phosphorus concentrations therefore provides an important indication of the potential for proliferations to occur in the monitored catchments (all other factors such as light, stream bed and temperature conditions being equal). These measurements also provide an indication of the contribution of nutrients from the monitored catchments to downstream receiving waters such as larger rivers, lakes and estuaries.

The determination of guidelines relating to nutrient concentrations in rivers and streams is a scientifically complex issue. The concentrations at which nitrogen or phosphorus actually begin to have an adverse effect on ecosystem health or amenity values is highly site- and catchment-specific and depend on many factors.

- For example, a stream with relatively fast, variable flow that discharges to an open coastline may be able to support high nutrient concentrations that do not have an observable impact (eg, nuisance growths).
- However, if that stream discharges to a lake or an estuary where nutrients are likely to accumulate and boost plant growth, then in-stream concentrations become much more important to control.
- Likewise, a stream with primarily sandy substrate may be more resistant to nuisance blooms than a rock- or cobble-bottomed stream (given similar concentrations of nutrients).

The table below gives statistics derived from SOE river monitoring data (2006 to 2011) for sites in each area.

	NNN	NNN	NNN	DRP	DRP	DRP
	Area 1	Area 2	Area 3	Area 1	Area 2	Area 3
No samples	565	1588	151	565	1589	151
Schedule 16	2.0 mg/l	0.5 mg/l	0.075mg/l	0.045mg/l	0.035mg/l	0.006mg/l
Median	0.396	0.025	0.022	0.016	0.006	0.005
75%ile	0.922	0.07	0.033	0.023	0.011	0.005
80%ile	1.062	0.098	0.035	0.026	0.013	0.005
95%ile	2.010	0.4453	0.059	0.041	0.036	0.008
99%ile	3.003	1.242	0.080	0.078	0.125	0.024

The table below gives recommended discharge limits for NNN and DRP.

Characteristic	**Description (from Schedule 15)**			
Algae	Healthy levels of algae: • Do not cover more than 30% of the bed. • Strands are less than 20 mm in length. • No slime on the surface of the water.			
Characteristic	**Analyte**	**Effects Reason to Monitor**	**Guideline value**	**Reference**
Algae	Nitrite/nitrate nitrogen (NNN)	Periphyton	Area 1 - 2 mg/l	ORC[1], AgResearch 2011[2]
			Area 2 - 0.5 mg/l	ORC[1], AgResearch 2011[2]
			Area 3 - 0.075 mg/l	Biggs, 2000[3]
Algae	Dissolved reactive phosphorus (DRP)	Periphyton	Area 1 - 0.045 mg/l	ORC[1], AgResearch 2011[2]
			Area 2 - 0.035 mg/l	ORC[1], AgResearch 2011[2]
			Area 3 - 0.006 mg/l	Biggs, 2000[3]

In New Zealand, two national guidelines are commonly used to assess nutrient concentrations.

1.1 Periphyton guidelines (Biggs, 2000).

These guidelines provide *suggested* thresholds for the dissolved nitrogen and phosphorus concentrations required to control periphyton growth. A range of thresholds are provided that are related to flow conditions (high flow events tend to scour out periphyton growth). Biggs (2000) found 61.8 percent of the variance in peak algal biomass was explained by mean days of accrual (determined as the mean number of days per year between flood events exceeding 3 x median flow).

The table below shows how the Periphyton guidelines vary according to accrual days.

	Wet – less than 30 days accrual	**Dry – more than 30 days accrual**
Nitrate–nitrite nitrogen	0.295mg/l	0.075mg/l
Dissolved reactive phosphorus.	0.026mg/l	0.006mg/l

[1] ORC – 95th percentile of SOE water quality data in Area1 or 2 (July 2006 to June 2011)

[2] McDowell RW, Monaghan RM, Muirhead, RW, 2011, Water quality of the Pomahaka River catchment: scope for improvement. AgResearch, Report for ORC.

[3] Biggs B. 2000. New Zealand Periphyton Guideline: Detecting, Monitoring and Managing Enrichment of Streams. Prepared for the Ministry for the Environment. Wellington: Ministry for the Environment.

Otago has been split into three regions:

- *Area 1 (more flushing flows- less than 30 days accrual). The recommended guidelines are less stringent than those proposed by Biggs (2000).*
- *Area 2 (fewer flushing flows - more than 30 days accrual). The recommended guidelines are less stringent than those proposed by Biggs, 2000.*
- *Area 3 (Lakes Wanaka, Wakatipu and Hawea and their tributaries). The recommeded guidelines are the same as those proposed by Biggs, 2000.*

1.2 ANZECC guidelines (ANZECC, 2000).

These guidelines provide default trigger values for total and dissolved nitrogen and phosphorus for assessing the risk of adverse effects in slightly disturbed ecosystems.

The table below shows the ANZECC trigger values which are based on the ***80th percentile*** of a distribution of reference data.

