Options for numeric water quality objectives and standards for rivers and lakes of Canterbury

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Prepared for

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Contents

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Executive Summary

NIWA was commissioned by Environment Canterbury (ECan) and the Ministry for the Environment (MfE) to develop options for numeric water quality objectives and standards for rivers and lakes in Canterbury, and to document the process in a report. There were two distinct elements to the development process:

1) Developing a framework and a system for implementation of objectives and standards;

2) Deriving options for the numbers to be used for objectives and standards.

ECan's requirement for this work followed the public release, in October 2001, of the Discussion Draft Canterbury Natural Resources Regional Plan (NRRP), the receipt of public comments on the Draft NRRP, and subsequent work by ECan staff that resulted in the conclusion that water quality standards would be helpful for the NRRP. MfE's interest in this work was due to its functions and duties under s24 of the Resource Management Act (RMA), and in particular an interest in national and regional water quality standards.

The work reviewed the issues and highlighted problems associated with numeric water quality objectives and standards in regional plans (Section 4). This included a discussion of common issues associated with existing regional plans, a description of concepts associated with developing spatial frameworks for management, and consideration of legal aspects of the RMA and regional plans. The key problems were summarised and the components of a solution to these problems were then developed and refined by workshop sessions with participating staff from MfE, ECan and NIWA (Section 5).

The key components of the framework include:

- A spatial framework was defined by confirming six different management units (MUs) for rivers, and four MUs for lakes, similar to those used in the Draft NRRP. These MUs were then mapped using the GIS-based River Environment Classification (REC) as a basis for spatial delineation. The result is a GIS layer that can be used to display the ten MUs as an overlay on a topographic map (Section 6).

- The key 'purposes' for managing different types of rivers and lakes were developed by ECan for the Draft NRRP. These were reviewed and assigned to each of the ten different MUs (Section 7).

- The purposes for management were then used as a basis for selecting a series of options for numeric water quality objectives and standards from existing water quality guidelines (Section 8). These are presented as tables for each MU in Appendix 4.

- The use of numeric standards requires consideration of the extent to which mixing in the receiving environment is allowable to achieve the standards. Issues associated with mixing (including the term *reasonable mixing*) were reviewed, and options were then provided for defining the allowable mixing for compliance with numeric standards (Section 9).

These key elements were incorporated into a proposed model for discharge consent decision-making (Section 10). The model illustrates how the decision-making steps would work, if the proposed framework was implemented in a regional plan (Figure 5).

A draft report was prepared (containing the proposed framework, the tables of numbers, and the model for discharge consent decision-making) and presented to a workshop panel of experts in aspects of water quality science and resource management. The feedback generated from this workshop, and subsequent discussions with staff from MfE and ECan, was used to refine the proposed framework and standards. The implications and limitations of the proposed approach are discussed in Section 11.

The report concludes by recommending (in Section 12) that ECan:

1. Adopt the proposed framework, subject to a number of additional analyses and considerations, including further consideration of the two options for dealing with mixing zones, i.e., the relative benefits of using ‘maximum allowable non-compliance’ (MANC) zones versus ‘maximum allowable dilution ratios’ (MADR), and further analysis of the existing ECan water quality data in order to determine which options for numeric standards and objectives to select from the tables.

2. Recognise the limitations and risks of the framework, and take active steps to ensure these risks will be effectively managed. Specific steps are listed in Section 12 and these include undertaking a review of legal implications, providing for user education and clear presentation of concepts in the NRRP, as well as developing a web-based decision support system.

3. Recognise that this is a developmental piece of work and the framework is adaptable. Make a commitment to continued development to improve the framework. Specific improvements to the framework that could be achieved in the short term have been identified in Section 12.

1. Introduction

NIWA was commissioned by Environment Canterbury (ECan) and the Ministry for the Environment (MfE) to develop options for numeric water quality objectives and standards for rivers and lakes in Canterbury, and to document the process in a report.

ECan's requirement for this work follows the public release, in October 2001, of the Discussion Draft Canterbury Natural Resources Regional Plan (NRRP) (ECan 2001) and receipt of public comments on the Draft NRRP. ECan staff subsequently prepared a draft working paper entitled "*Objectives, Policies, Water Classes and Rules for Water Quality"* (Loe, 2002), to look at the advantages and disadvantages of including standards in the NRRP, and concluded that water quality standards would be helpful. ECan also received several review responses on the draft working paper, including a response from NIWA (August 2002). Copies of the draft working paper and the NIWA review comments are provided in Appendices 1 and 2 respectively.

MfE's interest in this work arises because of its functions and duties under s24 of the Resource Management Act (RMA), and in particular an interest in national and regional water quality standards (s43(1)a(iii) RMA).

2. Aims

The aim of this work is to define options for numeric water quality objectives and standards for the rivers and lakes described in Chapter 7 (Water Quality) of the Draft NRRP, and to address issues associated with the definition of mixing zones in the Draft NRRP. More specifically the aims of this report are to:

- discuss some of the problems of existing regional plans and intricacies of the RMA that must be addressed in order to overcome them,
- document a process for defining options for the objectives and standards,
- list the options for objectives and standards,
- provide a technical recommendation on the options.
- address issues associated with the definition of mixing zones

It is intended that ECan will use the report and options contained within, as a basis for drafting a new format and wording for the objectives and rules in Chapter 7 of the Draft NRRP.

It is intended that MfE will use the report in a wider context, as a documented example of a process for developing regional, numeric water quality objectives and standards.

It is anticipated that the numeric water quality objectives and standards will provide:

- a more transparent and defensible regional plan,
- increased certainty for resource users and environmental outcomes,
- increased guidance for processing resource consents,
- better definition of bench-marks by which to assess cumulative effects,
- more quantifiable means to measure the effectiveness of regional plans.

3. Recognising limitations

The development of options for numeric water quality objectives and standards is a complex topic, and the implementation of these into a regional plan is unlikely to satisfy all situations. The planning process is not entirely technical, value judgements are made and practical considerations are incorporated, particularly during the process of consultation and political decision-making. This report has attempted to develop options that are as technically defensible as possible. This does not preclude changes being made to these options, and development of additional plan provisions, which reflect social and political judgements. We stress, however, that this report has deliberately provided options that can be argued for on a technical basis and that options for provisions that involve value judgements or practical considerations must be made elsewhere in the planning and/or political process.

There will be advantages and disadvantages with the approach proposed in this report. The issues listed in section 4 cannot be overcome without some consequences for other parts of the management framework. Limitations arise that are due to the limits of scientific certainty that can be achieved at a strategic level of management, and also due to constraints that arise from the existing legal and planning structure. However, the aim of this work is to present an improved approach that will be a significant improvement for regional frameworks for managing water quality. In doing this we aim to ensure that the proposed approach is compatible with future improvements through plan review and revision, and that the potential risks and disadvantages, so far as we have been able to identify them, are stated so that they can be effectively managed.

4. Background: – Issues with existing regional water quality plans

This section considers some of the issues that have been identified with regional plans. Specifically two fundamental and interrelated problems are considered; (1) the lack of use of spatial framework as consistent basis for identifying and protecting (with objectives, policies and methods) the water bodies being managed and, (2) the use of 'region-wide' plan provisions that are non-specific and have poorly justified links between objective, policies and methods. In addition, there are intricacies contained within the RMA that need to be addressed to make a plan work effectively. The combination of these problems means that regional plans have considerable potential for improvement in order to better serve as strategic frameworks for water management.

4.1. General acceptance of the problems

The RMA is largely administrative law. It provides an overarching goal of promoting sustainability but devolves responsibly for interpreting what this means and how it shall be achieved to local authorities (generally regional councils in the case of water quality management). The RMA provides regional councils with powers, duties and functions to undertake water management. In particular, the RMA allows regional councils to prepare regional water plans to resolve resource management issues (s65(3) RMA). Regional water plans allow councils to set objectives and prescribe standards, thereby establishing in advance how the goal of sustainability is interpreted and providing a strategic basis for management.

Many commentators have expressed concern at the lack of consistency and justifiability of regional plans (Frieder, 1997; OECD, 1996; MfE, 1998; Erickson, et al., 2001). In a review of New Zealand's environmental performance by the Organisation of Economic Co-operation and Development (OECD, 1996), the criticism was made that objectives developed under the RMA are "too broad and not sufficiently quantified". The report commented that the ambiguity of policy provisions developed under the RMA led to a lack of accountability by management agencies, both in terms of environmental outcomes and for the licensing of resource use. It was concluded by the OECD (1996), that management was "largely proceeding on the basis of individual consents" and that in "quasi-absence of quantified objectives" it was "unlikely that the many goals of the RMA such as water quality, habitat and biodiversity management would be realised".

While many people are aware of these problems, the complexity of environmental issues, and the intricacies of the RMA and of the mechanics of regional plans present difficult challenges to finding solutions. Internationally the need for spatial frameworks as a means for consistently identifying and mapping different types of resources, requiring different management provisions, within a region is considered to be a fundamental component of resource management (e.g., Omernik 1994, McMahon *et al.* 2001). However, McLea (1999) analysed the spatial specificity of six NZ regional water plans and found only:

- 0-8% of objectives in each plan identified specific water bodies.
- 0-33% of plan policies identified specific water bodies.
- 3-65% of plan rules identified specific water bodies.

Many existing plans can be described as 'region-wide' plans, where provisions apply to the whole region without accounting for differences among different types freshwater resources. MfE developed the Management Framework approach (known as REMF) (Snelder and Guest 2000) and River Environment Classification (REC) (Snelder and Biggs 2002) as an approach to developing 'regional plans'. The management framework approach increases the resolution of a region-wide plan by consistently identifying different types of freshwater resources within a region and developing sets of justifiable regional plan provisions for each type. There remains, however, planning and legal issues for regional authorities in developing water quality objectives and standards in their plans. The ECan draft working paper (Loe, 2002) provides a summary of these problems, specifically as they apply to setting water quality standards in Canterbury's regional plans (refer Appendix 1).

4.2. Increasing resolution with spatial frameworks

The Management Framework approach aims to increase the specificity of region-wide plans by first classifying the water bodies of a region into (say) 10 'management units' (MUs). The approach proposes that an environmental classification (e.g., REC) can provide a consistent basis for defining MUs such that (1) water bodies within an MU have similar characteristics, and (2) the characteristics vary significantly between MUs.

Plans are concerned with the sustainable management of resources, including the identification of environmental 'values'[1], and the definition of limits to resource use such that these values are not adversely affected. The Management Framework approach is based on the idea that freshwater ecosystems vary spatially but the broad types of freshwater resources can be identified and mapped and used as a basis for defining management units in a regional plan. Plan provisions would then vary among management units. For example, objectives and water quality standards may vary

[1] The specific meaning of several terms used in this document are provided in the Glossary.

depending on the type of fish species present in an environment or whether a resource is important as a contact recreation area. In addition, standards may need to be higher where environmental conditions mean there is less assimilative capacity for a contaminant. A key idea then becomes the level of detail, or resolution, that is used to discriminate among different types of water body.

It is perhaps useful to think of resolution as adjusting a zoom lens from a satellite, or changing to a map of different scale. In both cases resolution is changed in order to increase or decrease the detail of the characteristics being considered. If an individual consent were being considered, the lens would be zoomed to the 'site scale'. However, if a plan of a region's water resources were being developed it would be better to 'zoom out' so that the broad differences in rivers and lakes could be resolved without the confusion of detail. This idea is illustrated in Figure 1.

The broad goals of the RMA[2,3] are nationally applicable and therefore have a low level 'national' resolution (see Figure 1). These goals apply to all waterbodies, discharges, and permitted activities (respectively) in the country and must, therefore, be flexible enough to deal with the variation in characteristics that exist among all the water bodies in NZ. This low level of resolution is achieved by including words and phrases within the RMA that have definitions that are open to interpretation, such as 'after reasonable mixing', 'significant', 'objectionable', 'unsuitable' and 'conspicuous'. At the national scale these broad terms are necessary because they are flexible and thus provide local authorities with some discretion for making decisions on resource use.

At the high end of the resolution scale, individual resource consents are 'site-specific' and are concerned with the characteristics of a specific reach in a particular river, or a specific area in a particular lake. At this level of resolution the characteristics of the water body in question can be determined with greater detail (see Figure 1). The exact interpretation of words and phrases such as 'beyond reasonable mixing', 'significant', 'objectionable', 'unsuitable' and 'conspicuous' can be defined during the consent process on a case-by-case basis and included as a condition on the consent.

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[2] For example, s107 RMA states that, a consent authority shall not grant a discharge permit if, after reasonable mixing, the contaminant or water discharged, is likely to give rise to all or any of the following effects in the receiving waters:
(a) The production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials:
(b) Any conspicuous change in the colour or visual clarity:
(c) Any emission of objectionable odour:
(d) The rendering of fresh water unsuitable for consumption by farm animals:
(e) Any significant adverse effects on aquatic life.

[3] s70 RMA sets out minimum standards for permitted activities in a regional plan that are the same as those for s107 RMA.

The RMA provides a basis for developing policy frameworks that provide intermediate levels of resolution (see Figure 1) that is somewhere between the two extremes (national and case-by-case consents). Regional Policy Statements and region wide plans can further refine and articulate the issues and goals for managing the resources of a region. A regional or catchment plan may develop more specific provisions for strategically managing different types of resources within the region. For example, the Management Framework approach proposes that a 'regional plan' may increase the resolution by differentiating ten management units, each of which has its own set of characteristics as is the case for the Draft NRRP. Management units may be also be defined within catchment specific regional plans (e.g., Proposed Waimakariri River Regional Plan (PWRRP).

The Management Framework approach proposes that a regional plan that is based on a number of MUs effectively bridges the gap between the high level broad goals of RMA, the region wide objectives of Regional Policy Statements and region-wide plans and the detailed case-by-case treatment of consents (see Figure 1). The establishment of an appropriate spatial framework to identify and map management units is, therefore, proposed as a key component for implementing water quality objectives and standards into regional plans.

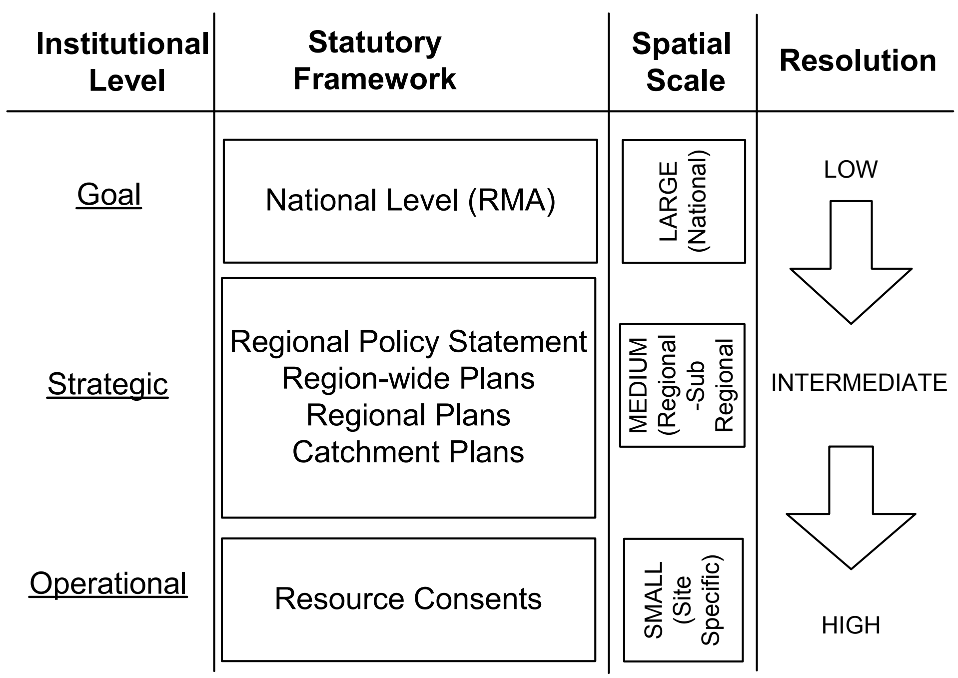

Figure 1: Management Framework Concept Diagram

4.3. Generality and lack of linkage in plan provisions

Generally existing region-wide plans tend to contain provisions that are broad and not quantified. One reason for this is that these provisions are attempting to apply to the large variation in the characteristics of water bodies that occurs within a region. Plan objectives that are sufficiently flexible to be applicable to all water bodies will typically provide little increase in resolution than the broad goals for sustainability set out in the RMA. General objectives are also relatively straightforward to write, and are less likely to be debated. In addition, general objectives allow greater discretion to be applied during the resource consent process.

Broad objectives lead to the use of narrative standards. Narrative standards mean that plans effectively retain the discretion of the consent authority for decision processes that consider consents for resource uses. The result is unclear objectives and standards that fail to provide a transparent and justifiable process for issuing resource consents and which cannot be used to unequivocally measure either attainment of an objective, or compliance with a standard. While rules are more specific, there is often inadequate justification for the limits set and no explanation that links the rules back to the management objectives. In addition, there is uncertainty regarding the environmental outcomes sought and the total use of the resource that will be allowed.

4.4. Intricacies of the RMA when implementing water quality standards

There are several sections of the RMA that place restrictions on the manner in which water quality standards may be incorporated into regional plans. These, and other relevant sections are noted below.

section 43: Regulations prescribing national environmental standards

(1) Subject to section 44, the Governor General may from time to time, by Order in Council, make regulations, to be called national environmental standards, for either or both of the following purposes:

a) Prescribing technical standards relating to the use, development, and protection of natural and physical resources, including standards relating to
(i)…
(iii) …water quality, level, or flow…

b) Prescribing the methods of implementing such standards…

At present there are no national environmental standards for water quality.

section 69: Rules relating to water quality

(1) Where a regional council-

a) Provides in a plan that certain waters are to be managed for any purpose described in respect of any of the classes specified in the Third Schedule; and

b) Includes rules in the plan about the quality of water in those waters,-

The rules shall require the observance of the standards specified in that Schedule in respect of the appropriate class or classes unless, in the council's opinion, those standards are not adequate or appropriate in respect of those waters in which case the rules may state standards that are more stringent or specific.

(2) Where a regional council provides in a plan that certain waters are to be managed for any purpose for which the classes specified in the Third Schedule are not adequate or appropriate, the Council may state in the plan new classes and standards about the quality of water in those waters.

(3) Subject to the need to allow for reasonable mixing of a discharged contaminant or water, a regional council shall not set standards in a plan which result, or may result, in a reduction of the quality of the water in any waters at the time of the public notification of the proposed plan unless it is consistent with the purpose of this Act to do so.

The Third Schedule contains 11 classes and specifies a set of water quality standards for each class. The standards are a mix of quantitative variables and narrative statements that are to apply after reasonable mixing (as stated in the heading of that Schedule) of any contaminant or water with the receiving water, and natural perturbations that may affect the water body are to be disregarded. The standards are mostly narrative but a few are numeric (e.g., dissolved oxygen). The term 'reasonable mixing' is not defined and nor is any guidance given for interpretation. However MfE have provided guidance for practitioners in Resource Management Ideas No. 10 – A Discussion on Reasonable Mixing in Water Quality Management (Rutherford et al., 1994).

Note that s69(3) provides explicit directions about setting standards in a regional plan.

section 128: Circumstances when consent conditions can be reviewed

(1) A consent authority may, in accordance with section 129, serve notice on a consent holder of its intention to review the conditions of a resource consent -

a) At any time [or times] specified for that purpose in the consent…

b) In the case of a water, coastal, or discharge permit, when a regional plan has been made operative which sets rules relating to maximum or minimum levels or flows or rates of use of water, or minimum standards of water quality or air quality, or ranges of temperature or pressure of geothermal water, and in the *regional council's opinion it is appropriate to review the conditions of the permit in order to enable the levels, flows, rates, or standards set by the rule to be met…*

Note that parts of the quoted section have been underlined to emphasise the point that s128(b) RMA essentially dictates that water quality standards must be written as a regional rule, if the regional council wishes to retain the ability to review consents granted before the plan becomes operative. A review under s128(b) RMA can review and adjust consent conditions, but cannot render the consent inoperative.

section 35: Duty to gather information, monitor, and keep records

(1) Every local authority shall gather such information, and undertake or commission such research, as is necessary to carry out effectively its functions under this Act.

(2) Every local authority shall monitor-

a) The state of the whole or any part of the environment of its region or district to the extent that is appropriate to enable the local authority to effectively carry out its functions under this Act; and

b) The suitability and effectiveness of any policy statement or plan for its region or district; and

c) The exercise of any functions, powers, or duties delegated or transferred by it; and

d) The exercise of the resource consents that have effect in its region or district, as the case may be, -

And take appropriate action (having regard to the methods available to it under this Act) where this is shown to be necessary…

The parts underlined emphasise the point that, while a local authority can perform such monitoring, it cannot measure with any certainty, how effective a plan is at addressing environmental issues and achieving outcomes, unless its plan provisions (e.g., objectives and standards) are specific and certain, and therefore measurable. Other problems associated with non-specific objectives and standards have been discussed previously (Section 4.3).

4.5. Intricacies of the mechanics of regional plans

There are several other sections of the RMA that determine the structure of regional plans. All of these features of regional plan mechanics have implications for the way in which numeric objectives and water quality standards can be implemented.

Section 67 RMA lists the requirements for regional plans, which includes, amongst other things; issues, objectives, policies and methods that may include rules. A regional plan may include rules[4] that provide for the following 'activity categories'; permitted activities, controlled activities, discretionary activities, non-complying activities, prohibited activities and restricted coastal activities. Section 105 RMA sets up a 'tiered' approach to the treatment of these activity categories and reserves differing levels of discretion for each activity category. The tiered approach reflects the potential level (or risk) of adverse effects. The discretion reserved by Section 105 RMA for each activity category is as follows:

section 105: Decisions on applications

(1) Subject to subsections (2) and (3), after considering an application for -

- *a) A resource consent for a controlled activity, a consent authority shall grant the consent, but may impose conditions… in respect of those matters over which it has reserved control.*
- *b) A resource consent for a discretionary activity, a consent authority may grant or refuse the consent, and (if granted) may impose conditions under section 108:*
  Provided that, where the consent authority has restricted the exercise of its discretion, consent may only be refused or conditions may only be imposed in respect of those matters specified in the plan or proposed plan to which the consent authority has restricted the exercise of its discretion.
- *c) A resource consent (other than for a controlled activity or a discretionary activity or a restricted coastal activity), a consent authority may grant or refuse the consent, and (if granted) may impose conditions…*

(2) A consent authority shall not grant a resource consent-

- *a) Contrary to the provisions of section 106 or section 107 or…*
- *c) For a prohibited activity; or…*

(2A) Notwithstanding any decision made under section 94(2)(a), a consent authority must not grant a resource consent for a non-complying activity unless it is satisfied that-

- *a) The adverse effects on the environment (other than any effect to which section 104(6) applies) will be minor; or*
- *b) The application is for an activity which will not be contrary to the objectives and policies of,*
  - *(i) Where there is only a relevant plan, the relevant plan; or*

[4] according to s68 RMA

(ii) Where there is only a relevant proposed plan, the relevant proposed plan; or

(iii) Where there is a relevant plan and a relevant proposed plan, either the relevant plan or the relevant proposed plan...

'Permitted activities' are not included in s105 RMA because they are explicitly authorised by a regional plan without the need for a resource user to apply for consent. Permitted activities are at the top of the 'tiered list', with no discretion reserved by the consent authority. It is therefore very important that 'permitted activities' are defined with absolute certainty, and that the consent authority is satisfied that those activities will not cause any of the effects listed in s70 RMA, the same as those standards in s107 RMA listed previously (section 4.2). The remaining activity categories in the list require progressively more scrutiny of potential adverse effects. Such a 'tiered' approach lends itself well to the concept of spatial frameworks discussed previously (section 4.2).

A further complication arises when a water quality standard is placed within a rule, such that it behaves as a 'category-determining' criterion - that is, it determines which activity category a discharge falls into. For example, a rule might set a water quality standard for a 'permitted activity'. If the standard cannot be met, then the activity is not permitted by the Plan and a resource consent must be sought. Similarly, a rule might set a water quality standard for a 'discretionary activity'. If this standard cannot be met, then the activity becomes a 'non-complying activity'.

A legal opinion obtained by ECan (Simpson and Grierson, cited in Loe 2002) contends that standards, if used as category-determining criteria, must be unambiguous and certain. A potential resource user must be able to read the plan and determine (albeit possibly in association with advice and technical information from consultants, local or regional authorities, or other information providors) whether their activity is 'permitted', 'discretionary', 'non-complying' or 'prohibited' before they lodge an application. The opinion contends that the existing use of some narrative standards in this way in several regional plans around NZ could be legally challenged. The opinion contends that it is unreasonable for a consent authority to withhold discretion on category-determining criteria, that is, withhold discretion for assigning resource use applications to an activity category. In particular, this opinion applies to all standards that include the term 'reasonable mixing'. The definition of 'reasonable mixing' cannot be known (no matter how much technical information or advice is obtained) until a resource consent process has been followed and a decision is made on the definition of 'reasonable'. Thus, any standard that includes the term 'reasonable mixing' withholds the discretion for assigning applications to an activity category. Of course once the category is assigned, the authority does, by definition, retain the discretion to either grant or refuse consent for a 'discretionary' or 'non-complying' activity (refer s105 RMA).

4.6. Summary of problems with current regional water quality plans

In summary the key problem areas discussed for current regional plans dealing with water quality are:

- The lack of resolution of the characteristics of concern to management.
- A lack of clear linkage between objectives, policy and methods
- General objectives and standards
- Complications within the legal framework defined by the RMA
- Complications with applying mechanics of regional plans, as defined by the RMA
- Use of the term 'reasonable mixing' in regional plans.

5. Developing a solution

This section considers the problems highlighted in the previous section and proposes a framework for establishing numeric water quality objectives and standards. This framework builds on the River Environment Management Framework (REMF) that was previously proposed by Snelder and Guest (2000). There are four key components to this framework that can be summarised as the answers to the four questions: Where? Why? What? How?

5.1. The key components of the planning framework for a solution

1. <u>A Spatial Framework (Where does it apply? i.e., which area applies?):</u> It is necessary to clearly define a spatial framework, where rivers and lakes are grouped into 'management units' (MUs). This is based on the premise that objectives and standards must be specific to the characteristics of a water body (rivers and lakes) in order that they can be applied. Furthermore, it is assumed that environmental classifications such as REC can be used to group rivers and lakes into MUs, which will share similar characteristics. The premise is that there will be some level of spatial resolution where the characteristics will be sufficiently discriminated to suit the strategic purpose of a regional plan.

2. Purposes for Management (Why?): It must be established why objectives and standards are being developed, by stating the specific values of waterbodies that management seeks to sustain. It is important that one or more 'purposes for management' are defined for each MU. This purpose will drive the technical derivation of objectives and methods (the methods will include rules and water quality standards) to achieve that purpose. Purposes for management are established from prior consultation with the community that has determined the environmental and resource use values of the region's water bodies, and can also come from other means such as the Regional Policy Statement. The 'purpose for management' concept recognises the basic tension between resource use and environmental sustainability that is defined by the purpose of the RMA (s5 RMA). From amongst a range of values that the community may hold for a water body, the most fundamental resource management decision is which values will be explicitly managed for and sustained. ECan has established the purposes for management for rivers in Canterbury by public consultation as part of the plan formulation process.

3. Numeric Objectives (What is the outcome?): Ideally objectives should be specific, quantifiable statements that describe what environmental outcome is required to support the defined 'purpose for management' for each MU. The difficulty is that quantitative outcomes are hard to define, because it is not possible to foresee all outcomes, and scientific knowledge is uncertain. This is the reason that narrative outcomes are often used. Numeric objectives should be used where possible, and where it is necessary to use narrative objectives, these should be as specific and precise as possible.

4. Policies (How will the Objectives be achieved?): The policies must define how the objective is to be achieved. For example, policies could state that land uses or point discharges should not give rise to water quality that is inconsistent with the objectives. In this report, we are specifically concerned with policy requiring that point discharges do not give rise to water quality that is inconsistent with the objectives.

5. Methods (How will the Policies be implemented?): The methods must define how the policy will be implemented to achieve the numeric objective. Regional plans typically use a wide range of methods for achieving water quality objectives. These range from rules governing land development in catchments, to community education initiatives, to water quality rules and standards for discharges. A mix of regulatory and non–regulatory methods that complement each other is more effective at achieving resource management outcomes than reliance on one or two methods to implement a policy.

In this report, we are specifically concerned with one type of method - setting numeric water quality standards for point discharges, and defining the mixing zones that will be allowed within the water body (outside of which the standards must be met).

These components are discussed in detail in Section 6 (A Spatial Framework), Section 7 (Purposes for Management), and Section 8 (Development of Objectives and Rule Standards). However first we will consider the application of this framework to the structure of the ECan NRRP.

5.2. Integration with the mechanics of a regional plan

For this work, we have been provided with guidance on ECan's choices for the spatial framework (component No. 1) and purposes for management (component No. 2). The aims of this work are to establish options for components 3 (numeric objectives) and 4 (numeric rule standards), and to debate the pros and cons of the options.

To be practically useful the options for these components must be provided in a manner that is consistent with, and must integrate with, the mechanics of the existing RMA and planning framework. Specifically it is necessary to overcome the problems identified in Section 4.5 and in Loe (2002) (refer Appendix 1).

SOLUTION TO PROBLEMS WITH RMA AND REGIONAL PLAN MECHANICS

We have followed a path of logic for developing a solution for the problems identified in Section 4.5 and in Loe (2002) as follows:

1. ***Problem***: If numeric statements are to be used to guide water management, where should they sit in the plan:

   - If existing consents are to be reviewed – then numeric statements must be in the Rules.

   - If plans are to provide a benchmark for measuring the cumulative adverse effects of point sources or non-point sources, and for monitoring plan effectiveness – then these must be in the objectives

   Solution:

   Place numeric statements in both rules and objectives, in a clearly linked fashion so that the objectives state 'what' and the rules state 'how'.

2. ***Problem***: There are legal considerations if standards are placed in rules. If standards must be in the rules (as proposed above) there are two options, as follows:

   - Use 'category-determining' rules (rules that determine activity category e.g., 'permitted', 'discretionary', 'non-complying' etc.). A legal opinion (see Section 4.5) suggests that these must be certain and unambiguous (e.g., the term 'reasonable mixing' cannot be used in such rules).

   - Use 'stand-alone' rules (rules that do not act to determine 'activity category'). A legal opinion (see Section 4.5) suggests that these can contain narrative standards that have some ambiguity. The term 'reasonable mixing' could also be used to retain some discretion.

   Solution: Use both approaches. Provide as many as possible numeric standards for 'category-determining' rules. Use narrative standards in 'stand-alone' rules to act as catch-all provisions that retain discretion for the consent authority. This is linked to problems 3 and 4 below.

3. ***Problem***: There is a technical problem associated with our ability to set appropriate standards at a strategic level (i.e., in a regional plan) without the site-specific detail that is generally required. From a technical perspective, numeric standards should not be absolute immovable 'bottom lines', because this limits the authority's discretion to consider the detail of the characteristics of concern once a site is identified. There will be situations where the rule standards are too conservative and a resource-use that breaches the rule standard could be allowable without compromising the plan objective. Therefore, standards should not be immovable 'bottom lines', and their application should allow some flexibility. However, there cannot be flexibility associated with standards in 'category-determining' rules, as discussed.

   Solution: We propose that the required flexibility should be provided by the mechanics of the plan, not by the standards. We propose the following system to provide this flexibility:

   - Provide 'category-determining' rules that contain specific numeric standards for each MU, and a defined 'maximum allowable non-compliance zone' (MANC zone) (Note: this term and an alternative term [the 'maximum allowable dilution ratio' (MADR) are described in more detail later in Section 9]. If a discharge can meet the standards within some MANC zone defined for permitted activities – then it is a 'permitted activity'. If the discharge can meet the standards within some different (and greater) MANC zone defined for discretionary activities – then it is a 'discretionary activity'. If the discharge would not meet the standards within the MANC zone defined for discretionary activities – then it is a 'non-complying activity'.

- The 'non-complying' discharge may still be granted a consent, provided the discharge is not contrary to the objectives or policy of the plan. Therefore, standards in the rule do not act as an immovable bottom line. A potential resource-user that cannot meet the standards with the defined MANC zone may still justify their case on the basis of meeting the plan objectives and policies or by demonstrating that the adverse effects are not more than minor. Thus the objectives (which can include both numeric and narrative statements) act as the higher measure of environmental protection, and these are critical to the decision for 'non-complying activities'.

4. ***Problem:*** It is possible to provide numeric standards for a list of the common contaminants of concern. However there will be in some cases, some contaminants and combinations of contaminants that cannot be foreseen in advance and which will therefore not be covered by the numeric standards we can provide. There are also a large number of contaminants for which the risk is unknown.

   Solution: In addition to providing the best possible list of numeric standards, also provide 'catch-all' necessarily narrative standards. These cannot appear in category-setting rules, but they could appear in a 'stand-alone' rule that applies to all activity categories, as suggested in the legal opinion obtained by ECan (see Section 4.5).

This model is summarised in the schematic diagram (Figure 5) in the Discussion (Section 11) of this report. It can be compared to the diagram in Loe (2002), which illustrates the various models currently used in other Canterbury regional plans (refer Appendix 1).

While this model has not been subjected to legal opinion, the planning mechanics have been discussed with ECan planners to ensure a common understanding. The remaining sections will build on the justification for this model. Legal aspects will need further investigation and we have not undertaken this as part of the current report. We have recommended a review of legal implications in the Conclusions (Section 12).

6. A spatial framework

6.1. Resolution

In Section 4.2 it was noted that the scale of spatial frameworks can vary and contain greater or less detail. A regional council must decide what resolution it will use to define management units (MUs) in a plan. For example, the Proposed Waimakariri River Regional Plan (PWRRP), a catchment plan, defines six MUs (which the PWRRP calls 'classes' of waterways) and illustrates the spatial boundaries of these on a map. The PWRRP then applies purposes, objectives, policies, methods and rules (including water quality standards) to each of these MUs.

There are pros and cons associated with increasing or decreasing the resolution (scale) of the spatial framework for the Draft NRRP. These are summarised in Figure 2 below.

DECREASED RESOLUTION	INCREASED RESOLUTION
• Fewer MUs	• More MUs
• More heterogeneity within MUs	• More homogeneity within MUs
• Less specific objectives & standards	• More specific objectives & standards
• Necessitates conservative standards	• Enables less conservative standards
• Less enabling of resource use	• More enabling of resource use
• More non-complying activities	• Fewer non-complying activities
• Less guidance for Plan-users	• More guidance for Plan-users
• Less complex Plan	• More complex Plan

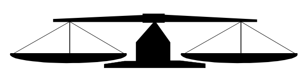

Figure 2. Balancing the pros and cons of resolution of the spatial framework

It is clear that there are no rules for establishing the 'correct' number of MUs. The appropriate resolution is a pragmatic decision that is made by considering the trade-off between the complexity of a plan and the level of specificity, certainty and justifiability.

6.2. Current NRRP Management Units

ECan has indicated a clear preference for a set of MUs for the NRRP. This preference is based on:

- Maintaining similarity with the spatial framework of the existing Draft NRRP because water-body 'values'[5] and 'purposes for management'[4] have been established during community consultation on the basis of the Draft NRRP's existing six 'river types' and four 'lake types' management units (MUs). These are described in tables in the Draft NRRP. A copy of tables is provided in Appendix 3.
- Minimising complexity and therefore enhancing readability of the NRRP for most people.

The Draft NRRP provides examples of some named rivers and lakes that fall into each of the 10 MUs (refer Appendix 3). However, in the Draft NRRP the MUs are not mapped, and there are no comprehensive lists of all the water-bodies that comprise each MU. There is therefore a lack of certainty associated with the existing spatial framework in the Draft NRRP. Several submitters on the Draft NRRP have indicated a desire for certainty with the definition of the MUs, preferably using maps or lists, or both. Therefore, a key initial task in this work was to develop a method for delineating the existing ECan spatial framework.

6.3. Mapping the NRRP Management Units

The NRRP MUs have been mapped to create a spatial framework that provides a high level of certainty for the plan provisions. The mapping is discussed briefly below.

6.3.1. River Management Units

The NRRP has identified six river MUs that are based on climatic, topographic and geological factors within the catchment of the river. The names of each MU reflect these factors; Mountain Sourced Rivers; Hill Sourced Rivers, Lowland Sourced Rivers, Volcanic Sourced Rivers, Intermontane Basin Sourced Rivers. These MUs have been mapped using the REC as a basis for delineation. Some features of the REC have been omitted and others added to produce a map that complies with ECan's MUs, however, both the REC and the map of Ecans MUs are fully compatible allowing any location to be associated with both systems of classification.

[5] The specific meaning of several terms used in this document are provided in the Glossary.

The Climate level of REC has been ignored. The assumption is that macro scale climate is homogenous within Canterbury and that regional climate variation is determined by, or correlated to, the four main topographic factors used to define MUs; Mountains, Hills and Low Elevation and Intermontane Basins. This is a reasonable assumption for a regional scale classification. Differences in geology among catchments are ignored for the four main topographically defined MU's. This assumption is very reasonable for Mountains and Intermontane Basins, which are generally dominated by greywacke. Low Elevation and Hill MUs in Canterbury comprise reasonably heterogeneous geology, namely; hard sedimentary, soft sedimentary and volcanic rock types. Differences in geology can have marked effects on river characteristics, values (e.g., fish communities) and ambient water quality (e.g., nutrient concentrations). Thus, using Low Elevation and Hill as MUs will require designing standards that are protective of the most sensitive member of the MU. The Volcanic MU covers catchments that are dominated by volcanic geology, essentially the streams of Banks Peninsular and the Mount Horrible area near Timaru, although small areas of volcanic dominated streams are scattered throughout the region. The volcanic geology results in quite distinctive characteristics, for example phosphorus concentrations tend to be high in volcanic rivers and fish communities tend to be different to those in rivers with different geology. Thus the MU is logically treated as a specific type. It is assumed that the differences among streams in the volcanic MU (for example Banks Peninsular comprises Wet and Dry climate classes and Hill and Low Elevation topographic classes) are small compared to differences among the MUs.

The REC Source of Flow categories; Mountain, Hill Low Elevation were used to assign sections of the REC river network to Mountains, Hills and Low Elevation MUs respectively. All sections of the REC river network that have a volcanic Geology category were then reassigned to the Volcanic MU. The Intermontane Basin MU was assigned to all river sections with an altitude of greater than 400 meters and an area weighted average catchment slope less that 4%.

River MUs for Canterbury are illustrated in Figure 3.

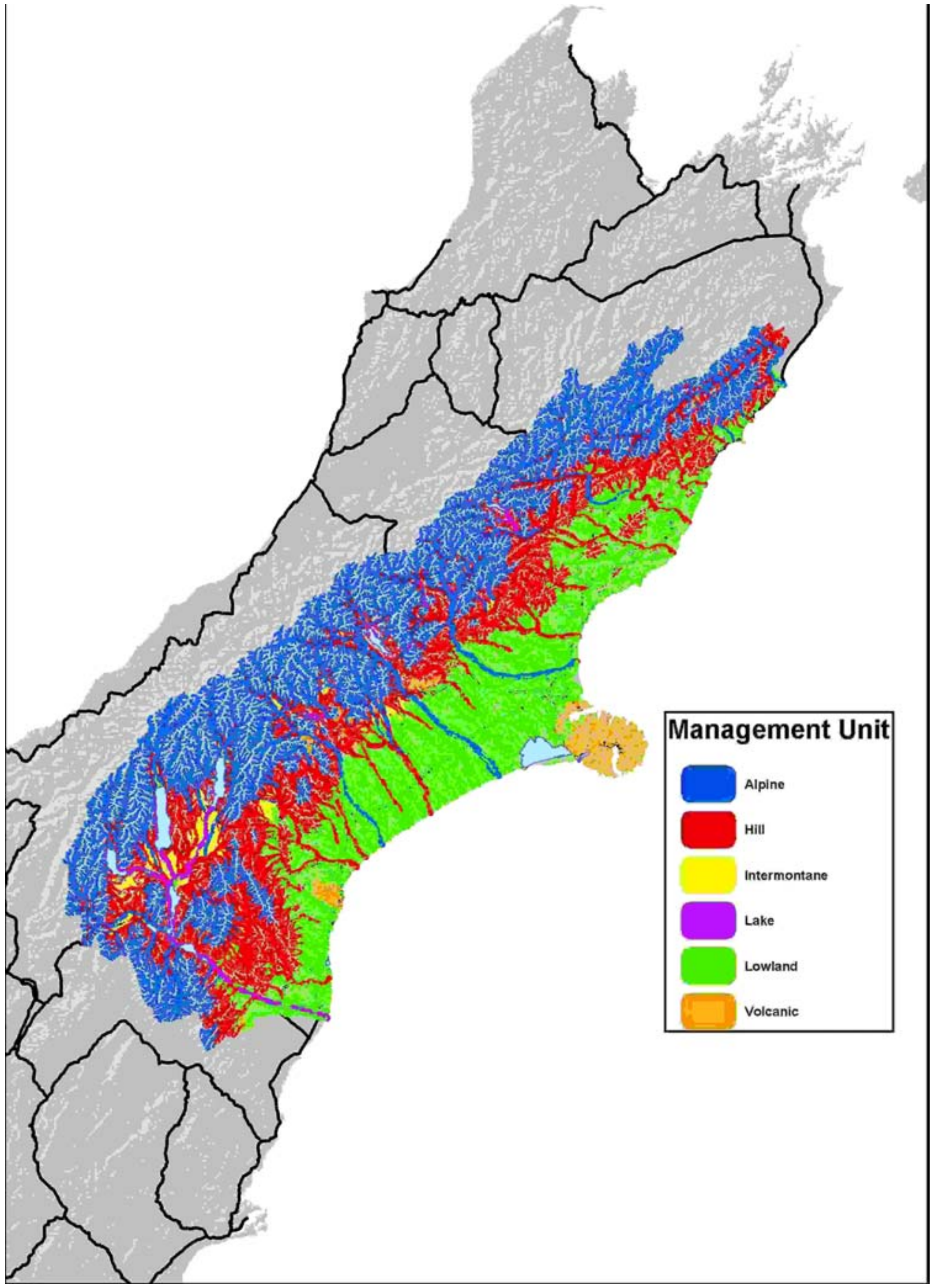

Figure 3: ECan river management units (MUs) for Canterbury

6.3.2. Lake Management Units

The lake MUs have used a combination of GIS data delineating lakes and the REC. From the Topomap lakes layer we first divided the lakes into three size classes; large (those with surface area greater than 8 km^2), small (those with area less than 8 km^2 and greater than 1 hectare) and very small (those with surface area less than 1 hectare). Next we defined the average catchment elevation of all lakes and subdivided this into High Country (greater than 400 meters) and Low Elevations (less than 400 m). This process used data from the REC, however, many lakes were too small to be explicitly accounted for by the REC. In this case we simply found the elevation of the lake centroid. We then found the shortest distance from the centroid of each lake to the coastline and the elevation of the centroid of all lakes. Each lake was then assigned to one of four MUs based on the rules shown in Table 1. Lake MUs for Canterbury are illustrated in Figure 4.

Table 1: Assignment criteria for Canterbury Lake Management Units (MUs)

Lake Management Unit	Assignment Criteria
Large High Country	Catchment elevation > 400, or centroid elevation > 400 m, surface area > 8 km^2
Small High County	Catchment elevation > 400, or centroid elevation > 400 m, surface area < 8 km^2
Low Elevation	Catchment elevation < 400, or centroid elevation < 400 m, 1 ha < surface area < 8 km^2
Coastal	Centroid elevation < 20 m, 1 ha < surface area

6.4. Other options for a spatial framework

At this point in time we consider that use of the REC tool to delineate management units on the basis of physical attributes is the most defensible method available for several reasons:

- It has been developed as a spatial framework for policy development and operates as a Geographic Information System (GIS) allowing maps to be easily displayed.

- It is flexible and can be used to delineate the existing NRRP MUs by custom adjustments to the standard REC system

- It can also be used to assist with analysis of regional data, assessments of the state of environment, and tests of the effectiveness of planning provisions. These uses will be enhanced if the NRRP's spatial framework is compatible with REC delineation.

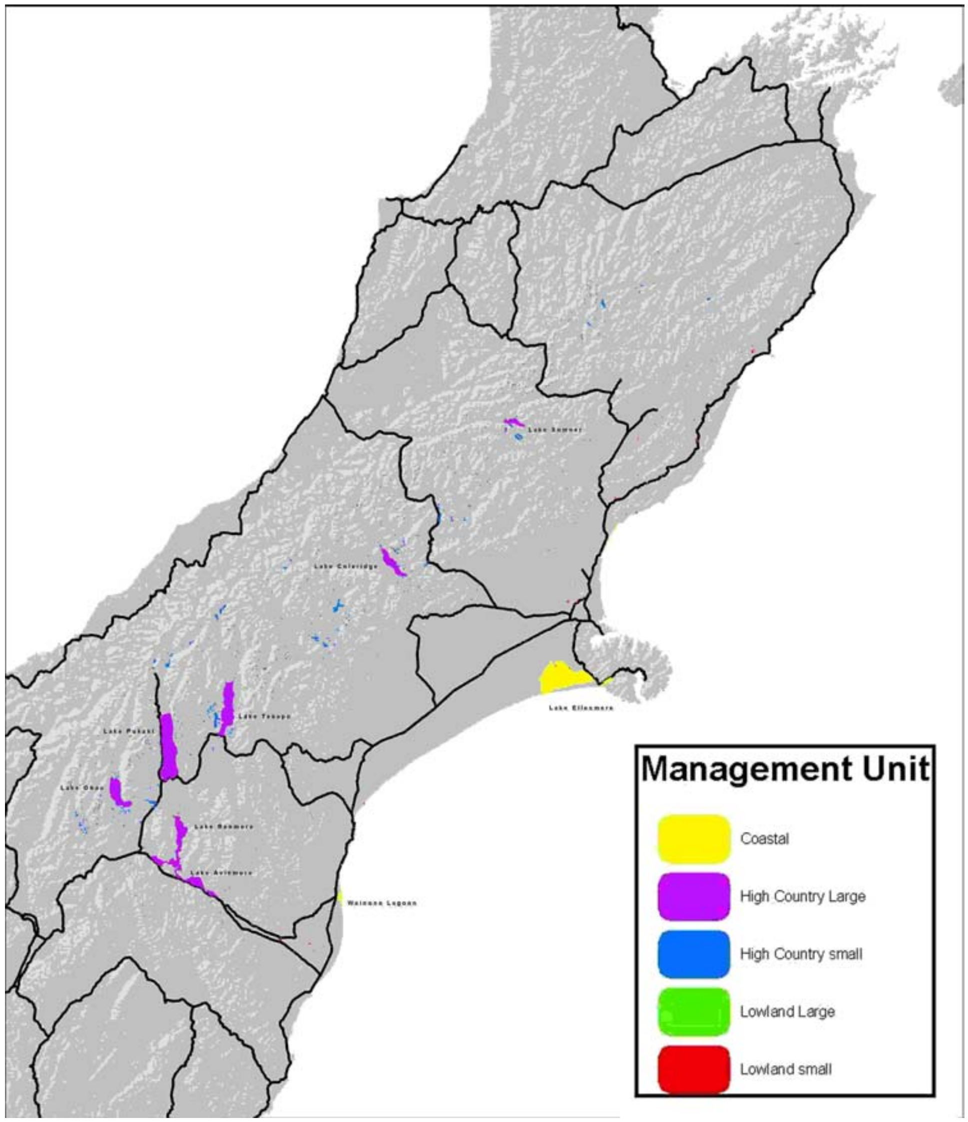

Figure 4: ECan lake management units (MUs) for Canterbury

7. Purposes for management

The 'purpose for management' is an explicit decision that determines which of the identified values of a water-body or a group of water-bodies (e.g., an MU) will be supported. This recognises that not all potential values may be explicitly managed for. It is important that the purpose for management is defined as specifically as possible because this will drive the derivation of objectives, policy and methods in the plan. For example, the purpose for management may be defined in terms of a biological community, or may be specific species (e.g., trout or salmon). Other environmental values may also be included as purposes for management (e.g., recreational or natural character values) and these should also be defined as specifically as possible, for instance as a specific recreational activity or attributes of natural character, such as river braiding.