	Lowland Rivers (<150m)	**Upland Rivers (>150m)**
Nitrate–nitrite nitrogen	0.444mg/l	0.167mg/l
Dissolved reactive phosphorus.	0.010mg/l	0.009mg/l

The ANZECC 2000 Guidelines emphasise that the best reference conditions are set by locally appropriate data. ORC has used locally appropriate data to derive statistics for the three areas. The data were sourced from five years of SOE water quality data (July 2006 to June 2011).

NNN is very soluble and easily leached from saturated soils, more so than phosphorus which readily binds to soils. In the wetter catchments of Otago instream NNN is generally elevated, the specific nutrient limiting periphyton growth (Biggs, 2000) is therefore DRP which should be the focus nutrient in these wetter catchments.

- *The recommended limit for Area 1 is set at the 95%ile (2mg/l NNN, 0.045mg/l DRP) which is less stringent than the ANZECC 2000 default trigger values for lowland rivers.*

- *The recommended limit for Area 2 is set at the 95%ile (0.5mg/l NNN, 0.035mg/l DRP) which is less stringent than the ANZECC 2000 default trigger values for upland rivers.*

- *The recommended limit for Area 3 is set at 0.075mg/l NNN, 0.006mg/l DRP i.e. the levels recommended by Biggs (2000) this is more stringent than the ANZECC 2000 default trigger values for upland rivers.*

1.3 Limits set at 95th percentile rather than median

The Notified Plan contained discharge limits for NNN and DRP, which were the same as those proposed for the in-river Schedule 15 limits. Schedule 15 numbers are median values designed to protect the receiving water from widespread nuisance algal growth. They do not directly relate to individual discharges throughout the catchment. The Plan limits need to protect against cumulative effects, but assimilative capacity in receiving waters does occur. Therefore a 95th percentile value, taken from the SOE monitoring of rivers representing the different Groups is recommended. The intended discharges to which these limits apply are intermittent discharges, over a limited area of

the catchment. A 95th percentile keeps the limits within the values known to occur most of the time in the main watercourse, including assimilative factors. Widespread algal blooms would not be expected from the recommended nutrient levels, from intermittent local diffuse pollution.

2 Toxicant: Ammoniacal nitrogen

Ammoniacal nitrogen can, at sufficiently high concentrations, be toxic to fish and other aquatic life (in addition to contributing to eutrophication). In farmed catchments, elevated concentrations of this compound generally arise from stock effluent reaching the streams via direct discharge, paddock run-off or direct stock access to stream banks and beds. This is most likely to be exacerbated when stream flows are low (eg, in late summer), when cattle are often near waterways and when dilution rates are low. Run-off and leaching of urea fertiliser can also contribute.

A zero tolerance stance is taken on effluent entering waterways.

The toxicity of ammonia is complex. Generally total ammonia becomes more toxic at higher pH values because at higher pH there is a greater proportion of unionised ammonia in solution. The concentration at which ammoniacal nitrogen becomes toxic is also dependent on stream water temperature. ANZECC (2000) recommends adopting a trigger value of 0.9 mg/L ammonia nitrogen for pH 8 and 20°C to adequately protect 95 per cent of species.

The ANZECC guidelines do not specify a particular statistic to apply to the total ammonia guideline, but they relate to chronic toxicity (e.g. over a 96-hour period). A median or average value may be appropriate to use.

The table below shows statistics derived from SOE river monitoring data (2006 to 2011) for sites in each area.

	NH4	NH4	NH4
	Area 1	Area 2	Area 3
No samples	563	1584	151
Schedule 16	0.1mg/l	0.1mg/l	0.1mg/l
Median	0.010	0.009	0.009
75%ile	0.020	0.01	0.009
80%ile	0.030	0.01	0.009
95%ile	0.069	0.04	0.010
99%ile	0.138	0.730	0.015

- *The recommended limit for in Areas 1, 2 and 3 is set at 0.1mg/l for NH_4. This is more stringent than the default ANZECC 2000 guideline of 0.9mg/l. However based on the set of reference data for the three areas the recommeded guideline is less stringent than the 95th percentile. Therer is no change from the Notified Plan.*

3 Contact Recreation: Bacteria

Faecal contamination of waterways poses a public health risk. Illness may be contracted as a direct result of ingesting bacterial, viral and protozoal pathogens that occur in faecal material. Faecal material reaches streams in run-off from the land through effluent pond discharges (eg, Smith et al, 1993) and from cows defecating directly into the water (e.g. Davies-Colley et al, 2004).

Risk of illness is primarily associated with recreational activities where water may be ingested (including harvesting fish and other aquatic food for consumption). The indicator commonly used to assess this risk is *E. coli*, a faecal coliform bacterium that originates in the gut of warm blooded animals and indicates the presence of other potentially harmful microbes. There are several reference values and guidelines used for interpreting *E. coli* data.

For contact recreation, the MfE/MoH (2003) guidelines are based on the 95th percentile of a set of reference samples and the ANZECC (1992) guideline is based on the seasonal median.