Determining the purpose for management involves value judgements regarding the significance of the potential values that have been identified for an MU. The significance of values must be determined because values may occur in MUs but may not be significant enough to warrant that MU being managed for that value. For example, small numbers of salmon and trout may occur in rivers with volcanic geology in Canterbury (e.g., in the Volcanic MU). However, these catchment rock types do not provide the substrate that is the preferred habitat or spawning gravel for salmon and trout. Therefore the Volcanic MU could be judged as not significant habitat for these species.

Defining purposes for management has potential for considerable controversy. The reasons for the selection of specific purposes for management should therefore be clearly set out in the plan, and should be subjected to wide consultation. The final choice of the purposes for management is a political decision.

ECan did not use the term 'purpose for management' in the existing Draft NRRP but essentially defined the purpose for management for each MU by stating 'management outcomes' in Section 7.5 of the Draft NRRP. During the preparation of this report ECan has further refined the 'purpose for management' for each management unit and has provided these for inclusion in Table 2 below.

Table 2: Environment Canterbury Purposes for Management defined for each Canterbury Management Unit (MU)

Management Unit	Purposes for Management
RIVERS	
Mountain	Retain 'natural state'*, amenity and contact recreation, mauri and mahinga kai, biodiversity (native fish, birds and salmonids), irrigation, stockwater, human drinking water (low-moderate health risk).
Hill	Retain 'natural state'*, amenity and contact recreation, mauri and mahinga kai, biodiversity (native fish, birds and salmonids), irrigation, stockwater, human drinking water (low-moderate health risk).
Lake-fed	Retain 'natural state'*, amenity and contact recreation, mauri and mahinga kai, biodiversity (native fish, birds and salmonids), irrigation, stockwater, human drinking water (low-moderate health risk).
Intermontane - excl. Amuri Basin	Retain 'natural state'*, amenity and contact recreation, mauri and mahinga kai, biodiversity (native fish, birds and salmonids), irrigation, stockwater, human drinking water (low-moderate health risk).
-Amuri Basin only	Mauri and mahinga kai, biodiversity (native fish, birds and salmonids), irrigation, stockwater.
Lowland	Amenity and contact recreation, mauri and mahinga kai, biodiversity (native fish, birds and salmonids), irrigation, stockwater.
Volcanic	Mauri and mahinga kai, biodiversity (native fish, birds and salmonids), irrigation, stockwater, human drinking water (low-moderate health risk).
LAKES	
Large High Country – unregulated	Retain 'natural state'*, high natural character and scenic value, amenity and contact recreation, mauri and mahinga kai, biodiversity (native fish, birds and salmonids), irrigation, stockwater.
- regulated	High natural character and scenic value, amenity and contact recreation, mauri and mahinga kai, biodiversity (native fish, birds and salmonids), irrigation, stockwater.
Small High Country	High natural character and scenic value, amenity and contact recreation, mauri and mahinga kai, biodiversity (native fish, birds and salmonids), irrigation, stockwater.
Low Elevation	Amenity and contact recreation, mauri and mahinga kai, biodiversity (native fish, birds and salmonids), stockwater.
Coastal	Amenity and contact recreation, mauri and mahinga kai, biodiversity (native fish, birds and salmonids), stockwater.

*Applies only to water-bodies within the MU where water quality is currently considered by ECan to be "relatively unmodified by human activities" (ECan interpretation for "natural state"').
Source: Purposes for management in table provided by ECan.

7.1. Difficulties with 'natural state' as a purpose for management

Environment Canterbury has indicated 'natural state' as a purpose for management of some freshwater water bodies in the NRRP (see Table 2). We have not been able to provide a set of water quality standards that are consistent with natural state as a purpose for management. The reasons for this are explained below.

The management framework approach establishes a 'purpose for management' in order to establish a linkage between plan provisions (objective, policy, method) and to justify the choice of standard. All standards are ultimately established by accepting existing guideline values for the protection of quite specific aspects of the ecosystem, which are applied in specific MUs. For example, guideline values for certain water quality variables have been derived to protect specific species (e.g., salmonids) or human uses for which a desired environmental state has been established (e.g., algal cover for contact recreation). A purpose for management is a fundamental resource management decision that is required to make it clear which nominated value (such as salmonids or contact recreation) has been used as the basis for establishing the objective, policies and ultimately, a standard. The purpose for management provides the basis for increasing the resolution of a regional plan because it nominates a very specific value (or set of values) to be managed. With this approach, a regional plan's specificity can be increased over the necessarily broad national resolution goals of the RMA or narrative objectives in an RPS or region-wide plan. The approach increases certainty because a standard is set and is justifiable because there is a clear decision path.

The problem with using 'natural state' as a purpose for management, in the management framework approach that we apply here, is that it is too unspecific to be used as a nominated value for setting standards. We have adhered to a rigorous approach to derive the standards presented in this report in order to overcome this problem and to establish certain and justifiable plan provisions. Thus, the options for rule standards that follow have not included natural state as a purpose for management and we briefly discuss the 'natural state' concept in our final discussion.

7.2. 'Human drinking water' as a purpose for management

ECan has indicated 'human drinking water' as a purpose for management of some freshwater water bodies in the NRRP (see Table 2). This purpose for management is different from the other purposes for management (e.g., contact recreation, stock drinking water etc) because of the existence of the published *Drinking-Water Standards for New Zealand 2000* (MoH 2000, hereafter abbreviated to "DWSNZ 2000") administered by the Ministry of Health. Other purposes for management are associated with published <u>guidelines</u> but none have associated national <u>standards</u>. The

DWSNZ 2000 are applicable to water intended for drinking, irrespective of its source, treatment, distribution system, whether it is from a public or private supply or where it is used. The only exception is bottled water, which is subject to different standards under the Food Regulations.

Clearly the national standards define the appropriate contaminant limits (standards) for drinking water at the point before consumption (i.e., at the tap). However many drinking water supplies have some form of treatment prior to consumption. The difficulty with defining water quality standards for drinking water supplies prior to treatment (i.e., raw water in rivers or lakes), in a regional plan, is that treatment efficiency is highly variable. Some supplies will have no treatment (and will therefore require the national standards to be achieved outright), while other supplies will have advanced treatment (e.g., filtration and disinfection), and could therefore tolerate raw water of significantly lower quality. An added complication is that some common water contaminants can adversely affect the functioning of treatment systems (e.g., high suspended solids loads will decrease filtration efficiency and increase wear on supply infrastructure).

Therefore, if a waterbody is assigned 'human drinking water' as a purpose for management in the NRRP, the conservative option to protect the most sensitive case (i.e., where there is no treatment), would be to use the standards prescribed in the DWSNZ 2000. However this approach is clearly not practical because the DWSNZ 2000 standards are very restrictive and are probably not achievable in many rivers. In addition, it would be unnecessary to achieve such stringent standards in raw water (and therefore unfairly restrictive of resource use) in situations where effective treatment systems are in place. Several alternative approaches could be considered:

1) Attempt to derive specific numeric community water supply standards that are less stringent than the DWSNZ 2000 standards but more stringent than those for the underlying MU. We have not been able to recommend a defensible basis for doing this, given the variability with different types and efficiencies of treatment.
2) Set some basic narrative standards (in addition to the underlying MU standards which include standards for *E. coli*) that are designed to ensure that water is not rendered unsuitable for treatment, or unsuitable or unpalatable for humans after treatment. Such standards are set out in the Third Schedule RMA.
3) Do not set specific community water supply standards, but instead define any discharge to a 'human drinking water' MU as a non-complying activity, so that a high level of discretion can be retained for case-by-case consideration. The consent process would include consideration of the raw water quality, the proposed discharge quality, the level of treatment of the drinking water supply, and the DWSNZ 2000.

8. Development of Objectives and Rule Standards

In this section we present options for objectives and rule standards that have been gathered from existing published guideline documents. First we state the general principles we have used in deciding which options to present. Then we list tables containing the options for numeric objectives and standards and the reference sources used. We then provide a recommendation on the options based on our understanding of the purpose for management ECan has defined in the Draft NRRP.

8.1. Guiding principles for objectives and standards for water quality

We have used some key guiding principles when considering options for objectives and rule standards. These are as follows:

Guiding principles for Objectives

- Objectives should establish the environmental state that is sought for each MU, given the chosen purpose for management. The MU has established 'where?', the purpose for management has established 'why?', the objective needs to establish with certainty 'what' environmental state is required to support the purpose for management?

- There is usually some choice of the level of protection desired for the purpose for management and this leads to options for objectives at different levels of protection. Where practical we have provided such options.

- Where possible the objectives should be 'numeric' rather than narrative, so that they can be used to establish an unequivocal base-line against which to measure progress towards the outcomes sought by the plan (i.e., to facilitate s35 RMA functions[6]). This unequivocal base-line is also useful as a means to establish the acceptable limit for cumulative effects and effects of non-point source activities.

- Some narrative objectives will be necessary in order to ensure a 'catch-all' definition of 'what?' environmental state is required to achieve the purpose for management.

- Objectives will be considered in all decisions in consent processes (see s104 RMA), but in particular will be considered when a decision must be made on

[6] s35 RMA was quoted and discussed in Section 4.4.

whether to grant or decline a consent for a 'non-complying' activity, as discussed previously in Section 4.5.

Guiding principles for Rule Standards

- Rule standards should be transparently linked to the objectives they are designed to achieve. The rule standard needs to establish 'how?' the objective will be achieved.

- It is accepted that it is not possible to define in advance, numeric standards for all known water quality variables for all management units. It is also acknowledged that numeric standards will not protect against effects from currently unknown water quality variables or unknown combinations of known variables. Therefore some narrative standards will be needed, in order to ensure 'catch-all' theoretical protection against these effects.

- The RMA s69(3) sets some explicit directions about standards in a regional plan, as noted previously in Section 4.4.

8.2. Options for Plan Objectives and Rule Standards

Options for numeric objectives and standards are presented in Appendix 4. There are a total of 11 tables for the 10 ECan MUs listed in Section 6.3 and in Table 2. The 11 tables are as follows:

Table 1. Alpine Source Rivers

Table 2. Hill Source Rivers

Table 3. Lake Source Rivers

Table 4. Intermontane Rivers

Table 5. Lowland Rivers

Table 6. Volcanic Rivers

Table 7. High Country (Large) Lakes

Table 8. High Country (Small) Lakes

Table 9. Lowland (Large and Small) Lakes

Table 10. Coastal Lakes

Table 11. Toxicants

The final 'Table 11 - Toxicants' lists all the toxicants together for convenience and is referred to in the preceding 10 tables.

8.3. Two types of options

The tables in Appendix 4 contain two types of options that can be used to differentiate between different river and lake types (i.e., between MUs).

First, there are options that vary depending on discrimination of physical differences between MUs. For example the options for nutrient standards are different for alpine rivers, hill rivers and all other rivers because the effect of nutrients (in causing undesirable algae growths) is different between these river types. This is because physical processes that differ between the MUs (particularly flow and flood disturbance) affect the relationship between nutrient concentrations and the effects to which they contribute (i.e., undesirable algae biomass). Therefore different options have been provided for different MUs where this is technically defensible.

Second, there are options that are independent of the physical differences between MUs, and instead depend on the purpose for management and the chosen level of protection. For example the effect of a particular concentration of toxic contaminant or microbiological contaminant does not vary depending on any different physical processes between MUs. Toxicants at a given concentration have the same potential toxicity in alpine rivers as they do in hill rivers or other rivers (although the diversity of organisms present may vary). Equally, microbiological contaminants at a given concentration present the same potential risk to human health regardless of river type (although recreational use may vary between river types). Therefore the options for these standards do not vary unless a different purpose for management or level of protection is chosen by ECan. For the microbiological example, differentiation of the *E. coli* standard between MUs depends on which option ECan selects as a 'tolerable contact-related illness risk' for each MU. Three different illness risk options have been provided.

8.4. Recommendations on the options

Several options for 'levels of protection' are listed for many water quality variables, although for some variables only one option could be provided. We have indicated a recommended option (in orange), based on our understanding of ECan's chosen purpose for management from the current Draft NRRP. However we reiterate that the 'purpose for management' and the desired 'level of protection' are political not scientific decisions. We recommend that all options be revisited when the Draft NRRP is revised.

In some cases we have highlighted options in purple. These purple cells indicate the water quality variables for which it has not been possible to recommend a numeric objective and/or a numeric rule standard. This necessitates the use of a narrative objective and/or rule standard at this stage. This is because either;

a) there is insufficient information currently available to scientifically define the number for a water quality variable that will support an identified critical value (e.g., there is significant scientific uncertainty with the nutrient concentrations required to achieve the objective of <50 mg/m^2 chl. *a* that supports benthic biodiversity in 'lowland' rivers (Biggs 2000)), or,

b) the number for a water quality variable that will support an identified critical value is dependent on the existing environmental state and we currently do not know what that state is (e.g., we have not identified the colour or clarity required to support existing amenity value in high country lakes).

These purple cells indicate opportunities for further development of the management framework by examination of existing environmental data, collection of new environmental data, and continued scientific study of the relationships between numeric water quality variables, objectives, values and purposes for management. This is discussed further in Sections 11.9 and 11.10, and is also included in the Conclusions and Recommendations (Section 12).

9. Implementing mixing zones in a regional plan

This section reviews the terminology that has been adopted in the application of mixing zones in water management in NZ, and makes a recommendation on the definition and implementation of mixing zones as part of water quality standards in a regional plan.

9.1. Aims

Section 4.5 and Loe (2002) (see Appendix 1) discuss the problems associated with a lack of a clear certain definition for 'reasonable mixing' when mixing zones are specified in regional plans. The problems are widespread and the question "what is a reasonable mixing zone?" is asked regularly by resource users, their consultants and resource consent processing staff around the country. The question often becomes the critical consideration at hearings and in decisions on discharge applications.

The brief for this work was to provide a clear definition or guidance for the use of 'reasonable mixing' in the NRRP. However, on consideration we do not believe this term can be defined at a regional scale and, furthermore, we consider there are good reasons why a specific definition for 'reasonable mixing' should not be attempted at a regional scale. Therefore the aim of this section is to overcome some of the specific planning problems by clarifying the understanding and use of mixing zone concepts and terminology in regional plans. The specific aims are to;

- Provide options for defining allowable mixing for the purpose of providing category-determining criteria in a plan; and,
- Recommend the key test for determining 'reasonable mixing' on a case-by-case basis and provide guidance on how to apply this test.

9.2. Background

The concept of a mixing zone associated with a discharge to water bodies is common in water management decision-making. The topic is complex and a variety of approaches exist worldwide for determining what sized mixing zone is acceptable for a given situation. Various authorities have published guidance on the topic including; the NZ Ministry for the Environment (Rutherford et al., 1994), the United States Environmental Protection Agency (USEPA, 1995) and the Australian and New Zealand Environment and Conservation Council (ANZECC & ARMCANZ 2000).

The RMA contains several references to 'reasonable mixing' but does not define the term or provide guidance. However MfE prepared a guidance publication titled Resource Management Ideas No. 10 – A Discussion on Reasonable Mixing in Water Quality Management (Rutherford et al., 1994). As was suggested in Section 4.2 of this report, the flexibility in the term 'reasonable mixing' is in fact necessary when the RMA is prescribing provisions and standards (e.g., s107 RMA) at a national level of resolution. In other words, the RMA recognises that what is 'reasonable' in one situation may not be reasonable in another situation. As stated in the decision of *Mahuta and Others v National Water and Soil Conservation Authority* (NZTPA 73, cited in Rutherford et al., 1994):

> "…what is a reasonable mixing zone will be a question of fact and degree in each particular case…".

The implications of this for water management under the RMA are discussed in detail in Rutherford et al. (1994). Since that discussion document was written, there has not been, to our knowledge, any significant advancement in the form of guidance or any case-law definition of reasonable mixing generally. Therefore we have taken the concepts presented in that discussion document as the basis for our recommendations here.

9.3. Understanding mixing zone terminology

It is fundamentally important when considering mixing zones to understand the terminology. To quote directly from Rutherford *et al*. (1994):

> "The RM Act requires that any standards imposed through classification or through s107[7] be met "after reasonable mixing". This implies the existence of a zone in which the underlying standards need not be met. It is important to appreciate the distinction between the near-field mixing zone, the point of complete mixing and the non-compliance zone.
>
> "Effluents generally have contaminant concentrations higher than those in the receiving waters. There is an area close to the outfall, called the "near-field mixing zone", where the effluent mixes rapidly with the receiving water because of the momentum and/or buoyancy of the effluent and turbulence in the receiving water.
>
> "Close to a river outfall contaminant concentrations usually drop quite rapidly, while further away from the outfall transverse dispersion often takes a long time to completely mix contaminants across the entire flow (especially in wide, straight river channels). In the ocean the initial rate of dilution close to the outfall is usually high because of jet momentum and/or mixing induced by the buoyancy of the effluent, but once the plume reaches the surface the subsequent rate of dispersion by wind and tidal currents is often significantly lower.
>
> "'Complete mixing' occurs once the effluent is completely dispersed through the receiving waters. The concept of complete mixing is only relevant in flows confined between banks (such as rivers and estuaries). In unbounded flows (such as lakes and the oceans) mixing continues more or less indefinitely. There is a common misconception that mixing is only "reasonable" once it is complete. There is, however, nothing in the legislation or the case law to support this notion.
>
> "As mixing does not occur instantaneously, contaminant concentrations close to the point of discharge often exceed the water quality standards for the receiving waters. The area where the standards are not met is of great significance for water management and we define this to be the 'non-compliance zone'."

In the past, many people have loosely used the term 'mixing zone' to describe this area. The term 'non-compliance zone' is preferable because it avoids giving the impression that natural mixing processes are the only factors that determine the size of

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[7] Note that this consideration of "after reasonable mixing" equally applies to standards in s70 RMA and also standards for water quality classes in the Third Schedule of the RMA.

this zone. The term 'non-compliance' zone also focuses our attention on the key point, which is, that this is the area within which water quality does not meet the-prescribed standards.

9.4. The non-compliance zone

Unlike the 'reasonable mixing zone', which requires a subjective judgement to define, the size of the 'non-compliance zone' can be calculated for a specific situation and therefore can be estimated with some confidence. The factors that are used to calculate the size of the 'non-compliance zone' are:

- Effluent flow rate and concentration
- Design of the outfall influencing dispersion
- Depth, velocity and rate of turbulent mixing of the receiving water
- Ambient concentrations in the receiving water.
- Receiving water concentration limit or numeric "standard" for contaminants

The size of the non-compliance zone is not fixed but varies over time with variations in the factors listed above. This point is commonly misunderstood, as is also the fact that the size of the non-compliance zone is also different for each contaminant because each contaminant concentration in the receiving water is compared with its own corresponding standard. However it is not helpful for management purposes to consider a continuously changing non-compliance zone. Therefore the upper limit for the size of the non-compliance zone can be conservatively estimated based on realistic worst-case conditions for each of the above factors. This is often done when deciding on discharge consent conditions. This upper limit is a 'maximum non-compliance zone' and can be estimated for each contaminant in a particular discharge. The largest of these zones will be the overall 'maximum non-compliance zone' for the discharge. There are numerous texts containing methods, calculations and guidance for estimating the size of such 'non-compliance zones' (e.g., Rutherford *et al*., 1994, Rutherford, 1994).

It is important to appreciate that the size of the non-compliance zone (and the 'maximum non-compliance zone') is not determined solely by conditions within the receiving waters. It can be controlled to some extent by the discharger altering the level of treatment, the effluent flow and the design of the outfall.

9.5. The maximum allowable non-compliance (MANC) zone

The implication of the above discussion is that, in theory, the 'maximum non-compliance zone' for any proposed discharge could be estimated by the resource-user, without needing any subjective decisions from the consent authority, as long as the authority provides the numeric standards in a plan. This could then be compared to some 'maximum allowable non-compliance' (MANC)[8] zone, if such a zone was also to be defined by the consent authority in the plan. A MANC zone could be defined in terms of length and width. For example, in a river the MANC zone for a toxic contaminant (e.g., ammonia) could be defined as less than 50 m in length and less than one third of the channel in width. In a lake the MANC zone could be defined as less than 50 m radius from the discharge.

In practice, estimating the maximum non-compliance zone for a discharge could involve complex calculations that would be beyond the technical capability of the majority of users. However this complexity depends on the level of precision that is expected by the consent authority. As is currently the case for resource consent applications, the expected level of precision would normally increase with the scale and significance of the discharge. For a major discharge the user would normally hire a consultant who could do mixing investigations and complex calculations, but for the large number of smaller discharges it would be desirable to simplify these calculations. For rivers it would be possible to significantly simplify the calculations by instead defining a 'maximum allowable dilution ratio' (MADR)[8] as described in Section 9.6 below.

9.6. An alternative – the maximum allowable dilution ratio (MADR)

For discharges to rivers the calculations could be simplified by using a broad assumption about river mixing to define a 'maximum allowable dilution ratio' (MADR) instead of a MANC zone. This approach simplifies the calculations by assuming that, in practice, the length of the non-compliance zone in a river will be closely related to the width of the zone and hence the percentage of flow used for mixing. For example, instead of defining a MANC zone in terms of length and width in a river, the MADR would define the allowable percentage of flow that could be used to dilute a particular contaminant to meet a particular standard. For example a MADR of 50% of the river flow at flows greater than the 7Q10 could be defined for meeting the standard for nutrients. For a toxic contaminant (e.g., ammonia) the MADR could be only 10% of the river flow at the 7Q10 to ensure that the non-compliance zone would only occupy a small proportion (approximately 10%) of the channel width. In other words, the MADR is a simplified way of defining a maximum

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[8] Note that working definitions for these terms are provided in the Glossary.

allowable non-compliance zone for a river. For discharges to lakes the concept of a MADR does not work because there is no 'flow' in a lake. Therefore for lakes the MANC zone will need to be defined in terms of length and width. The MADR will be discussed in more detail later in Section 9.10.

9.7. Advantages of defining a MANC zone or MADR

While it may seem unnecessarily complicated to introduce additional terminology, there are some advantages in defining a MANC zone or a MADR, rather than attempting to place some arbitrary definition on 'reasonable mixing' in a regional plan. The advantages are as follows:

- Defining a certain MANC zone or MADR (and the numeric standards to go with it) allows the use of standards in rules that determine which 'activity category' a proposed activity will fall within (refer discussion in Section 4.5). The legal problem discussed in Section 4.5 is overcome because the resource-user can determine whether their activity is 'permitted', 'discretionary', or 'non-complying' before lodging an application (i.e., without needing to go through a consent process for a decision on the definition of 'reasonable'). In this way the MANC zone or MADR is used in combination with the 'tiered' activity approach of s67 RMA and s105 RMA (refer discussion in Section 4.5). For clarification of a plan structure that would allow this, refer to Section 10 below.

- Importantly, a MANC zone or MADR can be defined without the consent authority losing the discretion that is afforded by the uncertainty of the word 'reasonable'. We recommend that the term 'reasonable mixing' could be used elsewhere in the plan (i.e., not in the 'category-determining' rules) to ensure that the consent authority retains the discretion to require, during a consent process for a 'discretionary activity', a mixing zone smaller than the MANC zone (or a dilution ratio smaller than the MADR) if this is appropriate in a particular situation. This is important and will need to be made very clear in the Plan, because it is not possible to pre-define a MANC zone or MADR that will be appropriate for every situation[9]. For clarification of a plan structure that would allow this, refer to Section 10 and Figure 5 below.

- In addition, regardless of what is contained in a regional plan, the term 'reasonable mixing' exists in s107 and will therefore be considered during every consent process for a discharge to water. The term reasonable also exists in s70 RMA. If

[9] We note that the need for the consent authority to retain discretion in this manner may have legal implications. This issue will need further investigation from a legal perspective and we have not undertaken this as part of the current report.

a consent authority did define the term 'reasonable mixing' for a region in a plan, it may create confusion for plan users as to the application of these sections of the RMA. We recommend that the plan does not include a specific definition for reasonable mixing, but instead provides guidance on how reasonable mixing will be assessed during a consent process. This guidance is discussed further in Section 9.8 below. For clarification of a plan structure that would allow this, refer to Section 10.3 and Figure 5 below.

9.8. Options for defining the MANC zone or MADR

The primary purpose of defining a MANC zone or MADR is to enable a certain definition, at a regional-scale resolution, for the mixing zone that will provide category-determining criteria in a regional plan. This definition is specifically needed to overcome the legal problem discussed in Section 3.5. It should not be confused with the definition of 'reasonable mixing' because this can only be judged for individual consents on a case-by-case basis.

Notwithstanding the independence of these definitions, the MANC zone definition (or MADR definition) should be developed using the same principles that the consent authority would use to make case-by-case decisions on 'reasonable mixing'. In this way a second purpose of the MANC zone definition is to provide useful guidance, at a regional-scale resolution, on the characteristics of a zone that is likely to be considered 'reasonable' in the vast majority (about 90%) of cases. In accepting that resource-users will undoubtedly find this guidance useful, it must be acknowledged that some uncertainty (about 10%) is unavoidable when operating at a regional-scale resolution instead of a case-by-case resolution (refer Section 4.2). This is why it is very important (as already discussed) that the consent authority must retain discretion over these uncertainties.

Rutherford *et al.* (1994) suggest that:

> "Reasonable mixing may be said to have occurred when the management objectives of the receiving water are not compromised by the non-compliance zone."

We recommend that this statement be used as the key test for defining 'reasonable mixing'. Taking this further, in considering whether a non-compliance zone compromises the management objectives of a water body, we are primarily concerned with the following key factors:

- The size (length, width and area) of the non-compliance zone relative to the size (length, width and area) of the receiving waterbody.
- The type of contaminant, and therefore the type of effect that occurs within the non-compliance zone (e.g., acute vs chronic effects).
- Whether the non-compliance zone could cause effects beyond the area of non-compliance with the standards (e.g., restricting the passage of fish to upstream waters).
- Any special localised use or value of the receiving water that the non-compliance zone intrudes into.
- The cumulative impact of more than one mixing zone on water bodies.

We have used these listed key factors to provide guidance for the test of 'reasonable mixing', and, therefore also to define the MANC zone and MADR in Sections 9.9 and 9.10 respectively.

It is worth noting that an alternative conservative option would be to define a MANC zone or MADR of zero for all contaminants at all times for all types of activities. However, this would severely curtail discharges to water-bodies and it seems likely that this would be difficult for the consent authority to defend. It would also contravene s70, s107, and the Third Schedule RMA, in the sense that no mixing would be allowed for.

On this basis we recommend that ECan consider a certain definition for the MANC zone and/or MADR (together with appropriate water quality standards) as described in the following Sections 9.9 and 9.10 respectively.

9.9. The proposed MANC zone

We propose that MANC zones be defined in the NRRP for 'permitted activities' and for 'discretionary activities'.

9.9.1. MANC zones for permitted activities

We found that, in order to satisfy the requirements of s70(1) RMA, we could not define a generic permitted MANC zone for all types of activities of anything greater than zero. The reasons for this are discussed in more detail later in Section 11.5. However we acknowledge that using only a MANC zone of zero would be very restrictive and we also propose that, for some activities whose effects are well known, a permitted activity MANC zone greater than zero could be appropriate. Therefore we recommend for permitted activities, the use of a combination of rules in the Plan as follows:

1. Include several activity-specific rules that define appropriate MANC zones for contaminants based on a practical management decision about the known effects of particular types of discharges.[10]

2. Include a single generic rule that also defines any activity capable of meeting the standards with a MANC zone of zero as permitted. This provides an incentive for dischargers to provide the treatment necessary for high quality discharges.

9.9.2. MANC zones for discretionary activities

For MANC zones that apply to discretionary activities, we propose to divide potential contaminants into two classes; 'Type 1' and 'Type 2'.[11] This recognises that some contaminants have direct effects or are acutely toxic (Type 1) while others have generally indirect or chronic effects (Type 2), and therefore the former should arguably be managed with smaller MANC zones than the latter. The assignment of contaminants to the two classes is a pragmatic decision based on known characteristics of each contaminant. A table is provided in Appendix 5 that shows our recommended list of 'Type 1' versus 'Type 2' contaminants for this purpose. The two MANC zones shall be defined as follows:

1. The MANC zone for standards for ***Type 1*** contaminants shall satisfy all of the following criteria at all times:

   For rivers the MANC zone;

   a) Shall be no longer than 5 times the channel width, and
   b) Shall be no longer than 50 m along the longest axis of the zone, and
   c) Shall occupy no greater than one third of the width of wetted channel.

   For lakes the MANC zone;

   a) Shall occupy no greater than 1% of the total minimum wetted area, and

[10] ECan has already proposed several rules that make discharges of swimming pool, aquifer, bore test, reservoir, land drainage waters, and some stormwater discharges as 'permitted activities', provided that a number of conditions are met. Some of these conditions require that standards (for temperature, colour, clarity, pH, oils, grease, scums and foams) are met in the receiving water below a mixing (MANC) zone of 20 times the width of the receiving water at the point of the discharge (Main, 2003). This is discussed further in Section 11.5.

[11] Note: We have considered dividing contaminants into more than two classes and this is discussed in Section 11.6.

b) Shall be no greater than 50 m along the longest axis of the zone.

2. The MANC zone for standards for ***Type 2*** contaminants shall satisfy all of the following criteria at all times:

   For rivers the MANC zone;

   a) Shall be no longer than 10 times the channel width, and
   b) Shall be no longer than 100 m along the longest axis of the zone, and
   c) Shall not be restricted in width.

   For lakes the MANC zone;

   a) Shall occupy no greater than 2% of the total minimum wetted area, and
   b) Shall be no greater than 100 m along the longest axis of the zone.

Note 1: When a potential discharger is calculating maximum non-compliance zones to compare with these MANC zones for the purpose of determining whether their proposed discharge is a 'discretionary activity', it will be necessary to define with certainty in the NRRP, the characteristics to be used in the calculation (in order to overcome the problem raised in Section 4.5). We propose that the following be used:

- River channel width shall be the average wetted width at the point of discharge.
- Lake area shall be defined as the minimum wetted area of the lake.
- The 95th percentile case shall be used for effluent flow rate and effluent contaminant concentration.
- The median case shall be used for ambient receiving water contaminant concentrations.
- A defined river flow statistic shall be used to calculate dispersion and dilution in the receiving water. We recommend that ECan consider either the mean annual low flow (MALF) or 7-day 10 year recurrence interval low flow (7Q10). The choice of options is discussed further in Section 11.6, and in the Conclusions and Recommendations (Section 12).

Note 2: Notwithstanding the reason for Note 1, when it comes time for decisions on applications and setting conditions on resource consents, the consent authority may decide that different characteristics (e.g., different river or lake wetted areas, contaminant percentiles, or flow statistics) are appropriate for determining whether a discharge is contrary to objectives or policies of the plan, or is *reasonable* under s107 RMA. This allows the consent authority to retain discretion for discretionary activities, as already discussed in Sections 9.7 and 9.8. The consent authority would do this only where there was a good reason for departure from the characteristics defined above.

9.10. The proposed MADR alternative for rivers

For discharges to rivers we propose that ECan consider a simplified alternative to defining the MANC zones in Section 9.9 above. The alternative uses a broad assumption about river mixing to define a 'maximum allowable dilution ratio' (MADR) instead of a MANC zone. This approach simplifies the calculations required to assess compliance, by assuming that in practice, the length of the non-compliance zone in a river will be closely related to the width of the zone and hence the percentage of flow mixing. Therefore, instead of defining a MANC zone in terms of length and width in a river, the MADR defines the allowable percentage of flow that can be used to dilute a particular contaminant to meet a particular standard.

9.10.1. MADR for permitted activities

For permitted activities the discussion presented in Section 9.9.1 applies equally if the MANC zone is substituted with the MADR. In other words, we could not define a generic permitted MADR for all types of activities of anything greater than zero. However this is clearly impractical and we therefore recommend for permitted activities, the use of the same combination of rules in the NRRP as described in Section 9.9.1.

9.10.2. MADR for discretionary activities

For discretionary activities we propose that the allowable proportion of flow used to dilute contaminants should vary for different contaminants, for the same reason that a smaller MANC zone was proposed in Section 9.9.2 for highly toxic contaminants than for nutrients or BOD. Proposed MADRs for rivers are shown in Table 3.

Table 3: Proposed 'maximum allowable dilution ratios' (MADR) for discharges to rivers that are discretionary activities

Water quality variable (for which a rule standard is proposed in Appendix 4)	Maximum Allowable Dilution Ratio (MADR) for discretionary activities (as a percentage of the river flow at flows above the 7Q10)
Dissolved oxygen (DO)	30%
Temperature	30%
pH	30%
Ammonia	10%
All toxicants in Table 11	10%
E.coli	50%
Faecal coliforms	50%
Clarity	30%
Colour	30%
Nutrients	100%
Biochemical Oxygen Demand (BOD)	100%
Suspended Solids (SS)	30%
Turbidity	30%
Objectionable materials (visible)	10%

Note 1: When a potential discharger is calculating whether their proposed discharge complies with the water quality standards (and therefore whether it is a discretionary activity), it will be necessary to define with certainty in the NRRP, the characteristics to be used in the calculation (in order to overcome the problem raised in Section 4.5). We propose that the following be used:

- The 95th percentile case shall be used for effluent flow rate and effluent contaminant concentration.
- The median case shall be used for ambient receiving water contaminant concentrations.
- A defined river flow statistic shall be used when applying the MADR to calculations. We recommend that ECan consider either the mean annual low flow (MALF) or 7-day 10 year recurrence interval low flow (7Q10) (as used in Table 3). The choice of options is discussed further in Section 11.6, and in the Conclusions and Recommendations (Section 12).

Note 2: Notwithstanding the reason for Note 1, when it comes time for decisions on applications and setting conditions on resource consents, the consent authority may decide that different characteristics (e.g., different effluent or ambient contaminant percentiles, or different flow statistics) are appropriate for determining whether a discharge is contrary to objectives or policies of the plan, or is *reasonable* under s107 RMA. This allows the consent authority to retain discretion for discretionary activities, as already discussed in Sections 9.7 and 9.8. The consent authority would do this only where there was a good reason for departure from the characteristics defined above.

9.10.3. Advantages of the MADR

A significant advantage of using MADRs over MANC zones is that the calculations are much simpler, in particular the dispersion element of the calculation is avoided. Therefore it will be much simpler for users to assess whether their discharge is a discretionary or non-complying activity. The complexity of calculations associated with MANC zones is a significant consideration for implementation of the Plan.

The disadvantage of using MADRs is that they cannot be used for lakes and this necessitates using two different systems of terminology (i.e., both MANC zones and MADRs). ECan would also need to consider which terminology it would adopt for permitted activities because maximum non-compliance zones have already been proposed (in Main 2003) in terms of length and width for several activity-specific rules for permitted discharges.

We recommend that ECan consider the relative merits of using MADRs instead of MANC zones for rivers. We also note that regardless of which system is used, the process of applying water quality standards and mixing considerations in a regional plan is unavoidably complicated. There will be a significant requirement for education and guidance of plan-users through this process. We also recommend that ECan consider developing a decision support system as described in Section 10.5.

10. Proposed model for discharge consent decision-making

This section describes a proposed model for discharge consent decision-making that incorporates the MANC zone (and/or MADR) and the numeric water quality standards together in combination with the ‘tiered’ activity approach of s67 RMA and s105 RMA, to assign activities to an appropriate ‘activity category’ (see Section 4.5). In this way the tiered structure would be used to provide the intermediate ‘regional scale’ guidance that it was suggested is needed in Section 4.2. An overview of the model is shown in Figure 5. Note that where the model refers to MANC zones, these could equally be substituted with MADRs as an alternative for rivers. The key consent decision-making steps are described in sections 10.1-10.4 below.

10.1. Prohibited Activities

There are a number of activities that the existing Draft NRRP expressly defines as ‘***prohibited activities’***. By defining these activities ECan makes a clear statement about activities for which no resource consent can be granted. If a resource user finds that their intended activity is defined in the plan as a ‘prohibited activity’, the decision-making model ends at that point. The only option open to the potential resource user is a plan change. Examples of prohibited activities in the Draft NRRP include; discharges of treated sewage effluent to surface water without passing through soil or constructed wetland, discharges of solid waste or hazardous waste into surface water or riverbeds or margins of lakes and rivers.

10.2. Permitted Activities

A discharge, or any activity that might cause contaminants or water to enter surface water, shall be a ***‘permitted activity’*** (and therefore not require consent) if it satisfies either one of two questions in the decision-making model as follows;

1) The activity is expressly authorised as a ‘permitted activity’ in one of several activity-specific rules[12]. These rules are discussed further in Section 11.5.
2) The nature of contaminants are known to be only water and/or contaminants listed in the standards tables in the NRRP; and,

   The concentration of those contaminants can be demonstrated to comply with the standards before discharge (i.e., with the ‘permitted activity’ MANC zone [or MADR] of zero) at all times; and,

   The activity is not expressly defined as a discretionary, non-complying, or prohibited activity elsewhere in the NRRP; and,

   The activity does not cause any erosion or flooding (this is similar to one of the conditions that applies to activity-specific permitted activity rules in Main 2003).

[12] ECan has currently proposed several rules that make discharges of swimming pool, aquifer, bore test, reservoir, land drainage waters, and some stormwater discharges as ‘permitted activities’, provided that a number of conditions are met. Some of these conditions require that standards (for temperature, colour, clarity, pH, oils, grease, scums and foams) are met in the receiving water below a mixing (MANC) zone of 20 times the width of the receiving water at the point of the discharge (Main, 2003).

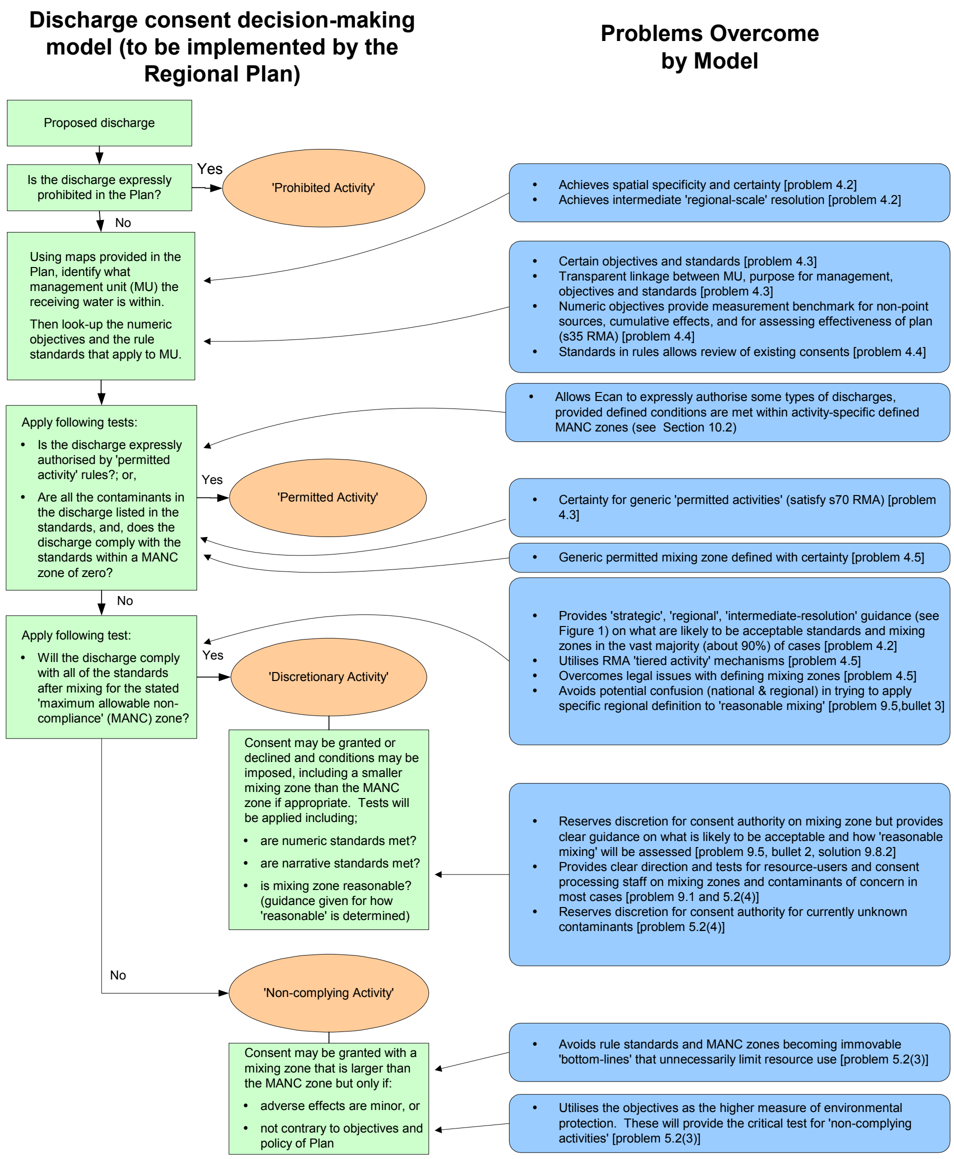

Figure 5. The proposed planning model and the problems it overcomes

(Note: Where the model refers to MANC zones, these could equally be substituted with MADRs as an alternative for rivers.)

10.3. Discretionary Activities

A discharge, or any activity that might cause contaminants or water to enter surface water, shall be a ***'discretionary activity'*** if;

1) The concentration of any discharged contaminants listed in the standards tables in the NRRP can be demonstrated to comply with the MANC zones (or MADRs); or,
2) The activity is expressly defined as a discretionary activity elsewhere in the NRRP; and,
3) The activity is not expressly defined as a permitted, non-complying, or a prohibited activity elsewhere in the NRRP.

Note that the defined MANC zones (or MADR) allow an 'entry test' for the activity to be considered as a discretionary activity rather than a non-complying one. However the consent authority may grant or refuse consent for a discretionary activity, and in doing so may impose conditions, on a case-by-case basis, that require a smaller non-compliance zone than the MANC zone defined in the NRRP (or a smaller dilution ratio than the MADR), if in the opinion of the consent authority a smaller non-compliance zone (or smaller dilution ratio) is appropriate to comply with the plan objectives and policies in a particular case.

In this regard the consent authority will apply, amongst other considerations, three tests in making decisions on discretionary activities, as follows:

1. First, an application for a 'discretionary activity' must demonstrate that the 'maximum non-compliance zone' of the discharge is not greater than the MANC zone prescribed in the Plan (or the discharge meets the standards using the MADRs). This is the certain test to determine the activity category.

2. Second, the application must demonstrate that the proposed non-compliance zone is 'reasonable'. The consent authority reserves discretion over the definition of 'reasonable'. However, when making a decision on this matter the authority will apply the test where *reasonable mixing will be said to have occurred when the management objectives are not compromised by the presence of the proposed non-compliance zone*. Generally if the proposed non-compliance zone is less than the MANC zone defined in the NRRP, the management objectives will not be significantly compromised in the vast majority (about 90%) of cases. This is because the MANC zone limits the length, width and area of the non-compliance zone. Exceptions (about 10%) could occur where the discharge;

- Is located in an area which is particularly sensitive for the management objective (e.g., high user-density recreation or amenity areas, fish spawning areas, important mahinga kai sites etc.); or,
- Is located in an area that is particularly vulnerable to accumulation of contaminants (e.g., nutrients or toxicants in contained or semi-contained water bodies such as lakes or estuaries); or,
- Contains a contaminant or combination of contaminants that exert a particularly toxic or otherwise adverse effect.

3. Finally, the consent authority will apply the test of whether all practicable and reasonable measures have been taken to minimise the size of the non-compliance zone, regardless of the MANC zone or MADR definition.

10.4. Non-complying Activities

A discharge, or any activity that might cause contaminants or water to enter surface water, shall be a ***'non-complying activity'*** if;

1) The concentration of any discharged contaminant listed in the "standards tables" in the NRRP causes a non-compliance zone that is larger than the MANC zones (or does not comply with the standards using the MADR); or,
2) The nature of contaminants is unknown and/or not listed in the "standards tables" in the NRRP; and,
3) The activity is not expressly defined as a prohibited activity elsewhere in the NRRP.

Note that the consent authority may grant or refuse consent for a non-complying activity, and in doing so may decide that a larger 'non-compliance zone' than the MANC zone defined in the NRRP (or larger dilution ratio) is acceptable, provided that the larger zone (or dilution ratio) does not compromise the objectives or policy of the NRRP. This is where the objectives in the NRRP are very important because they provide the higher measure of environmental protection, and will be used to determine the outcome on applications for non-complying activities.

10.5. Automating the process

Regardless of whether MANC zones or MADRs are used, the process of applying water quality standards and mixing considerations in a regional plan is unavoidably complicated. There will be a significant requirement for the education and guidance of plan-users through this process. We recommend that ECan consider developing a decision support system that will help regional council staff and plan-users to do the calculations associated with the discharge rules. Such a decision support system would reside on the ECan web-site and could include;

1) a database with the relevant rules and standards for a range of contaminants.
2) a database and/or calculation method for estimating receiving water flows and background contaminant concentrations.
3) a database of typical/extreme contaminant concentrations and flow rates for various activities (that can serve as defaults).
4) provision for the user to over-ride these defaults with measurements.
5) a calculation engine that allows the user to estimate the effects of their discharge on receiving water contaminant concentrations.
6) a system that links to database (1) and compares predictions with standards and rules and hence determines whether the activity is permitted, discretionary or non-complying.
7) a system that submits a report detailing the calculations to ECan staff for consideration/approval.
8) a system whereby ECan staff can add comments and changes, which go back to the user.
9) a formal approval/rejection system for the application.

11. Discussion – implications of this approach

This section discusses the implications, advantages and disadvantages of the proposed approach. This discussion has been generated following a workshop session at which the details of the approach were debated by a panel of experts in aspects of water quality science and resource management. A draft report was presented to the review panel at the workshop, including the previous sections 1-10 and draft options for numeric objectives and standards in Tables 1-11. The participants at the workshop are listed in the Acknowledgements at the front of this report. The key issues raised by the review panel at the workshop, and in discussions since the workshop, are detailed in sections that follow.