Reference values and guidelines

Values and guidelines used	E.coli per 100ml	Description and source
Contact recreation		Microbiological Water Quality Guidelines for marine and Freshwater Recreational Areas (Ministry for the Environment and Ministry of Health, 2003)
Single sample 'Alert' Single sample 'Action'	260 550	Single sample thresholds indicating elevated health risk (Alert) and unsafe concentrations of pathogens (Action). The guidelines are based on an explicit choice of acceptable risk. The upper 95th percentile value of 260 *E. coli*/100mL relates to an average probability of one case of *Campylobacter* infection in every 100 exposures, and the upper 95th percentile value of 550 *E. coli*/100mL relates to an average probability of five cases of *Campylobacter* infection in every 100 exposures
Contact recreation	126	ANZECC 1992. This seasonal median corresponds to a swimming-associated illness risk of 8 per 100 bathers.
Stock drinking	100*	ANZECC 2000. However, ANZECC also recommends that 'investigations of likely causes (of contamination) are warranted when 20% of results exceed four times the trigger value'.

*Faecal coliforms/100ml (not *E.coli*)

To be consistent with the old ANZECC (1992) guidelines, the guideline could be applied as a median. To be consistent with MfE (2003) the guidelines could be applied as upper 95th percentile values.

The table below gives statistics derived from SOE river monitoring data (2006 to 2011) for sites in each area.

	E.coli	E.coli	E.coli
	Area 1	Area 2	Area 3
No samples	514	1289	147
Schedule 16	260	260	126
Median	178	30	1
75%ile	520	84	5
80%ile	804	102	9
95%ile	3135	514	36
99%ile	7335	1800	168

- *The recommended guideline for Areas 1 and 2 is set at 260 cfu/100ml. This is based on the MfE/MoH 2003 single sample 'alert' threshold. The set of reference data for Areas 1 and 2 indicates that the guideline is more stringent than the 95th percentile.*

- *The recommended guideline for Area 3 is set at 126 cfu/100ml. This is more stringent than the MfE/MoH 2003 single sample 'alert' threshold. The set of reference data for Area 3 indicates that the guideline is less stringent than the 95th percentile.*

The Notified Plan contained discharge limits for E. coli, which were the same as those proposed for the in-river Schedule 15 limits. Schedule 15 numbers are median contact recreation values, but do not directly relate to individual discharges throughout the catchment. The Plan limits need to protect against cumulative effects, but can allow some assimilative capacity in receiving waters as long as contact recreation values are maintained throughout the waterway. Therefore in Areas 1 and 2 the single sample alert threshold is recommended. In Area 3 the initial value of 126 cfu/100ml is recommended to be retained, which reflects the currently recorded very low values.

4 Sites in each group

Area 1	Area 2	Area 3
Catlins at Houipapa	Cardrona at Mt Barker	Dart at The Hillocks
Clutha at Balclutha	Clutha at Luggate Br.	Lake Hawea Outflow at Dam
Crookston Burn at Kelso Road	Clutha at Millers Flat	Lake Wakatipu at Outflow
Heriot Burn at Park Hill Road	Dunstan Creek at Beattie Road	Lake Wanaka at Outlet
Kaikorai Stream	Fraser at Marshall Road	Matukituki at West Wanaka
Leith at Dundas Street Bridge	Hawea at Camphill Bridge	
Lindsays Creek	Kakanui at Clifton Falls Bridge	
Pomahaka at Burkes Ford	Kakanui at McCones	
Pomahaka at Glenken	Kauru at Ewings	
Tokomairiro at West Branch Bridge	Kawarau at Chards	
Waipahi at Cairns Peak	Kye Burn at SH85 Bridge	
Waipahi at Waipahi	Lake Dunstan	
Wairuna Stream	Lake Hayes	
Waiwera at Maws Farm	Lake Johnson at Surface	
Waitahuna at Tweeds Bridge	Lake Onslow at Boat Ramp	
	Lake Tuakitoto at Outlet	
	Lake Waihola at End of jetty	
	Lindis at Ardgour Road	
	Lindis at Lindis Peak	
	Luggate Creek at SH6 Bridge	
	Manuherikia at Galloway	
	Main Drain at Waipori Pump	
	Manuherikia at Ophir	
	Mill Creek at Fish Trap	
	Owhiro Stream at Burns Street	
	Shag at Craig Road	
	Shag at Goodwood Pump	
	Shotover at Bowens Peak	
	Silverstream at Taieri Depot	
	Sutton at SH87	
	Taieri at Allanton Bridge	
	Taieri at Linnburn Runs Road	
	Taieri at Outram	
	Taieri at Stonehenge	
	Taieri at Sutton	
	Taieri at Tiroiti	
	Taieri at Waipiata	
	Trotters Creek at Mathesons	
	Waianakarua at Browns	
	Waiareka Creek at Taipo Road	
	Waikouaiti at Orbells Crossing	
	Waipori at Waipori Falls Reserve	