11.1. Recognising limitations

To re-iterate the limitations presented in Section 3, the development of options for numeric water quality objectives and standards is a complex topic, and the implementation of these into a regional plan is unlikely to be able to anticipate all possibilities. The planning process is not entirely technical, value judgements are made and practical considerations are incorporated, particularly during the process of consultation and political decision-making. This report has developed technically defensible options for management implementation. This does not preclude changes being made to these options and additional plan provisions, which reflect social and political judgements. We stress, however, that this report has deliberately provided options that can be argued for on a technical basis and that options for provisions that involve value judgements or practical considerations must be made elsewhere in the planning and/or political process.

There will be advantages and disadvantages with the approach proposed in this report. The issues listed in section 4 cannot be overcome without some consequences for other parts of the management framework. Limitations arise that are due to the limits of scientific certainty that can be achieved at a strategic level of management, and also due to constraints that arise from the existing legal and planning structure. However, the aim of this work is to present an improved approach that will be a significant improvement for regional frameworks for managing water quality. In doing this we aim to ensure that the proposed approach is compatible with future improvements through plan review and revision, and that the potential risks and disadvantages, so far as we have been able to identify them, are stated so that they can be effectively managed.

11.2. Why have numeric objectives and standards in a regional plan?

Incorporating numeric provisions in regional plans raises significant issues because the resolution that is achievable at the strategic level of a plan is low, thus there is significant uncertainty. This is the same reason that water quality criteria are generally provided in 'guidelines'. So why try to incorporate numeric objectives and standards in a regional plan when technical defensibility of guidelines is generally only assured for case-by-case implementation? There are three key answers to this. First, numeric objectives and standards provide a plan with statutory certainty and justifiability. The term '<u>standard</u>' is cross-referenced and provided with statutory meaning in a number of sections in the RMA (e.g., sections 43, 69, 128). <u>Guidelines</u> in documents external to plans do not have this meaning. Statutory objectives and standards increase certainty for environmental outcomes and for resource users seeking consent. The use of numeric, rather than narrative plan provisions, strengthens the relationship between purpose for management, objective and standard. A particular advantage of strengthening these relationships is to provide justifiability for the consent conditions that are processed under the plan.

The second reason for numeric objectives and standards arises because plans can serve to influence future developments, not known or contemplated at the time of issuing the plan. Plans can signal to developers where the more sensitive environments are, and what will be required if development is to procede at a particular location. This signal will be more quantitative, and therefore clearer, if numeric objectives and standards are used as well as narrative objectives and standards.

The third reason for numeric objectives and standards arises because regional plans have purposes beyond processing new resource consents. Plans provide frameworks for many regional council functions, for example, state of environment reporting and iterative review and revision of policy. The effectiveness of policies created by plans must be monitored. In addition, thorough consideration of individual resource consents requires that cumulative effects be taken into account. This cannot be achieved by case-by-case processing of consents and must be guided by a 'higher level' framework. All these functions require 'benchmarks' and structures that are most effectively and certainly provided by numbers. The use of numeric objectives and standards in the proposed framework attempts to provide that structure.

11.3. Standards versus Guidelines

There is some discomfort with the use of guidelines to define numeric 'objectives' and rule 'standards' in a regional plan. The use of guidelines to create regional plan provisions does not obviate the need for guidelines, nor does it diminish the caveats contained within guidelines. The water quality guidelines, upon which our options for objectives and standards are based, attempt to provide a 'strategic level' of guidance in that they also generally contain caveats that site-specific conditions must be factored into their use. The incorporation of guideline values in a plan provides the guidelines with statutory power, but does not replace the need for the various guideline documents. On the contrary, the guideline documents describe the detail surrounding the numbers that will be used during case-by-case consent processing.

The term 'standard' has connotations of inflexibility that are inconsistent with the caveats contained within guidelines. This same flexibility that is required in guidelines is necessary at the strategic level of a regional plan. To achieve the required flexibility, while retaining the statutory benefits of numeric standards, we have proposed a system for implementing the standards that is flexible. Thus it is the implementation system that provides the flexibility rather than using narratives to retain flexibility in the standards themselves. This flexibility means that consents may be granted where standards set in rules of the plan are <u>not</u> met, as long as the activity is not contrary to the plan objectives and policies or the adverse effects are minor (e.g., for non-complying activities). This may cause some discomfort politically, because the public perception may be that consents are granted (for non-complying activities) despite the 'standard' not being achieved. However, this flexibility is necessary because the plan is a strategic level of guidance that cannot foresee all case-by-case details. It will be important to educate the public and plan users on the meaning of the numbers. Plan users will need to be referred to the various guideline documents for more detailed information to help them with their proposed resource use, particularly when applications are for non-complying activities.

A key concern is the scientific uncertainty associated with the numbers presented in guidelines such as ANZECC & ARMCANZ (2000). This uncertainty can be subdivided into two parts. First, there is real 'scientific' uncertainty that is associated with limitations of current knowledge. For example, is the choice of test organisms used to produce guidelines appropriate, or is the laboratory result of a bioassay relevant to actual environmental conditions. Second, there is uncertainty created by trying to provide a number that is broadly applicable, when case-by-case conditions will determine its relevance.

There will always be scientific uncertainty (limitations of current knowledge) with standards. However, it is a requirement of the RMA that a plan is reviewed after 10 years. The plan review process will allow numeric objectives and rule standards to be changed in the future. Many of the numbers proposed in this report were published as guidelines ten years ago and have been in use for some time. The use of these numbers as standards is unlikely to be 'scientifically' controversial because they are already in wide use. We have been more cautious with some recent guidelines. For example, we propose periphyton biomass (*chl a*) objectives for all rivers, but that we can only be confident about applying nutrient standards to achieve these objectives in alpine and hill rivers because the uncertainty surrounding the relevant importance of factors other than nutrients (e.g., light intensity, flood frequency, invertebrate grazing rates) is higher for lowland rivers (Biggs, 2000). At this stage the limitations in scientific knowledge means that nutrient standards to achieve these objectives in lowland rivers or springs will need to be devised on a case-by-case basis.

We propose that the uncertainties associated with the use of numeric standards at the strategic level of a plan is outweighed by the requirement to create a robust structure for management and the checks and balances created by a flexible system for implementation. The consequence of not incorporating numbers into regional plans will be a loss of certainty, both for new resource users and environmental values, and a loss of the plan's ability to guide other regional council functions. Unless a management structure is created with numbers in the plan, we are unlikely to be able to monitor the effectiveness of the plan, and accordingly adapt the management approach in future. We propose that these consequences outweigh the disadvantages associated with standards and that areas of discomfort must be tackled by ensuring that the plan is accompanied by appropriate education and guidance documents both for the public and users.

11.4. Objectives provide the higher measure of environmental protection

Under the proposed system, the plan 'objective', as opposed to the 'rule standard', provides the higher measure of environmental protection against which all activities, and effectiveness of the plan can be measured. The system we have proposed is flexible and would allow consents to be granted despite not meeting rule standards. The test in this case, is if the activity will still meet the plan objectives. In this sense the 'objective' is very important because it provides the higher measure of environmental protection in the proposed framework and is less flexible than the 'rule standard'.

The precedence of the objective over the rule standard also reflects the level of confidence that we have in the justifiability for the objective. We are confident that numeric objectives that describe 'what environmental outcome is required', can be more easily justified than rule standards that describe 'how that outcome is to be achieved', especially if the purpose for management is clearly defined. The objective reflects the 'purpose for management' and a desired level of protection, which are subjective rather than scientific decisions. The bulk of the scientific uncertainty lies with determining 'how' the objective is to be achieved. For example the following objectives are probably easily defended; maintain a maximum tolerable swimming-related illness risk of 1% for waters managed for the purpose of contact recreation (MfE, 2003), maintain less than 50 mg/m^2 *chl. a* for diatoms, cyanobacteria and filamentous algae for waters managed to support benthic biodiversity (Biggs, 2000). However, there is relatively more scientific uncertainty in proposing the corresponding rule standards for 'how' these objectives will be achieved (e.g., faecal indicator/health risk relationships and nutrient/biomass relationships respectively.

The efficacy of the proposed framework relies to a major degree on the numeric objectives. We have set these numeric objectives based on providing nominated values (the critical values) with a set level of protection. This requires scientific information (from guidelines) about the relationship between 'dose' and 'response' (i.e., level of protection). Unfortunately not all water quality variables have had dose response relationships developed or guidelines established. Where there aren't appropriate numbers available for defining options for objectives we have resorted to narrative objectives. These are not ideal, and create the uncertainty and lack of justifiability that we have tried to address with the proposed framework. Where we have resorted to narrative objectives these are indicated in the tables in Appendix 4 by purple shading.

These purple cells, in particular, are key areas for future development of the framework.

11.5. Permitted Activities (PAs)

We recommend a general MANC[13] zone (i.e., irrespective of the type of discharge) of zero for permitted activities and include this in our recommended ‘discharge consent decision-making model’ (see Figure 5). However we acknowledge that using only a MANC zone of zero would be very restrictive and we do suggest that, in addition, activity-based rules could define PAs with a MANC zone greater than zero (also included in Figure 5). Therefore we recommend for permitted activities, the use of a combination of activity-specific rules (with appropriately defined MANC zones based on the known effects of a particular type of activity), and a generic rule that defines as permitted, any activity capable of meeting the standards with a MANC zone of zero.

A zero MANC zone is recommended because to generically declare that an activity be a PA, there must be certainty that ‘reasonable mixing’ will always occur. The legal implication of a ‘reasonable’ mixing zone is that any adverse effects that do occur within the mixing zone may be argued to be the ‘permitted baseline’. Permitted baseline means the accepted level of effect against which future resource consent applications will be evaluated. Our view is that we are unable to defend a generic mixing (maximum allowable non-compliance [MANC]) zone, for all the listed contaminants, and across all management units (MUs), of anything greater than zero. MANC zones of greater than zero cannot be guaranteed to protect the most sensitive water-body in each Management Unit (MU) against all conceivable effects of the contaminants for which we have provided standards.

The value of a zero MANC zone rule is to provide a clear indication of the Council’s direction and to create an incentive for high levels of treatment for the future. However, a zero MANC zone may be unnecessarily restrictive or impractical for some specific types of discharges where the contaminants are well understood. The process of setting rules for PAs in a plan involves acknowledgement of the basic tension between practicability (the desire to enable reasonable use of natural and physical resources and avoid unnecessarily cumbersome administrative processes) and sustainability (particularly the protection of natural and physical resources). The generic mixing zone for PAs of zero, does not preclude the possibility of declaring some larger MANC zone (or an allowable dilution rate) is ‘reasonable’, and therefore permissible, for some specific activities for which we have a good understanding of the contaminants. Thus, we recommend some PA rules be developed on an ‘activity’

[13] Note that the discussion in section 11.5 applies equally if MADR is used instead of MANC.

basis (e.g., stormwater, bore test water, swimming pool discharges) rather than on a generic basis. These activity-specific rules could allow MANC zones greater than zero (see Figure 5).

The logical starting point for any defensible approach to activity based PA rules is section 70(1) RMA which states that:

(2) Before a regional council includes in a regional plan a rule that allows as a permitted activity-

(a) A discharge of a contaminant or water into water: or

(b) A discharge of a contaminant onto or into land in circumstances which may result in that contaminant (…) entering water,-

The regional council shall be satisfied that none of the following effects are likely to arise in the receiving waters, after reasonable mixing, as a result of the discharge:

(c) The production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials:

(d) Any conspicuous change in the colour or visual clarity:

(e) Any emission of objectionable odour:

(f) The rendering of fresh water unsuitable for consumption by farm animals:

(g) Any significant adverse effects on aquatic life.

Activity-based rules have already been recommended for ECan by Main (2003), for discharge of; swimming pool, aquifer, bore test, reservoir, and land drainage waters, with conditions requiring that standards (for temperature, colour, clarity, pH, oils, grease, scums and foams) are met in the receiving water below a mixing zone of 20 times the width of the receiving water at the point of the discharge. Main (2003) proposes that this mixing zone is 'reasonable' in the context of s70 RMA for these types of discharges. Main (2003) proposes that discharge of water tracers should be a 'controlled activity' but all other discharges are 'discretionary', 'non-complying' or 'prohibited'. From a technical perspective there are some other types of discharges that are relatively well understood and for which PA rules could be derived (e.g., domestic sewage oxidation pond and dairy shed oxidation pond discharges). However, these activities involve complications with cultural aspects of water quality that cannot be easily measured and that could impact on s6 RMA. We believe ECan is likely to want to manage these activities as discretionary or non-complying activities requiring resource consents.

Main (2003) also recommends PA rules for stormwater discharges but does not in this case use standards (and therefore mixing zones) in the conditions. Rather the conditions in the stormwater PA rules restrict the catchment area and type, and the treatment method, effectively following something akin to a best practicable option (BPO) approach. This approach is allowed for (instead of using standards) in s70(2) RMA.

It is beyond the scope of this report to review the detail of the recommended rules for PAs in Main (2003), however, we do have a general comment that relates to the management framework approach that we have adopted in our report. The framework (Section 4) establishes the importance of the link between the spatial management unit (where?), the purpose for management (why?), the objective (what?) and the method (how?). The management objective (and, therefore, the purpose for management) is important in determining what mixing zone is 'reasonable' in any particular case (refer Section 8.6). This has implications for the tests of s70(1) RMA that ultimately must be met for all the PAs proposed in Main (2003). It is not easy to conclude that all the tests of s70 RMA are met for the PAs recommended by Main (2003), particularly for stormwater. We suggest that the defensibility of the PA rules proposed in Main (2003), in particular the PA rules for stormwater discharges, would be enhanced if the purposes for management were more transparently communicated in the NRRP. For example we recommend that ECan consider the "collection and transportation of stormwater" as a legitimate additional purpose for management for waterways in the "Urban Streams" management unit (e.g., Avon and Heathcote Rivers). The existing purposes for management for the 'Lowland Rivers' MU (which most urban streams fall into) (i.e., trout, native fish, stockwater and contact recreation), make it very difficult to justify as 'reasonable', the large zones of non-compliance with standards (e.g., for clarity and colour) that occur during stormwater discharges. Thus we recommend that an appropriate 'purpose for management' is required in cases where activity-based PA rules apply, in order to retain the transparency and integrity of the management framework.

11.6. Mixing zones, MANC zones and MADRs

We consider that the concept (and the reasons for) defining MANC zones and/or MADRs in plans, are fully justified by the impossibility of defining 'reasonable' at the regional (strategic) level of resolution. In their discussion of reasonable mixing in water quality management, Rutherford *et al*. (1994) argue that 'reasonable' can only be determined on a case-by-case basis. They support their view by quoting from the court decision by *Mahuta and Others v National Water and Soil Conservation Authority* ([1973] 5 NZTPA 73; in Rutherford et. al. 1994) which states that:

"…what is a reasonable mixing zone will be a question of fact and degree in each particular case…"

We support this argument and can find no reason to propose that 'reasonable' could be determined on any other basis.

Potentially, several different MANC zones could be defined for different classes of contaminants instead of just the two (Type 1 and Type 2 contaminants) defined in Section 9.9. For example, the following has been suggested:

1. High toxics (e.g., arsenic) – smallest MANC zone

2. Moderate toxics (e.g., ammonia)

3. Direct temperature and DO effects

4. Chronic effect contaminants (e.g., nutrients, faecal indicators, BOD, suspended solids, colour, clarity etc) – largest MANC zone

The choice of MANC zones for different classes of contaminant are really social-political judgements and are not defined on a technical basis. These decisions are associated with the definition of purposes for management and objectives (i.e., subjective judgements that concern what constitutes an acceptable or unacceptable adverse effect) (see Section 11.4). Further subdivision of MANC zone sizes according to the suggested contaminant categories is possible, however, its effect would be to increase the number of subjective judgements associated with objectives, potentially increasing the requirement to justify differences, and also increasing the complexity of the final framework. The complexity of the framework will be a challenge when it comes to presenting these concepts in the NRRP.

It has also been suggested that a 'maximum allowable dilution ratio' (MADR) could be used as a simpler alternative to using the MANC zone (see Section 9.6). We agree with this suggestion and note that a significant advantage of using MADRs over MANC zones is that the calculations required are much simpler (see Section 9.10.3). The disadvantage of using MADRs is that they cannot be used for lakes and this necessitates using two different systems of terminology (i.e., both MANC zones and MADRs). ECan also needs to consider which terminology it will adopt for permitted activities because maximum non-compliance zones have already been proposed (in Main 2003) in terms of length and width (rather than as allowable dilution ratios) for several activity-specific rules for permitted discharges. We have recommended that ECan consider the relative merits of using MADRs instead of MANC zones for rivers.

It has also been suggested that the use of terms 'maximum allowable non-compliance zone'and 'maximum allowable dilution ratio' (and associated acronyms MANC and MADR) is complicated and possibly unnecessarily cumbersome. We agree that the terminology surrounding mixing zones is complex, and this represents challenges to create a simple presentation in the plan and to educate plan users. However the words have been chosen to be as precisely descriptive of the meaning of the terms as possible. The need for plan users to understand the meaning of the terms 'non-compliance zone' and 'dilution ratio' is unavoidable (see Section 9.3). Adding 'maximum allowable' is intended to clearly distinguish the fact that the defined MANC and MADR are the arbitrarily defined maximums allowable for discretionary activities under the ECan NRRP (see Glossary).

An important technical aspect of calculating the non-compliance zone (or using the MADR), is defining the magnitude of the river flow that is assumed, for example; median annual daily flow, mean annual low flow (MALF) or 7-day 10 year recurrence interval low flow (7Q10). It will be necessary to define the flow for calculating the non-compliance zone (or using the MADR) in the plan so that a potential resource user can compare their non-compliance zone with the MANC zone. It will equally be necessary to define the flow statistic to be used for applying the MADR.[14] The options for defining this flow statistic include anything from the median annual daily flow to the 7Q10, or statistics of even lower recurrence frequency (i.e., >10 years). The choice of flow to use is important because the flow rate will determine the shape and size of the non-compliance zone (or the amount of dilution available using the MADR). Clearly, decreasing the magnitude of the flow will reduce the allowable MANC zone (or the the available dilution using the MADR). Using very low flows to calculate non-compliance zones may lead to very restrictive discharge conditions that may be unwarranted because they are rare conditions (e.g once every 10 years for the 7Q10). On the other hand, using the median annual daily flow could lead to discharge non-compliance zones greater than the MANC zone for half the days in a year. The choice of flow rate cannot be made on a purely technical basis. ECan will need to consider carefully the size of the MANC zone or MADR, together with the flow statistic (these two factors are inversely inter-related), in making a decision on what it considers acceptable. At this stage we consider the MALF is a logical starting point as it represents an approximate mid-way in the range of options. However we recommend that ECan consider the different consequences of using MALF and 7Q10, at the least by running a range of hypothetical discharge scenarios for comparison. This could possibly be undertaken as part of ECan 'section 32 (RMA)' analysis.

[14] Note that this raises an interesting legal issue. In a Decision on the Otago Regional Water Plan (Environment Court decisions C71/2002 and C792002) the Judge rejected the notion that minimum flows could be calculated from a flow statistic (e.g. MALF, 7Q10) because the statistic is subject to change and is therefore uncertain. This could have implications for our framework because of the need to define the way that a potential discharger calculates their non-compliance zone (e.g. what river flow, what effluent flow, what ambient contaminant concentration, etc). It will not be possible to provide numbers for these measures for every waterway in Canterbury. This issue will therefore need further investigation from a legal perspective and we have not undertaken this as part of the current report.

11.7. Incorporating downstream effects

The plan needs to ensure that consenting processes consider situations where waterways flow into a different downstream management unit (MU), for which there might be different plan provisions. The obvious example is rivers flowing into lakes (e.g., alpine and hill rivers flowing into high country lakes, and lowland rivers flowing into coastal lakes). Another important example is rivers flowing into the Coastal Marine Area (CMA) for which management provisions (including water quality standards) are already defined in ECan's Proposed Regional Coastal Plan. We note that this issue also applies to rivers that change MU partway down the river network. However in most (if not all) cases the upstream MU will have provisions that are at least as onerus as the downstream provisions, and so this is likely to be less of a concern for rivers than for lakes. This is a complex problem that we cannot solve within the scope of this report. However, the use of the proposed spatial framework can improve the case-by-case assessment procedure because the plan provisions will be clearly tied to spatial management units (MUs) and it will be possible to identify whether downstream MUs are affected by a discharge. Plan provisions should state that any discharge to a river that flows into a different downstream management unit will have to meet the objectives for both the immediate MU and the downstream MU.

We acknowledge that the science that could establish a link between an activity in a river and the attainment of objectives in a lake (or the CMA or downstream MU) is complex. This makes the definition of standards for an upstream MU, which are intended to protect the downstream MU (e.g., nutrient concentrations in a river that will protect against mass loading issues, eutrophication and consequent changes to colour and clarity in a downstream lake), beyond the scope of this report. However we recommend that the link is made in the plan at the level of the objective, thereby informing resource users that this will be considered during consent processes.

11.8. Non-point source and cumulative effects

While the 'Consent decision-making model' (Figure 5) is primarily designed to deal with point-source discharges, the framework does offer some advantages for managing non-point source effects and the effects of cumulative point sources, and should be compatible with future developments in the assessment of non-point source and cumulative effects. There are two key advantages of the framework for dealing with these effects. First, the framework establishes a measurable (numeric) objective, against which to measure cumulative as well as non-point source effects. This is one of the key reasons that we propose that objectives are specific to the effects of different contaminants and are numeric. Second, there is no reason why the 'Consent decision-making model' (refer to Figure 5) could not be used for non-point source discharges. Sections 9 and 15 of the RMA provide for the management of land-use and discharges respectively. The key requirement will be to demonstrate the link between a particular land-use (or intensification of land-use) and receiving water contaminant concentrations and mass loads. Section 15 RMA is not limited to point-source discharges but includes any discharge of a contaminant onto, or into, land in circumstances which may result in that contaminant entering water. Several regional councils are pursuing regional rules that restrict land-uses that result in increased nutrients entering waterways (e.g., Environment Bay of Plenty's proposed Rule 11 [http://www.boprc.govt.nz/publications/PDF/PlansStrategies/ProposedRWLP.pdf], and Environment Waikato's proposed rules for Lake Taupo catchment land-use [http://www.ew.govt.nz/policyandplans/taupo/index.htm]). We reiterate that it is the objective that is the most important component of any framework that attempts to tackle such non-point source effects and identify key issues.

11.9. Providing a context with existing ECan water quality data

It would be useful, and probably necessary as a part of a 'section 32 RMA analysis' of benefits and costs, to compare measured water quality for the proposed ECan management units (MUs) with the numeric objectives and rules that have been proposed. This analysis is beyond the scope of the existing report but we do note that some useful comparisons can be made using the regional water quality results presented in *An Overview of the Surface Water Quality of the Rivers and Streams of the Canterbury Region* (Meredith and Hayward, 2002), acknowledging that the river groups are not identical to the management units (MUs) now proposed. We have conducted a preliminary comparison with the existing data and this is presented in Appendix 6.

In Appendix 6, four plots from Meredith and Hayward (2002) have been reproduced with the addition of horizontal lines indicating the position of the options for numeric water quality rule standards proposed in this report. From this preliminary comparison an analysis can be made on whether the proposed rule standards are likely to be restrictive (conservative) or enabling of resource use for most rivers within a particular MU, and therefore the likely consequences for management of selecting a particular option. This kind of analysis can be used by ECan in making decisions about which 'level of protection' options to select from the tables in Appendix 4. It is recommended that such analysis be taken further, as part of implementing the options for numeric objectives and rule standards provided in this report into the NRRP.

Data analysis will, in addition to having a 'section 32 RMA' purpose, allow some of the purple cells in the tables of proposed numeric objectives and standards (Tables 1-12, Appendix 4) to be developed further. The purple cells indicate variables to which we have not been able to assign numeric objectives and/or standards, and instead have resorted to less ideal narratives. An analysis of existing data may allow assignment of numeric objectives for some of these, in particular for example, for objectives for colour and clarity in both river and lake MUs.

11.10. Considering alternatives for the classification of lakes

Following the delineation of ECan's existing lake MUs (see Section 6.3.2) and the development of proposed numeric objectives and rule standards for these lake MUs (see Tables 8-12, Appendix 4), it has become clear that there is significant variability in the water quality characteristics between some lakes within an MU, particularly in the 'large high country lakes' MU. This variation has limited our ability to assign appropriate numeric objectives for some variables (e.g., for colour and clarity) because lakes within the same MU exhibit such different characteristics (e.g., colour and clarity differences between Lakes Coleridge and Tekapo).

While we have been able to recommend 'rule standards' for colour and clarity based on 'percentage change' criteria in published guidelines (see Table 8, Appendix 4), we have not undertaken data analysis that would enable us to recommend absolute numeric objectives for colour and clarity. This means that the opportunity to define a benchmark for assessing non-point source and cumulative effects is lost. The result is that, in theory, many consents could be granted for point source discharges, each allowed a percentage colour change, the cumulative total of which could significantly change the overall colour of the lake. Similarly non-point source effects (e.g., land-use changes) could significantly change the overall colour of the lake without this ever being recognised (or indeed even measured) as being contrary to plan objectives. Colour and clarity are likely to be key management drivers for high country lakes because if appropriate colour and clarity objectives are achieved, it is likely that most other objectives would also be achieved.

This situation, combined with the fact that the number of 'unique' lakes in the large high country MU is small (and therefore of manageable complexity) justifies a review of the existing lake classification in future. There is national interest in developing a classification system for lakes and we understand that ECan has initiated discussions about the possibility of a Canterbury lake classification system for other purposes. We recommend that this be investigated further and that any classification system for Canterbury lakes be developed for multi-purposes, one of which should be the improved resolution of a spatial framework for managing lake water quality.

11.11. Increased need for monitoring

A potential issue that this management framework approach raises is the requirement for monitoring. An increase in monitoring may be deemed necessary because the framework establishes the benchmarks with a higher level of measurability, thus creating the imperative to monitor its effectiveness. This is a cost that must be weighed against the commitment to environmental outcomes and increased certainty and justifiability that the framework achieves.

11.12. Natural State

The problem with using 'natural state' as a purpose for management, in the management framework approach that we apply here, is that it is too unspecific to be used as a nominated value for setting standards. However, we consider that 'natural state' is a relevant narrative objective. The use of natural state as an objective in a regional plan would incur the same disadvantages as other narrative objectives (i.e., lack of certainty and justifiability) (see Section 4). We have adhered to a rigorous approach to derive the standards presented in this report in order to overcome these disadvantages and to establish certain and justifiable plan provisions. An objective of 'natural state' would not allow such certain and justifiable plan provisions to be established. A natural state objective, however, would allow council to manage particular areas (in effect a specific management unit) to a very high level of protection, for example as set out in the Third Schedule of the RMA for Class NS (natural state) waters "The natural quality of the water shall not be altered". In line with this, we believe that the policies and methods that follow a 'natural state' objective, would require that all discharges (and possibly other activities) would need to be non-complying so that a high level of discretion was maintained and resource use in these areas would be carefully managed. The disadvantages incurred in using narrative objectives and standards discussed in Section 4, would need to be considered in adopting natural state as an objective.

11.13. Automating the process

It has been suggested that there will be a significant requirement for education and guidance of plan-users through the process proposed in this report. It has also been suggested that this would be helped by developing a decision support system. We agree and recommend that ECan consider developing such a decision support system as described in Section 10.5.

12. Conclusions and Recommendations

We endorse the approach to regional management of water quality that has been developed in this document. Any development in this complex area will be associated with risks. The effects and implications of the framework cannot be completely foreseen. Thus, as is the case with any policy framework, ongoing monitoring will be required and revisions may be necessary.

We conclude by suggesting that the proposed framework needs to be evaluated in terms of its benefits for all of the regional council's functions in respect to water quality management. In particular, the framework should not be 'tested' by considering how it might work in single, large and topical resource consent processes. We suggest that in these cases the framework will result in very little difference to the final decision because either with, or without this framework, decision making is made on a case by case basis with a high level of information. Rather, the framework should be considered with respect to the much greater number of small consents that are never involved in a public process, and as a framework for ongoing monitoring, feedback and long term revision of policy.

We recommend that ECan:

1. Adopt this framework for water quality management in the NRRP subject to section 32 RMA analyses. In particular we recommend that the following steps be taken, either as part of section 32 RMA analyses or as a separate exercise:

   a) Use the spatial framework described in Section 6, but add an 'urban' management unit (MU) to the framework. This will be useful for applying appropriate purposes for management to urban streams (e.g., Avon and Heathcote Rivers) and may help to justify ECan's proposed activity-specific permitted activity rules (Main, 2003), particularly for stormwater discharges (see Section 10.5). The REC can be used to delineate this MU.

   b) Use the MANC zones recommended for lakes (Section 9.9) and the MADRs recommended for rivers (Section 9.10), but undertake an analysis of the relative benefits of using MANC versus MADR, and the MALF versus the 7Q10 as the flow statistic for calculating non-compliance zones (see Section 11.6).

   c) Use the numeric objectives and rule standards recommended in Tables 1-11 of Appendix 4, but undertake an analysis to compare these numbers with existing data for river and lake MUs. Use this type of analysis to review decisions about which options to select, and to develop numbers for as many as possible of the outstanding variables (highlighted as purple cells in the Appendix 4 tables).

d) Use rules for 'permitted activities' on an activity-specific basis, as has been proposed in Main (2003), including the definition of appropriate MANC zones for each activity (see Section 11.5). Also, notwithstanding these activity-specific rules, use a generic rule for 'permitted activities' that defines all activities capable of meeting the standards with a MANC zone (or MADR) of zero, as permitted.

e) Use 'natural state' as a management objective for specified areas and identify these waterways in the spatial framework (see Section 11.12). Treat all discharges in these areas as non-complying activities.

(2) Recognise the limitations and risks of the framework, and take active steps to ensure these will be effectively managed. Specifically we recommend that the following will be needed:

a) Undertake a review of legal implications of the proposed framework including the footnotes in Section 9.7 (footnote 9) and Section 11.6 (footnote 14), as well as issues with s69(3) RMA, and solutions to problems raised in Section 5.2.

b) Provide a clear presentation of the framework and all key concepts and terminology in the NRRP.

c) Educate NRRP users on the source of the numbers and the importance of the link with guidelines at the operational level.

d) Consider developing a web-based decision support system as described in Section 10.5.

e) Ensure that a link is created in the NRRP (at the level of objectives) to provide for the incorporation of downstream effects (see Section 11.7), and acknowledge this as an area for future development of the framework.

f) Ensure that a link is created in the NRRP to establish the objective as the benchmark against which cumulative and non-point source effects will be measured and assessed (see Section 11.8). Also acknowledge this as an area for future development of the framework.

g) Acknowledge that this management framework may increase the requirement for monitoring, and the cost of this needs to be weighed against a commitment to environmental outcomes as well as certainty and justifiability for plan provisions (see Section 11.11).

(3) Recognise that this is a developmental piece of work and the framework is adaptable. Make a commitment to continued development to improve the framework. Specifically the following improvements to the framework have been identified that could be achieved in the short term:

a) There are still some variables for which we have not been able to provide both numeric objectives and numeric standards (these are highlighted in the purple cells in the tables in Appendix 4). These gaps should be targeted, first with the existing data analysis recommended under recommendation (1) above. If this is not sufficient then any outstanding gaps should be targeted with monitoring and investigations specifically designed to fill the gaps. In particular we recommend that objectives and rule standards for 'suspended solids' are desirable, because suspended solids are a key variable for environmental effects.

b) There may be significant advantages in reviewing the classification of lake MUs (as discussed in Section 11.10).

c) Progress with scientific understanding of non-point source (e.g., landuse) and cumulative effects. This is currently an active area of scientific investigation and should be compatible to incorporate with the framework (see Section 11.8).

13. Glossary

The meanings of terms used in this report are provided in the Glossary below. Where possible we have used the definitions for a number of common planning terms as provided in MfE (1994b).

CRITICAL VALUE: In the tables of Appendix 4 we have used the term critical value to establish the most sensitive value from amongst the values listed in the purpose for management. A critical value is nominated for each water quality variable and is then used to derive an objective and standard that is protective of all the values listed in the purpose for management.

GUIDELINES: The term guideline is used to describe the guidance for environmental outcomes provided in published guideline documents (e.g., ANZECC & ARMCANZ 2000, USEPA 1999, MfE 1992, MfE 1994a, Biggs, 2000). These documents suggest environmental outcomes (both as numbers and narrative statements) that may be appropriate depending on consideration of the particular location, the environmental values, the purpose for management, and the level of protection required. Guideline documents describe the detail surrounding this consideration and provide options, but they leave the determination of the appropriate environmental outcomes to the user. There is often confusion between the meanings of guidelines and standards. Guidelines do not have any statutory meaning and are therefore different from standards that appear in rules in a regional plan.

LEVEL OF PROTECTION: The concept of a level of protection acknowledges that values can be protected at different levels, and there is therefore a choice to be made about how protective management should be. The relationship between concentration of a water quality variable and the level of protection is technically defined (e.g., by scientific means) but the choice of level is ultimately a political decision. For example in Table 1 (Appendix 4), several levels of contact-related illness risk can be chosen to define objectives for microbiological water quality. The choice of a high level of protection (i.e., low risk of illness) leads to an objective and rule standard that is more restrictive of resource use than would be the case if a lower level of protection is chosen.

MANAGEMENT UNIT (MU): These are spatial units that group rivers and lakes that are considered to be similar enough to be treated similarly for management. In this report MUs have been defined by grouping rivers and lakes on the basis of physical attributes (e.g., source of flow, geology, size, catchment elevation). For rivers, the MUs have been delineated using River Environment Classification (REC) (refer Section 6). MUs could be defined by other means, such as by geographical location. An example of MUs being defined by geographical location is the various parts of the Waimakariri River catchment defined as classes in the Proposed Waimakariri River Regional Plan (PWRRP) (refer Section 6.1).

MAXIMUM ALLOWABLE DILUTION RATIO (MADR): This is the largest proportion of a river's flow that may be used to dilute a contaminant to meet a water quality standard for a discretionary activity. Note that this is an arbitrary limit set in the regional plan for the purpose of managing the mixing of discharges to water. Also note that while this is a *maximum* allowable dilution ratio, it does not preclude the requirement for a smaller dilution ratio in some circumstances. The MADR zone is not a replacement for the definition of *reasonable* mixing.

MAXIMUM ALLOWABLE NON-COMPLIANCE (MANC) ZONE: This is the largest zone within which water quality standards may be exceeded for a discretionary activity. Note that this is an arbitrary limit set in the regional plan for the purpose of managing the mixing of discharges to water. Also note that while this is a *maximum* allowable zone, it does not preclude the requirement for a smaller zone of non-compliance in some circumstances. The MANC zone is not a replacement for the definition of *reasonable* mixing.

METHODS: The term method is used as it applies to a method in a regional plan. The methods answer the question 'How will the policies be implemented?'. The methods should contain the specific actions, techniques, programmes and procedures to be adopted by the plan (MfE, 1994b). Regional plans typically use a wide range of methods for achieving water quality objectives. These range from rules governing land development in catchments, to community education initiatives, to water quality rules and standards for discharges. In this report, we are specifically concerned with one type of method - setting numeric water quality standards in rules for point discharges.

OBJECTIVES: The term objective is used as it applies to an objective in a regional plan. The objective answers the question 'What environmental outcome is required to support the purpose for management at the desired level of protection?'. The objective should expound the state of the resource or the environmental value which is sought (MfE, 1994b). It should relate directly to a specified issue and it should state what the council wishes to see from the resolution of the issue (MfE, 1994b)

POLICIES: The term policy is used as it applies to a policy in a regional plan. The policies answer the question 'How will the objective be achieved?'. The policies should relate directly to a stated objective and should address the effects that need to be managed in order to achieve that objective (MfE, 1994b). In this report, we are specifically concerned with policy requiring that point discharges do not give rise to water quality that is inconsistent with the objectives.

PURPOSE FOR MANAGEMENT: The purpose for management refers to specifically identified values that are the focus for management within an MU. The purpose for management is an answer to the question 'Why are we managing this MU?'. The identification of purposes for management involves value judgements as to the significance of each of the values identified in a specific MU. Judgements as to the significance of values is required because values may occur in MUs but may not be significant enough to warrant that MU being managed for that value. Judgements are also required where values conflict with one another. Defining purposes for management has potential for considerable controversy and is ultimately a political decision.

RULES: The term rule is used as it applies to a rule in a regional plan. Rules usually contain activity-specific restrictions or standards. Rules are just one of the methods that can be used to implement policies in a regional plan (refer methods above).

STANDARDS: The term standard is used as it applies to a rule in a regional plan and in the RMA (1991). Standards that are contained in rules in a regional plan are one method of implementing policy to achieve an objective. The standard should relate directly to a stated objective, and should provide a measure by which rules can define restrictions. Standards may be numbers or narrative statements but generally numbers provide a more certain measure. There is often confusion between the meanings of standards and guidelines. Standards that appear in rules in a regional plan have statutory certainty and are therefore different from published guidelines which do not have this meaning.

VALUES: A particular value for a river or lake may be considered as a 'worth' (e.g., as a habitat for fish and other species), a 'use' (e.g., for swimming, irrigation, or assimilating discharges), or a 'rated importance' (e.g., for human visual or spiritual satisfaction, or natural or historical significance). Values may be identified for each MU using combinations of data analysis, expert assessments and public consultation.

WATER QUALITY VARIABLE: This term is used to describe a measurable aspect of water quality (e.g., *E. coli*, dissolved oxygen, temperature, pH etc).

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Objectives, Water Classes, Standards and Rules for Water Quality

1. INTRODUCTION

Since 1967, legislation has provided for surface water bodies to be managed to maintain certain minimum levels of water quality. The original system of water classification and water quality classes established under the Water and Soil Conservation Act has been replaced in the RMA with a system of water classes for water bodies according to the purpose for their management.

The establishment of water quality classes is not a mandatory requirement under the RMA. Some regional councils, including Environment Canterbury, have adopted water quality classes in regional plans but other councils have chosen not to do so. Even where water classes have been used in regional plans, different approaches have been used to establish the water quality classes and implement water quality standards. A legal opinion obtained by ECan[15] has pointed out a number of problems with the water classification system in the RMA.

The purpose of this paper is to evaluate whether water quality classes will help ECan to achieve the regional water quality objectives in the Natural Resources Regional Plan.

2. LEGAL FRAMEWORK

The RMA provides for three types of water quality standards: national water quality classes, regional plans, and statutory minimum standards:

National environmental standards

National environmental standards can be prescribed relating to the use, development and protection of natural and physical resources, including standards for water quality[16]. These standards are not automatically included in regional plans. Regional councils when they are preparing or changing a regional plan must have regard to any national environmental standards to the extent that their content has a bearing on resource management issues of the region[17]. The regulations can prescribe the methods for implementing the standards. At present there are no national environmental standards for water quality.

Regional plans

Section 69 of the RMA allows a regional council to classify waters for specific management purposes. (Appendix 1) The Third Schedule contains the classes specified in the Act and the set of standards for each class.(Appendix 2) The water quality standards are a mix of quantitative parameters and narrative statements, such as *"water shall not be rendered unsuitable for bathing by the presence of contaminants*". The standards are to apply after reasonable mixing of any contaminant or water with the receiving water, and natural perturbations that may affect the water body are to be disregarded[18].

In most cases, water bodies will be managed for multiple values. Water quality classes could be established for several purposes, such as contact recreation and aquatic ecosystems. Alternatively, instead of specifying standards for each purpose, the standard could be based on the purpose or value that has the highest water quality requirements. This standard would define the class and at the same time provide for other values.

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[15] Milne P ECan Legal Opinion L960077
[16] RMA s 43
[17] RMA s66(2)
[18] RMA Third Schedule, Introductory Note

Unlike the previous legislation, the RMA gives regional councils more flexibility to develop water quality classes. Regional councils have the discretion to apply more stringent or specific standards[19], and to classify receiving waters on an area by area basis or throughout the region. Standards cannot result in a reduction of the water quality at the time the plan is notified, unless this is consistent with the purpose of the Act[20]. Section 69(3) implies that the current quality of the water must be known, to ensure that standards will either maintain or improve quality and not allow it to degrade.

Where a regional rule specifies minimum water quality standards, a regional council can choose to review the conditions on existing discharge permits to bring them into line with the water classification[21].

Section 69(1)(b) implies that dischargers must meet receiving water quality standards, and this may be enforceable as a statutory requirement, irrespective of consent conditions. Practically, a regional council must impose conditions to ensure that the standards will be observed.

Statutory minimum water quality standards

The RMA has through the provisions of sections 70 and 107 effectively put in place some statutory water quality standards that apply to all freshwater bodies in the country irrespective of whether there is a water quality rule in a regional plan or water quality class.

Section 70 of the RMA provides that before a regional council includes a rule in a regional plan allowing, as a permitted activity, a discharge into water or onto land where it may enter water, the council must be satisfied that none of the following adverse effects are likely to arise in the receiving water after reasonable mixing as a result of discharge of the contaminant (either by itself or in combination with the same, similar, or other contaminants):

"*. . . (c) The production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials:*

(d) Any conspicuous change in the colour or visual clarity;

(e) Any emission of objectionable odour:

(f) The rendering of freshwater unsuitable for consumption by farm animals:

(g) Any significant adverse effects on aquatic life."[22]

Similarly, section 107 provides that a consent authority when considering an application for a discharge permit cannot grant a permit[23] to discharge contaminants to water or onto land where that contaminant may enter water and give rise to the same adverse effects as listed above[24] unless the consent authority is satisfied that:

" . . .

(a) that exceptional circumstances justify the granting of the permit; or

(b) that the discharge is of a temporary nature; or

(c) that the discharge is associated with necessary maintenance work -

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[19] RMA s. 69 (2)
[20] RMA s 69 (3)
[21] RMA s 68 (7)
[22] RMA s 70 (1)
[23] RMA s 107 (1)
[24] RMA s 107 (1) (c). . .(g)

and that it is consistent with the purpose of this Act to do so. "

When making decisions on applications for resource consents, section 105 requires that no consent be granted contrary to s107[25].

The combined effect of ss 70 and 107 is that discharges to water causing any of the listed effects are effectively prohibited by the Act (unless the exceptional circumstances of s107(2) apply), and these sections in effect impose statutory minimum water quality standards. These baseline standards apply irrespective of whether there is a water class or water quality rule in force.

Sections 70(1) and s 107(1) use narrative or descriptive standards to set the limits to any decline in water quality. The application of these standards involves a value judgement, and therefore it is likely that debate will arise over the meaning of terms such as "reasonable mixing", "significant", "objectionable", "unsuitable" and "conspicuous". These provisions of the RMA appear to offer a very useful tool for the management of water quality in respect of discharges. Environment Canterbury has included the use of water quality classes in each of the Regional Plans produced to date. Not all other regional councils have included water quality classes in their plans. .

There are, however some constraints with the use of water quality standards in rules that apply where water classes have been established, particularly for those classes contained in the Third Schedule. . The standards set in these water classes are generally narrative, rather than quantitative standards, and are to be achieved after "reasonable mixing" of the contaminant in the receiving water. The standards are subject to interpretation and thereby are inherently uncertain. Moreover, any rule implementing a water class must require that a discharge observe the water quality standard after reasonable mixing. This requires a subjective judgement of both the 'reasonableness' of the mixing zone and the narrative standards. The final judgement on these matters is left to the decision-makers on a discharge permit application. A potential resource user could not, with certainty, know in advance of a decision on an application for a discharge permit whether or not their discharge would result in the water quality standard for the class being observed.

3. APPROACHES TO WATER CLASSES AND WATER QUALITY STANDARDS

Water classes and water quality standards are used in four Canterbury Regional Plans, and water quality standards are set in the National Water Conservation Orders for the Ahuriri River and the Rakaia River.

3.1. ECan Plans:

Environment Canterbury has four proposed or operative regional plans relating to water quality. In each of these, different approaches have been adopted around water classes and the setting of water quality standards. A summary of these approaches is presented in Figure 1.

3.1.1. Transitional Regional Plan

The Transitional Regional Plan (TRP) contains Final Water Quality Classifications made under the Water & Soil Conservation Act (WSCA), deemed under s369(3) of the RMA to be provisions in the Transitional Regional Plan. The water quality classifications apply to the water bodies specified in the Plan. All discharges within the classified waters require resource consent. The water quality standards for the various classes referred to in the TRP are contained in the schedules to the WSCA. These include a range of narrative and numeric standards.

The WSCA water quality standards themselves did not have an "after reasonable mixing" provision, but the consideration of reasonable mixing was made when considering a water right to discharge into any water that had been classified. RMA section 369(3) deemed that

[25] RMA s 105(2)

the TRP include a regional rule requiring the water quality standards to be complied with "after reasonable mixing". This size and nature of the mixing zone is required to be considered by decision-makers on a case-by-case basis during the assessment of the application for a discharge into classified waters.

The TRP establishes that meeting the water quality standards is the determining factor for whether a discharge is to be considered as a discretionary activity or a non-complying activity. The water quality standards are precedent conditions i.e. they set the entry/exit criteria for the status of the activity. As the standards are to be achieved after reasonable mixing, and there is no description of what reasonable mixing means, an applicant would not know whether their discharge was a discretionary or non-complying activity until the decision on whether the proposed mixing zone was 'reasonable' had been made in the consent process.

Other rules in the TRP apply to discharges outside of classified waters. These rules set conditions which a discharge is to meet if it is to be a permitted activity. There is no requirement to meet standards after reasonable mixing.

3.1.2. Opihi River Regional Plan

This plan does not contain policy provisions that provide for water classes to be established or to set water quality standards. However, the plan contains rules relating to discharges. Rule 1 Chapter 6 Surface Water Quality of the Plan makes any discharge to surface water (other than permitted activities in the TRP) a discretionary activity.

The rule sets standards and terms, requiring the activity to comply with the "standards contained in the water quality class", after reasonable mixing. The class, OPIHI water is then described as water being managed for a range of purposes and the water quality standards contain a mix of numeric and narrative standards.

The OPIHI water class applies to all surface water in the catchment. The water quality standards are to be observed subsequent to the discharge occurring, and presumably, conditions would be imposed on all discharge permits to ensure that the standards would be observed. The conditions are not precedent, i.e. they do not set the entry /exit criteria for the activity status as there is no mechanism to change the status of the activity if compliance is not observed. By default, an activity which did not meet the water quality standards would contravene the rule in the Plan and would thereby be a non-complying activity.

3.1.3. Waimakariri River Regional Plan

This plan contains policy to set water quality standards in various areas of the catchment which are identified for different purposes of management..

Rule 6.1 Discretionary Activity, makes discharges that are not permitted activities under the TRP, discretionary activities. The plan then sets standards and terms that the activity must comply with. The standards to apply in each "class" are then listed. The standards are a mix of narrative and numeric requirements. The water quality standards set out "*shall be observed*" with standards applying after reasonable mixing and the water quality standards are to be the "*sum total of all substances in the water body, whether they are contaminants from discharges or are existing in the background state*". Reasonable mixing is not defined in the Plan.

The plan provides for existing consents to be reviewed "*to enable the standards and terms set by the rule to be met*".

Rule 6.2 makes any discharge, apart from permitted activities, which does not comply with the water quality standards and terms set by rule 6.1 a non-complying activity.

Water quality standards have been set within activity rules. The standards are precedent conditions – if they are not met then the activity becomes non-complying. The standards are to be achieved after reasonable mixing. As there is no definition of what reasonable mixing means, an applicant would not know whether their discharge was a discretionary or non-complying activity until the decision on whether the proposed mixing zone was 'reasonable' had been made during the process to decide on the application.

The Section 32 analysis for the proposed Plan states that the use of water quality standards will:

- protect values associated with water bodies
- provide certainty about environmental results
- ensure a consistent approach to decisions on discharge permits
- ensure dischargers know the conditions they have to meet.

The S32 analysis concluded that, without standards each resource consent application would be decided on its merits without reference to receiving water standards and this would lead to inconsistent decisions and poor environmental outcomes. Consent hearings were considered the best place to determine the extent of mixing zones, the location of the discharge in relation to other discharges, the effect on other discharges and the uses of the river at the point of discharge.

The water quality standards in the Plan are both precedent and subsequent conditions for an activity. They must be observed prior to a discharge being authorised as a discretionary activity, and then continue to be observed during the exercise of the consent. As the standards to be observed include the background water quality, as well as any discharges, a discharger may be restricted by background water quality – if this were to change, and the discharge no longer "observed" the standards, then the discharger could be subject to enforcement, despite having a resource consent authorising the discharge.

3.1.4. Proposed Coastal Environment Plan

This plan has policy specifically to establish water quality classes and set water quality standards (Policy 7.2), and areas of water are "classified as water managed for…". The policies also provide for decision-making on consent applications for discharges which, after reasonable mixing, would not "achieve the water classification purposes for which the water quality standards [are] set in this plan" (Policy 7.4). Policy 7.6 provides guidance on the determining of a reasonable mixing zone to be set in resource consent conditions.

Rule 7.1 in the plan provides for discharges to be permitted activities if the conditions are met. Note there is no requirement for "reasonable mixing " in permitted activities and for discharges the zone of compliance (mixing zone) has been defined.

This appears to be the appropriate way to deal with permitted activities. The conditions are entry/exit conditions, and for the most part clear and certain. If a discharge cannot comply with the mixing zone requirement, then a resource consent is required. The TRP uses a similar approach although there is no zone of compliance for discharges in the TRP or for those same permitted activities which apply in the areas of the Waimakariri River and Opihi River Regional Plans.

Discharges which are discretionary activities (Rule 7.2) are required to comply with the terms and conditions set out either in the water quality classification (if the discharge occurs within a classified area) and/or some additional conditions, after reasonable mixing. Reasonable mixing is not defined.

Rule 7.5 makes any discharge that would result in the relevant water quality standards of the quality classes not being observed after reasonable mixing, a non-complying activity.

Therefore the water quality standards in the classified areas are both conditions precedent and subsequent. An applicant is not going to be certain whether their discharge is a discretionary or non-complying activity until the mixing zone has been accepted through the resource consent process..

3.2. Water Conservation Orders

The National Water Conservation Orders for the Rakaia River (1988) and the Ahuriri River (1990) were both issued prior to the RMA, however under s423(1)of the RMA these are deemed to be water conservation orders made on the same terms under s214 of the RMA. Each of these water conservation orders contain provisions preventing the granting of discharge permits and the making of permitted activities where discharges would result in the breach of specified water quality standards.

The water quality standards for the Rakaia River are a mix of narrative and quantitative standards, while those for the Ahuriri River are narrative standards only. In both cases a discharge must be "substantially free from suspended solids, grease and oil" and the other standards are to be met after allowing for 'reasonable mixing' of the discharge with the receiving waters.

3.3. Implementation of these Provisions

Environment Canterbury Consents staff are required to implement the provisions of the plans and water conservation orders as they relate to resource consent applications. Where plans have established water quality classes which include narrative standards that are to be met after reasonable mixing, and where compliance with the standards determines whether an application for a discharge permit is to be considered as a discretionary or non-complying activity there is a great deal of interpretation of these provisions required by both applicants and staff. Consents staff have developed a protocol around these provisions to reduce the uncertainty for consent applicants.

The water quality standards in the plans are used as outcomes for water quality as a result of a discharge. Applicants are asked to describe the mitigation measures they propose to ensure these outcomes are met and to provide information on the mixing zone which the applicant believes will provide reasonable mixing of the contaminants with the receiving water. While the final decision on the acceptability of these elements of the application lie with the consent authority it is likely to accept an applicant's proposed mitigation and mixing zone proposals if the assessment is soundly based.

Conditions which are certain and enforceable but which will ensure the water quality standards are observed are imposed on discharge permits. The narrative water quality standards are not used as conditions due to their uncertainty.

3.4. Draft NRRP Water Quality Chapter 7

The NRRP will head a hierarchy of Regional Plans in Canterbury. The other regional plans will be supported by the NRRP in that the NRRP will apply in the areas of the plans except for those matters which are explicitly addressed by the provisions of the existing Regional Plan for the area. Therefore in the Waimakariri and Opihi Rivers the water classes and water quality standards will continue in effect.

The draft NRRP water quality chapter does not contain any provisions for the establishment of water quality classes. The chapter does establish some management outcomes (objectives) for rivers, lakes and groundwater. These outcomes are a mix of narrative (e.g. *maintain water quality in natural state*) and numeric (e.g. *the maximum periphyton biomass does not exceed 200 mg/m^2 of chlorophyll a*.) objectives.

Policies contain some narrative standards (e.g. *after reasonable mixing the discharge does not repel, disrupt or create a barrier to migrating fish*) and some more explicit standards (e.g. *where the long term average nitrate concentration is between 50 and 100% of DWSNZ, ensure that it does not exceed the Standard*).

The rules for permitted activities predominately contain explicit conditions which avoid narrative standards. Where terms such as "conspicuous" is used this has been defined. Mixing zones for permitted activities have been defined. Some rules do however contain conditions that are narrative (e.g. *the passage of stock does not result in any significant reduction in the diversity and abundance…*). Rules containing narrative provisions need to be reviewed. Apart from these few instances the rules are clear and specific in the conditions. The entry/exit levels for the permitted activity rules are certain and can be objectively assessed.

Rules for controlled, discretionary and non-complying activities do not contain any provisions that reserve discretion to decide the exit/entry threshold for the activities. Matters for control or standards and terms are explicit, and no rules set water quality standards to be observed as precedent conditions on discharges.

3.5. Approaches other Regional Council's have taken in Regional Plans

Generally, other regional councils have not created water classes or established water quality standards in regional plans. Most regional plans for water quality only have rules for activities such as discharges, authorising some activities as permitted and others as discretionary activities. Most of the plans include narrative conditions for permitted activities, and as standards for discretionary activities. Regional Councils following this approach include Auckland RC, Otago RC, Environment Waikato, Taranaki RC, Hawke Bay RC, and Horizons.mw (outside of Manawatu River Catchment).

Few regional councils have set water quality standards in the rules. Where water quality standards have been set the rules require the standards to be achieved after reasonable mixing, and without any definition of the size of the mixing zone or guidance as to what would constitute "reasonable". E.g. Southland RC

Wellington RC has elevated the creation of water classes for specific water bodies and the water quality standards to policy level, and then in rules has some permitted activities (which have the s70 narrative provisions as conditions). Only one rule (discharge to natural state water is a non-complying activity) refers to a water class.

The Proposed **Manawatu Catchment Water Quality Plan** (1994) is now attached to the Horizons.mw Proposed Land and Water Plan. The catchment plan sets out policies to:

- establish water quality classes,
- set out the instances when a discharge permit for an activity which would breach standards would be granted,
- establish numeric standards as the primary criteria to interpret narrative standards,
- provide a guide to the size of the mixing zone.

Water quality standards are embodied in the rules, however the standards are still subject to an assessment of reasonable mixing, but with guidance provided as to the size of a "reasonable" mixing zone. The rules set dates by which compliance with standards is to be achieved. Discharges which comply with the standards are Restricted Discretionary activities; those that do not comply are Non-complying activities. Where minor discharges are permitted activities these are subject to conditions including "after reasonable mixing " and narrative standards of s107/s70.

This plan establishes the purposes for management of the waters in the catchment, and then sets the standards to be achieved, using numeric standards. While compliance with the standards is to be achieved after reasonable mixing, guidance is provided as to what would be considered a reasonable mixing zone. The standards are required to be observed by discharges not as background water quality standards.

This approach provides a higher level of certainty to applicants for resource consents about the level of treatment required for a discharge, and the allowable effect of the discharge, and therefore the status of their activity under the plan. The water quality standards are precedent and subsequent conditions.

Although it still has shortcomings, this plan provides the best example from those viewed of the use of water classes and water quality standards, principally from the inclusion of numeric standards and a method used to calculate the zone of reasonable mixing.

4 LIMITATIONS TO MANAGING WATER QUALITY USING WATER QUALITY STANDARDS

4.1. Point source discharges

Water classes and water quality standards have traditionally been used to manage the effects of point source discharges to surface water. They have been very useful tools particularly to address specific situations, such as the discharges to the lower Waimakariri River. Since the enactment of the RMA there has been a steady decline in the number of point source discharges of waste to freshwater in Canterbury, as the opportunities to discharge to land in the region have been taken up under the direction of the RMA and Regional Policy Statement and supported by Iwi policy statements and the community. Water quality standards have already been included in the plans where such discharges to surface water have had major impacts on the environment e.g. the Waimakariri River and the Opihi River.

Surface water bodies continue to be the principal receiving environment for discharges of stormwater run-off. The impact of these discharges on water quality is difficult to manage effectively using water quality standards as the water body is generally subject to perturbations in water quality as a result of natural run-off, and the effects of the point source stormwater discharge are not easily distinguishable from those arising naturally and from non-point sources.

4.2. Non-point source discharges

Many of the adverse impacts on water quality in hill country and lowland rivers and lakes in Canterbury occur as a result of land management practices and non-point source discharges in these catchments. These sources of contaminants cannot be managed by water quality standards as the discharges are not subject to the provisions of s15 of the RMA. Permanent or long term changes to background water quality, not resulting from natural fluctuations in water quality and including the effects of contaminants from non-point sources, may preclude the water quality standards being observed.

4.3. Knowledge of Water Quality

Defining numeric objectives and numeric standards for water quality requires a comprehensive understanding of existing background water quality, to ensure that any objectives or standards developed do not allow existing water quality to degrade. To do so would breach s69(c) of the RMA, unless this was consistent with the purpose of the Act. There is risk that water quality standards become the "lowest common denominator" of water quality for a water body, allowing contamination of the existing state up to the specified standard, albeit unknowingly.

Water quality objectives or standards established for a water class or a water body may not include all contaminants of concern in a particular water-body or part of a water body. When creating the standards there is potential to overlook contaminants which may degrade water quality and not set standards for these or for their effects. Also there may be contaminants in an existing discharge which have not been acknowledged, or a new discharge may contain contaminants which were not anticipated. Numeric water quality objectives or standards may not consider the synergistic or cumulative effects of the mix of contaminants.

4.4. Mixing Zones

The concept of mixing zones where the contaminants in a discharge are dispersed, diluted and assimilated with the receiving water and ecosystem are inextricably linked with discharges, water classes and water quality standards. The RMA requires that standards for any class, any standards imposed in rules, and the baseline standards of s70 and s107 are to be met "after reasonable mixing". This requirement allows for a zone in the receiving water where the water quality standards would not be met. At some point in the planning or decision-making process judgement must be made on the reasonableness of the extent and nature of the mixing zone, and of the acceptability of the adverse effects within the mixing zone.

The Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) discusses mixing zones in Volume 2 Appendix 1. A number a difficulties with mixing zones are identified. These include;

- Mixing zones should not be used for chemicals which bio-accumulate, nor to manage the impact of nutrients since the stimulation of algae may occur at considerable distance from the nutrient source.

- Mixing zones may not be applicable to waters where the values of the water are not compatible with the existence of a plume of water which does not meet the objectives for the water body e.g. lakes, natural state water quality areas.

There is a demand for methods to calculate the size and behaviour of mixing zones. Predictive models can be used but there is a need to understand the range of discharge and background water quality conditions which may be encountered, and the frequency with which these different conditions may occur. Models themselves will contain uncertainties inherent in the assumptions upon which a model is developed. Together these factors will produce a range of uncertainty in the model's predictions.

7.12 Legal Opinions

(i) In 1996, ECan sought a legal opinion (L960077) from Mr Philip Milne of Simpson Grierson & Partners on the standards and terms for rules setting water quality classes. His view was that, under the provisions of s 69 where rules are made identifying discharges as permitted and controlled activities which must comply with the water quality standards, a water quality standard would be like a condition on a discharge permit. The discharge would need to comply both as an entry/exit standard (precedent) and as an on-going (subsequent) requirement. For a discharge that was a controlled activity there may be a need for an applicant to demonstrate that the discharge would not cause a breach of the receiving water standards. If it were to appear that it might cause a breach the activity would no longer be a controlled activity.

For discharges which are discretionary activities the water quality standards may be precedent conditions – i.e. if the discharge does not comply with the standards then it will be a non-complying activity, or the standards could be conditions subsequent i.e. to be complied with if the discharge permit is granted, with the water quality standards reflected in discharge permit conditions.

The Environment Court, however, has established that a council should not reserve discretion to decide the status of an activity. For example, a discretionary activity rule should not contain a standard that provides that an activity only remains a discretionary activity if it does not cause any significant adverse effects on aquatic life. This would be invalid because it requires a subjective assessment by the council as to whether or not the activity causes such an effect and therefore reserves discretion.

There is a further complication in that water quality standards are to apply "*after reasonable mixing*". Determining what is reasonable mixing is a subjective discretion of the Council, which may determine whether or not the activity comes within the rule.

Mr Milne thinks that potentially this could invalidate the rule in which it is contained. (An amendment to the Act was sought to make this clearer, but MfE concluded that an amendment was not necessary.)

(ii) An opinion was sought by ECan in 1994 from Mr Geoff Venning of Wynn Williams & Co regarding the inclusion of policies in a plan to prevent point source discharges from increasing the mass loading of contaminants, as well as setting water standards in the plan. In his opinion Mr Venning thought that such policies could be challenged in the plan process, and that where Council prescribed water quality standards in a plan it could not then go further and attempt to prevent or prohibit discharges as well.

7.12 Alternative Approaches

6.1 Stand-alone Water Quality Rules

Philip Milne suggests an alternative approach. This is the use of stand-alone water quality rules that may overcome the risk of invalidating the rule, but still meet the requirement of s69 for the rule to require observance with the standards set.

Water quality standards would not be conditions precedent for discretionary or controlled activities i.e. compliance with the standards would not be a pre-condition of remaining in the class. Discharges would be required to ensure that water quality standards were observed once the activity commenced. The mixing zone would be set by resource consent conditions, along with discharge quality standards. This could be included in the plan by way of explanation, rather than as a *standard or term.* In this way the water quality standards would be conditions subsequent, not precedent.

Mr Milne sets out the advantages and disadvantages of this system.

Advantages:

- There would still be water quality standards, but they are outside of activity rules
- The approach meets the s69 requirement for a discharge to observe standards
- Standards are imposed by way of consent conditions on controlled and discretionary activities.
- Compliance with the standards is not determinative of the status of the activity, and therefore there is no issue of council unlawfully reserving discretion.
- Existing discharge permits could have their conditions reviewed under s128(1)(b).

Disadvantages:

- Some commentators consider that this approach is not sanctioned by the Act, as stand-alone standards do not regulate "activities" (as they claim is required by s68). However the combination of rules and standards outside the rules does regulate activities. Section 69 provides for water quality rules, which is additional to s 68.
- This approach doesn't work for permitted activities. Here compliance must be a pre-condition and on-going to be permitted. If a rule refers to quality "after reasonable mixing", the issue of reserved discretion arises. One solution may be to specify a mixing zone in the rule for a permitted activity i.e. if a discharge cannot comply with mixing zone then consent needed.

6.2 Water quality objectives or policies

The use of numeric water quality objectives establishes clear management outcomes for the regions rivers and lakes. Such objectives comprise the base-line against which progress towards the outcomes sought by the plan can be measured.

Numeric water quality objectives or policies in a plan can be applied to manage the effects of both point and non-point source discharges, as well as the effects of land use in a catchment, if this is needed.

Establishing numeric water quality objectives and policies can provide consistency in decision-making between non-complying activities and discretionary activities as the test of s105(2A) for non-complying activities requires that an activity must not be contrary to the policies and objectives of the plan.

Water quality objectives are not themselves enforceable, and do not determine the status of an activity, but a plan can provide by way of policy that conditions will be imposed on resource consents so as to ensure the objectives or policies are met. A disadvantage is that conditions on existing consents couldn't be reviewed under s128 as there are no water quality standards set in rules.

A summary of the advantages and disadvantages of various approaches is presented in Table 1.

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8 CONCLUSIONS

While the RMA appears to create a flexible regime for the management of water quality through the use of water classes and the creation of water quality standards, water classes are not a widely used water quality management tool. Where narrative water quality standards, which are to be met after reasonable mixing of the contaminants and the receiving water, are used in regional plans they generally lack the certainty required for rules in a plan. The conditions of many permitted activity rules are in general insufficiently certain to be enforceable, or able to be interpreted by a discharger to understand whether an activity would be a permitted or discretionary or non-complying activity.

Establishing water quality classes at objective and policy level in a plan has merit, but these need to be supported by explicit numeric standards either in the policies and/or in rules. Where permitted activity rules relate to water quality standards, which are subject to reasonable mixing, the rules need to define the mixing zone and include explicit standards for the discharge to ensure that the rule is legally valid, certain and enforceable. In this way a discharger and enforcement staff can clearly understand the threshold between when an activity will be permitted and when it would be of higher status, requiring a resource consent.

Stand-alone water quality standards could be included in a plan where these are not standards or terms on either controlled or discretionary activities i.e. they are not a precedent condition. The resource consent process would consider the mixing zone and conditions imposed on the consent to ensure observance with the receiving water quality standards. Where standards are to be met after reasonable mixing there is a need to be explicit in the plan about how this mixing zone will be determined.

Where rules in an operative plan set water quality standards the regional council can review the conditions of existing resource consents to enable the standards to be met.

A difficulty with a region-wide plan is that the provisions of the plan embrace many different water body types which would be managed for different purposes. Water quality objectives or standards established to embrace these water body types risk becoming generic, and may fail to address the contaminants of concern for a particular water body. To be effective it will be necessary to develop objectives and /or standards to cover the range of water body types identified in the plan.

The standards contained in the Third Schedule of the Act are likely to be unenforceable because they lack certainty. Specifically developed standards would have to ensure that the purpose for managing the water would be achieved through the standards specified. This will require a comprehensive understanding of the current water quality in any water body. Where water quality standards are contained in rules alone, this approach will only address the effects of point-source discharges. Even then the effects of stormwater discharges are not able to be effectively controlled through this mechanism due to the indistinguishable nature of natural effects, non-point source contaminants and those resulting from a discharge. Non-point source discharges are the principal cause of declining water quality in many of Canterbury's rivers, and rules containing water quality standards cannot be considered an effective method to manage these effects on water bodies.

Environment Canterbury has already established water quality classes and standards in the Waimakariri and Opihi River Regional Plans. These are arguably the water-bodies in the region most affected by point source discharges. The National Water Conservation Orders for the Rakaia River and Ahuriri River also contain water quality standards. The water quality classes and standards of these regional plans and orders will continue under the NRRP, so the benefits for managing point-source discharges into these rivers will continue.

Permitted activity rules for discharges that set standards that are to be met "after reasonable mixing" will not be legally valid unless the size of the mixing zone is established in the rule. The use of narrative standards should be avoided due to uncertainly and the subjective assessment required to interpret these standards.

The process of developing water quality classes, standards and rules for water quality which are able to overcome the constraints identified, for each of the water body types identified in the plan is likely to be a large and exacting task. The result may not provide any significant improvement in the ability of the NRRP to achieve the environmental outcomes it sets. The use of numeric water quality objectives is likely to be more effective for this task.

Establishing numeric water quality objectives in the NRRP will enable the environmental outcomes to be more explicit than if narrative outcomes are used. These outcomes will apply to the water body as a whole and can be used to measure progress toward the outcome. Importantly the outcomes will address the effects of all sources of contaminants in the water body, not just those arising from point-source discharges.

Those water quality standards already established in regional plans or water conservation orders for specified water bodies can continue to be used to guide decisions on discharge permit applications in those areas and resource consent conditions attached to ensure that the water quality standards will be observed. While the problem of the precedent conditions for an activity around the mixing zone issue is not resolved for these areas, the approach to the practical implementation of these provisions taken by ECan consents staff mean that the potential lack of clarity for applicants for discharge permits and decision makers is minimised.

In those other areas of the region where the NRRP provisions will apply, the objectives and policies of the NRRP will be the bench-mark against which the effects of both non-point and point-source discharges can be measured. The reasonableness of the size and nature of any mixing zone will be considered as part of the resource consent process. Resource consent conditions can be attached to both discharge permits and land use consents, where applicable, to ensure that the water quality outcomes will not be compromised.

8 RECOMMENDATIONS

- Develop and establish numeric water quality objectives in the NRRP that support the purpose of management of the water body.

- That the development of stand-alone numeric water quality standards to be set in rules be considered for those water bodies which are the receiving water for point source discharges but are not within existing regional plans or national water conservation order areas.

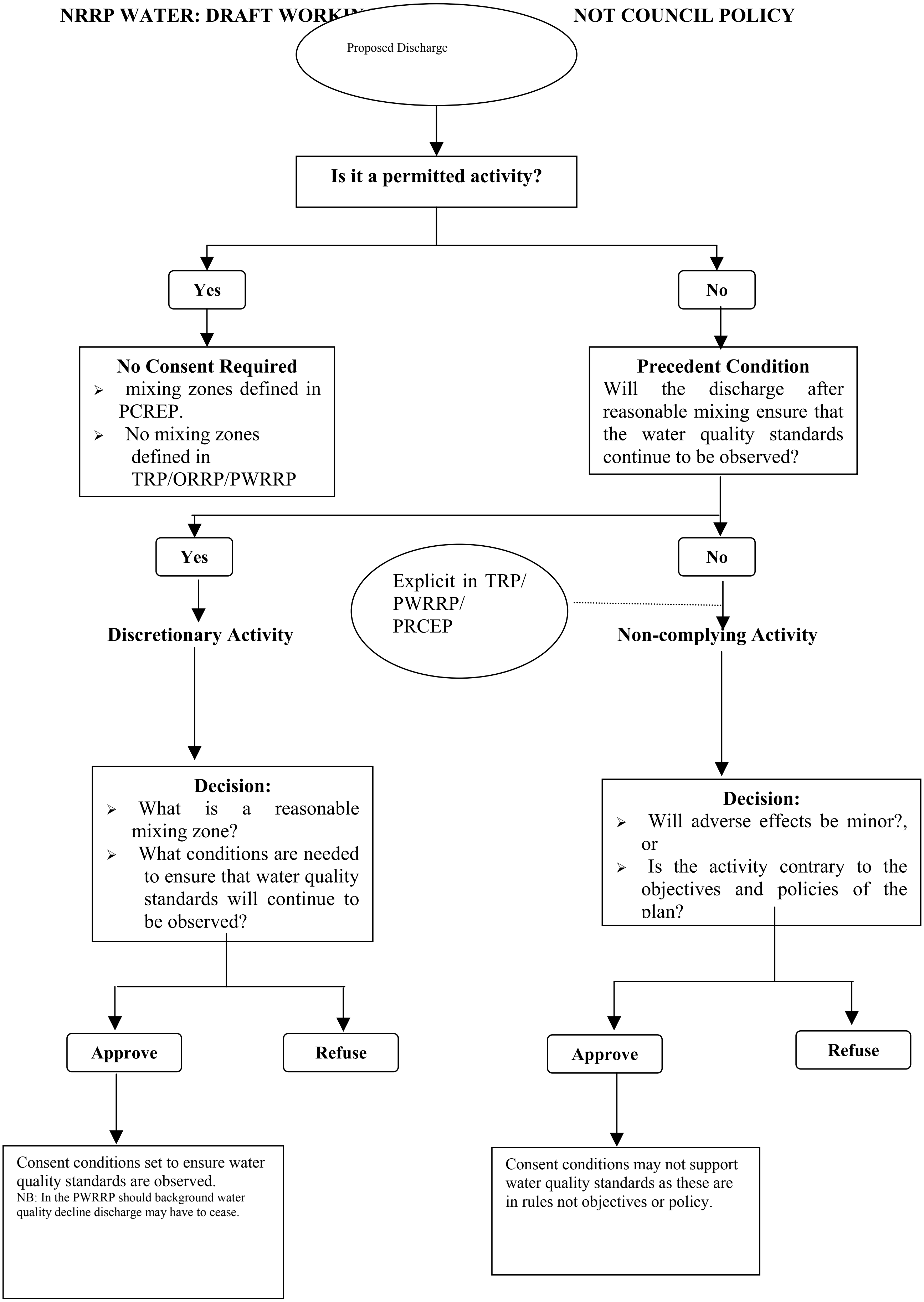
- Identify water bodies where the concept of a mixing zone is not appropriate.

- Develop a method (specific guidance or formulae) to enable a reasonable mixing zone to be calculated.

- Rules for discharges to water which are permitted activities contain, where necessary numeric water quality standards, and that the size of mixing zones are defined for each rule where these apply.

Table 1: Advantages and Disadvantages of water classes and water quality rules in regional plans

	Advantages	Disadvantages
RMA Third Schedule Water Classes	➢ Purpose for management identified ➢ Standards set bottom-line water quality ➢ Can review conditions of existing consents when plan operative	➢ Narrative standards are uncertain and must be interpreted. ➢ Provides only general guidance to decisions-makers ➢ Contaminants of concern may not be addressed in standards ➢ Standards apply after reasonable mixing. ➢ Standards must be enforced, background water quality could prevent observance. ➢ Standards could be lower than present water quality, allowing decline. ➢ Apply to point-source discharges only, do not consider the effects of non-point source discharges ➢ Mixing zones may not be appropriate for all contaminants, or for all water bodies.
Specifically developed Water Classes	➢ Standards specific to water body or purpose for management ➢ Can specify contaminants of concern ➢ Can have quantitative standards ➢ Can review conditions of existing consents when plan operative ➢ Can provide more specific guidance for decisions-makers than Third Schedule Classes	➢ Requires a good understanding of present water quality ➢ Standards apply after reasonable mixing ➢ Standards may not include all contaminants of concern ➢ Standards must be enforced, background water quality could prevent observance ➢ Apply to point-source discharges only, do not consider the effects of non-point source discharges ➢ Mixing zones may not be appropriate for all contaminants, or for all water bodies.
Water Quality Rules which include standards for specific water bodies	➢ Standards specific to water body or purpose for management ➢ Can specify contaminants of concern. ➢ Standards can be a bench mark of water quality against which change can be measured. ➢ Can review conditions of existing consents when plan operative ➢ Can specify quantitative standards ➢ Provides specific guidance to decision-makers ➢ Standards could be used as conditions on discharge permits	➢ Requires a good understanding of present water quality ➢ Standards may not include all contaminants of concern ➢ Need method to determine reasonable mixing zone. ➢ Mixing zones may not be appropriate for all contaminants, or for all water bodies. ➢ Cannot be used for permitted activities, as mixing zone needs to be specified in rule. ➢ Apply to point-source discharges only, do not consider the effects of non-point source discharges
Specific numeric water quality objectives and policies	➢ Objectives specific to water body or purpose for management ➢ Can specify contaminants of concern. ➢ Objectives can be a bench mark of water quality against which change can be measured. ➢ Can specify numeric outcomes ➢ Will consider contaminants from all sources ➢ Provides specific guidance to decision-makers ➢ Standards could be used as conditions on discharge permits. ➢ Conditions imposed on land use consents to ensure outcomes not compromised ➢ Effects of permitted activities can be measured against bench-mark ➢ Decisions on mixing zones can be decided as part of consent process.	➢ Requires a good understanding of present water quality ➢ Unable to review conditions of existing consents when plan operative as water quality outcomes not set in rules (s128)



30 July 2002

PWRRP – Proposed Waimakariri River Regional Plan
TRP – Transitional Regional Plan
ORRP – Opihi River Regional Plan
PCREP – Proposed Coastal Environment Regional Plan

Appendix 1: RMA Section 69

(1) Where a regional council -

(a) Provides in a plan that certain waters are to be managed for any purpose described in respect of any of the classes specified in the Third Schedule; and

(b) Includes rules in the plan about the quality of the water in those waters,--

the rules shall require the observance of the standards specified in the Schedule in respect of the appropriate class or classes unless, in the council's opinion, those standards are not adequate or appropriate in respect of those waters, in which case the rules may state standards that are more stringent or specific.

(2) Where a regional council provides in a plan that certain waters are to be managed for any purpose for which the classes specified in the Third Schedule are not adequate or appropriate, the council may state in the plan new classes and standards about the quality of water in those waters.

(3) Subject to the need to allow for reasonable mixing of a discharged contaminant or water, a regional council shall not set standards in a plan which result, or may result, in a reduction of the quality of the water in any waters at the time of public notification of the proposed plan unless it is consistent with the purpose of the Act to do so.[26]

[26] RMA s. 69

Appendix 2: RMA Third Schedule: Water Quality Classes

Note: The standards listed for each class apply after reasonable mixing of any contaminant or water with the receiving water and disregard the effect of any natural perturbations that may affect the water body.

1. Class AE Water (being water managed for aquatic ecosystem purposes)

(1) The natural temperature of the water shall not be changed by more than 3• Celsius.

(2) The following shall not be allowed if they have an adverse effect on aquatic life:

(a) Any pH change:

(b) Any increase in the deposition of matter on the bed of the water body or coastal water:

(c) Any discharge of a contaminant into the water.

(3) The concentration of dissolved oxygen shall exceed 80% of saturation concentration.

(4) There shall be no undesirable biological growths as a result of any discharge of a contaminant into the water.

2. Class F Water (being water managed for fishery purposes)

(1) The natural temperature of the water—

(a) Shall not be changed by more than 3• Celsius; and

(b) Shall not exceed 25• Celsius.

(2) The concentration of dissolved oxygen shall exceed 80% of saturation concentration.

(3) Fish shall not be rendered unsuitable for human consumption by the presence of contaminants.

3. Class FS Water (being water managed for fish spawning purposes)

(1) The natural temperature of the water shall not be changed by more than 3• Celsius. The temperature of the water shall not adversely affect the spawning of the specified fish species during the spawning season.

(2) The concentration of dissolved oxygen shall exceed 80% of saturation concentration.

(3) There shall be no undesirable biological growths as a result of any discharge of a contaminant into the water.

4. Class SG Water (being water managed for the gathering or cultivating of shellfish for human consumption)

(1) The natural temperature of the water shall not be changed by more than 3• Celsius.

(2) The concentration of dissolved oxygen shall exceed 80% of saturation concentration.

(3) Aquatic organisms shall not be rendered unsuitable for human consumption by the presence of contaminants.

5. Class CR Water (being water managed for contact recreation purposes)

(1) The visual clarity of the water shall not be so low as to be unsuitable for bathing.

(2) The water shall not be rendered unsuitable for bathing by the presence of contaminants.

(3) There shall be no undesirable biological growths as a result of any discharge of a contaminant into the water.

6. Class WS Water (being water managed for water supply purposes)

(1) The pH of surface waters shall be within the range 6.0-9.0 units.

(2) The concentration of dissolved oxygen in surface waters shall exceed 5 grams per cubic metre.

(3) The water shall not be rendered unsuitable for treatment (equivalent to coagulation, filtration, and disinfection) for human consumption by the presence of contaminants.

(4) The water shall not be tainted or contaminated so as to make it unpalatable or unsuitable for consumption by humans after treatment (equivalent to coagulation, filtration, and disinfection), or unsuitable for irrigation.

(5) There shall be no undesirable biological growths as a result of any discharge of a contaminant into the water.

7. Class I Water (being water managed for irrigation purposes)

(1) The water shall not be tainted or contaminated so as to make it unsuitable for the irrigation of crops growing or likely to be grown in the area to be irrigated.

(2) There shall be no undesirable biological growths as a result of any discharge of a contaminant into the water.

8. Class IA Water (being water managed for industrial abstraction)

(1) The quality of the water shall not be altered in those characteristics which have a direct bearing upon its suitability for the specified industrial abstraction.

(2) There shall be no undesirable biological growths as a result of any discharge of a contaminant into the water.

9. Class NS Water (being water managed in its natural state)

The natural quality of the water shall not be altered.

10. Class A Water (being water managed for aesthetic purposes)

The quality of the water shall not be altered in those characteristics which have a direct bearing upon the specified aesthetic values.

11. Class C Water (being water managed for cultural purposes)

The quality of the water shall not be altered in those characteristics which have a direct bearing upon the specified cultural or spiritual values.

Appendix 2. NIWA Review Comments on ECan Discussion Paper

8 August 2002

Environment Canterbury
PO BOX 345
CHRISTCHURCH

Attention: Raymond Ford

Dear Raymond,

Re: Environment Canterbury Natural Resources Regional Plan (NRRP): Draft Working Paper – Objectives, Policies, Water Classes & Rules for Water Quality

Thank you for the opportunity to make comments on this working paper. The topic is one that is of much interest to us.

In general we found that the paper provided a very useful review of relevant considerations, and was sound in its logic as conclusions were developed. We are in general agreement with the conclusions, and we are enthusiastic in our support of the three key recommendations made.

Specifically we understood the paper to make the following key points:

1. *The use of narrative water quality standards leads to a lack of certainty for resource users, and creates difficulties for consents investigations staff and decision makers during consent processes.*

We agree entirely with this point.

2. *Numeric standards provide greater certainty of the desired outcome and it is recommended in the paper that water quality outcomes be established in the NRRP using numeric standards in the plan objectives.*

We concur with this conclusion and support the recommendation, although we feel that the word "standard" used in conjunction with plan objectives is potentially confusing. We understand the paper to suggest that numbers be used in the objective to define the desired environmental outcome for a particular waterway. We refer to such number statements as "numeric objectives", and we note that these do not preclude the parallel use of "numeric standards" in the plan rules. We see an important distinction between numeric objectives and numeric standards, and this will be discussed further under point No. 3 of this review.

We consider that the use of numeric objectives would not only provide greater certainty for resource users and within consent processes, but would also provide a basis for addressing some of Council's other functions under s35 RMA (e.g., reporting on the state of the environment and monitoring the suitability and effectiveness of plan objectives and policies). We consider this latter role of plans to be very important. However it appears to us that this role is often overridden by a focus on plans providing a process for considering new consents.

The reason that numeric objectives provide these benefits, is that numeric objectives provide an unambiguous measure for the desired environmental outcome, and this allows the following:

- Measurement of the current environmental state or condition against 'criteria',
- Determination of the progress required to achieve the numeric objective from the current state, and thereby,
- An estimate of the appropriate time-frame to apply to policies and methods,

- A basis for quantifying limits for effects of non-point source discharges, and,
- A basis for quantifying limits for cumulative effects.

As pointed out in the paper, these benefits would not be convincingly achieved using narrative objectives. Nor would they be achieved by either narrative or numeric standards contained in plan rules, without having numeric objectives as well.

3. ***The paper points out that a disadvantage of setting specific numeric standards in the objectives of the plan and not in the rules, is that Council is then unable to review conditions of existing consents under s128 RMA (refer Table 1 of the paper).***

As stated under point No. 2 above, we feel that numeric objectives do not preclude the use of numeric standards in the plan rules. In fact we re-emphasise that we see the numeric objectives defining the desired environmental outcome (e.g., maximum periphyton biomass does not exceed 200mg/m^2 of chlorophyll a). The methods and rules must then provide the means for achieving these objectives. In the case of point discharges, setting corresponding numeric water quality standards in the plan rules is one method for achieving the objectives. These numeric standards would generally involve parameters that are different to the objective (e.g., discharges shall not result in nutrient (DIN and DRP) concentrations exceeding *x* mg/L). There would also be other methods for achieving a numeric objective that would be applied to address the effects of other resource uses (e.g., non-point source discharges, cumulative effects of land-use practices etc), such as education, advocacy etc.

We appreciate that developing such standards in rules requires a good understanding of particular water bodies involved, or at the least an understanding of the "class" to which the water body is assigned. We also consider that some flexibility or discretion must be retained by Council in this aspect of the plan, because not all water bodies will conform to the typical state or condition of a class. For example, it may be appropriate in some cases to grant consent for an activity that does not comply with the numeric standards in the rules but does not, as a result, compromise the numeric objective. Such a decision could be made during a resource consent process for a non-complying activity.

We take from the paper that there may be a legal issue associated with standards that behave as precedent conditions for establishing whether an activity is discretionary or non-complying. We do not fully understand the implications of this from the discussion of legal opinions in the paper. Further clarification of this would be helpful.

4. ***The paper notes that it will be necessary for any numeric standards (either in objectives or rules) to cover a wide variety of water body types in the region.***

We agree, and further consider that a spatial framework, on which to base class-specific numeric standards, is fundamental to any successful application of numeric standards. We also agree that development of such a framework and it's associated class-specific numeric objectives, as well as policies and rules, is a large and complex task. However we are unclear what is meant by paragraph nine of the paper's Conclusions section where it is suggested that, "There are other approaches which are likely to be more effective for this task". Some example of such other approaches would be helpful.

From a technical perspective, it appears to us that any viable alternative would involve a move back towards; less certainty for resource users, less effective planning direction for non-point source and cumulative effects, less effective environmental state monitoring, and more case-by-case treatment of consent issues.

5. ***Throughout the discussion on water quality classes and standards, the paper refers to the common problem of uncertainty associated with specifying a "reasonable mixing zone".***

We agree that for permitted activities, rules for discharges to water should contain unambiguous numeric water quality standards, and also need to unambiguously define a mixing zone. This could be an absolute value or it could be a formula, provided that the variables in the formula were also unambiguous. On this point we are again unclear on the implications of legal opinions in the paper regarding setting standards that behave as precedent conditions for establishing whether an activity is discretionary, non-complying, or in this case permitted. Further clarification of this would be helpful.

We also support the recommendation that a method be developed to provide guidance on determining a reasonable mixing zone for discharges that are discretionary or non-complying activities under a plan.

In our view the calculation of mixing properties of discharges (given discharge flow, contaminant and receiving water hydraulic characteristics), is a purely technical exercise for which formulae are available.

Importantly however, deciding on an appropriate or "reasonable" non-compliance (mixing) zone involves a fundamental resource management decision that should be, in our view, inextricably linked to the specific objectives for the water body concerned. In other words, how big can the non-compliance (mixing) zone be, before the desired environmental state of the water body is compromised? We consider it is appropriate that any guidance given in the plan for determining reasonable mixing zones, should reflect the plan objectives.

Summary

In conclusion, we consider the advantages of numeric water quality objectives and numeric standards discussed in the paper and in this review, are defensible and would provide for justifiable and certain plan provisions. The one point of difference is that we think the ability to review existing consents (under s128 RMA) is unlikely to be compromised by having numeric objectives. This is because in order for there to be clarity in how those objectives should be met, numeric standards which are linked to the objective, will generally be required in the rules.

Thank you again for the opportunity to comment on this paper. We would welcome any further discussion.

Yours Sincerely,

Ned Norton
Resource Management Consultant

Ton Snelder
Natural Resources Engineer

Appendix 3. Existing Management Units in the ECan Draft Natural Resources Plan

7.3 Ecosystem framework for water quality management

The management of the region's water resources needs to be based on an understanding of the interconnected nature of freshwater ecosystems, their physical and biological elements, and the interactions between them.

The rivers, lakes and groundwater of Canterbury can be grouped into different ecosystem types that have broadly similar physical and biological characteristics. They are subject to the same types of pressures from human activities, exhibit similar types of resource management issues, and therefore a common set of management provisions can be expected to apply. A list of the different water body types is contained in Appendix WQL1.

7.3.1 Rivers

For water quality purposes, Canterbury rivers have been grouped together on the basis of two parameters: the dominant source of flow and their geographic zone of origin. The source of flow determines many of the physical attributes of a river, such as seasonality of flows and river size, and it brings together rivers that behave in a similar hydrological manner. The volume of water and the flow regime of a river directly affect the capacity of a river to dilute, assimilate and transport contaminants. The zone of origin represents different parts of the region where the rivers rise, and indirectly, the different contaminant sources, such as geology, type and intensity of land use. The interaction of these two parameters determines the relative susceptibility of different river types to water quality degradation.

Many organisms have adapted to specific physical conditions, and therefore changes in flow, level and quality of water can have a significant influence on the distribution and lifecycles of many plant and animal species.

Six major river types have been identified:

River type	Water quality characteristics
Alpine/mountain sourced rivers	Large flows of high quality water; frequent floods. High suspended solids and sediment load. High turbidity in glacial fed rivers. Low concentrations of contaminants.
Hill country sourced rivers	Moderate flows of high to moderate water quality. Frequent floods disturb river ecosystems. High to medium suspended sediment concentrations and nutrient loads depending on catchment geology and land use.
Lake-fed rivers	Stable flows. Water quality of the river strongly influenced by the water quality of the lake.
Inter-montane rivers	Small inland spring-fed and rainfall-fed streams. Low capacity to assimilate contaminants.
Lowland rivers	Small coastal and plains spring-fed and rainfall-fed streams fed rivers. Low capacity to assimilate contaminants.
Volcanic (Banks Peninsula) rivers	Short steep catchments that respond rapidly to rainfall. Low capacity to assimilate contaminants.

7.3.2 Lakes

The water quality of lakes is influenced by the location of the lake in the catchment and the type and intensity of activities occurring upstream or in the surrounding catchment. Generally, high country lakes tend to have very low nutrient concentrations, while lowland lakes are enriched and have high nutrient concentrations. Lake water quality is also affected by the degree of mixing that occurs within the lake and the length of time water is resident within the lake.

Four types of lakes are recognised in the region:

Lake type	Water quality characteristics
Large high country lakes – regulated and unregulated	Large (> 8 km^2), deep cold water bodies with low nutrient concentrations. Water clarity is very high except where glacial-fed rivers supply water to the lake. Little variation in water temperature or stratification.
Small to medium high country lakes	Small to moderate size (<8 km^2) relatively shallow. Large range in water temperatures. Low to moderate nutrient concentrations .
Coastal lakes	Typically, closed from the sea. Shallow with high temperature range, variable clarity and high nutrient concentrations. High degree of mixing with some connection to the sea affecting salinity concentrations.
Artificial lakes	Lakes created by damming a catchment. Water quality depends on the local environment including: water residence time, ratio of water depth to width, quality of inflows, wind exposure aspect.

7.3.3 Groundwater

Groundwater in lowland Canterbury is largely contained in a system of unconfined and confined alluvial aquifers. In the inter-montane basins and river valleys, there are minor alluvial aquifers. Elsewhere in the region small quantities of groundwater are present in fractured basement rock, such as limestone, greywacke and volcanic rock.

Surface water and groundwater are part of an interconnected hydrologic system that is in a continual process of exchange. In the inland areas of the Canterbury plains, river and rainwater enter the unconfined aquifers. The water descends into the gravels and travels horizontally towards the coast recharging the deep unconfined aquifers of the central plains. In the middle and lower plains' areas, river and rainfall recharge is thought to stay at shallow levels and flow eastwards relatively quickly over the top of the deeper, slower moving groundwater.

Groundwater is vulnerable to contamination. The relative susceptibility of different types of aquifers to contamination is shown in the following table.

Aquifer type	Water quality characteristics	Vulnerability to contamination
Shallow unconfined aquifers	Water quality variable, influenced by geology and overlying land uses. Outflow from springs.	High, because of the combination of thin soils, permeable gravels and shallow water table, Over-abstraction near the coast may lead to salt water intrusion.
Deep unconfined semi confined aquifers	Generally high water quality. Very low concentrations of nutrients and microbiological contaminants. May be influenced by local geology, e.g. peat deposits resulting in elevated concentrations of iron and manganese.	Moderate. Depth to the water table provides some protection, but groundwater may still be vulnerable to contamination from persistent contaminants or land use activities in inland recharge zone.

7.13 Water quality appendices

Appendix WQL1 Summary of water body types in Canterbury

Summary of river types:

River type	Morphology	Hydrological characteristics	River mouths	Biological communities	Instream Values
Mountain source e.g. Hurunui Rakaia, Rangitata, Clarence, Waimakariri,	Most have substantial braided sections. Some reaches, narrow deep channel where river is incised in bedrock Some parts of lower plains reaches are channelised – straight channel constrained by river protection works.	Rainfall – snowpack and sometimes glacial influenced Relatively variable flow regime, frequent flood flows or freshes. Rapid response to rainfall conditions. Strong seasonal influence on flow regime with low flows during autumn, winter and mid -late summer. Relatively high flows during spring and early summer due to snow melt and precipitation from north west winds. Large floods occur relatively frequently. High sediment supply results in unstable bed morphology and channel braiding. Water quality is generally high. Low nutrient status Groundwater fed tributaries – high water quality of inland tributaries, and variable to low water quality in lowland tributaries.	Under natural flow regime river mouth always open or only closed during an extreme storm event Coastal lagoon forms behind gravel barrier beach where river enters the sea. The size of the lagoon varies depending on flow, barrier beach structure and southerly exposure. An exception is the Waimakariri River which has a sandy beach mouth and stable lagoon behind dunes.	Habitat comprises gravel substrate, high quality, cool, swift flowing water , Upper reaches – river bed largely unmodified indigenous vegetation Middle & lower reaches exotic plants, including woody weeds common on open riverbed Exotic/sport fish communities include chinook salmon, brown trout, and rainbow trout. Native fish include wide range of migratory and non-migratory in different reaches:–Lower reaches- short- finned eel, inanga, common bully, smelt, black flounder (important whitebait and eel fisheries); Middle reaches blue-gilled gully, torrentfish, long-finned eel; Upper reaches alpine galaxiids, long finned eels. Algal communities – Low biomass, mainly diatoms Invertebrate communities comprise few species of mayfly, caddisfly and midge larvae adapted to frequent flood disturbance. Birds – Very large populations of wading birds, including significant numbers of threatened species e.g wrybill . Range of habitats – breeding, feeding, roosting of individual birds and large colonies.	**Upper reaches & "Gorges"** Largely unmodified – very high degree of naturalness and high biodiversity values Outstanding natural features and landscapes – e.g. Mt Cook national park. Very high wild & scenic values, used for wide range of recreation activities Salmon, brown trout & rainbow trout spawning in spring fed tributaries. Native fish communities. Migratory species Ngai Tahu – mauri, Southern alps – very strong spiritual associations. **Middle lower reaches** Moderate to low level of naturalness. Braided rivers contribute to Canterbury identity & landscape Used extensively for recreation – fishing, jetboating Important biodiversity values - birds & native fish, including ithreatened migratory species Important salmonid habitat and migratory pathway – Chinook salmon, trout Drinking water – important source of recharge for plains aquifers

River type	Morphology	Hydrological characteristics	River mouths	Biological communities	Instream Values
					Ngai Tahu – mauri, mahinga kai
Hill rivers, e.g. Ashley, Pareora Waipara, Puhi Puhi, Kahutara and Kowhai rivers	Single thread & braided sections. Some reaches, narrow deep channel where river is incised in bedrock. Some parts of lower plains reaches are channelised – straight channel constrained by river protection works	Flow regime in upper catchments sustained by rainfall, snow melt or lake outflow and in the lower reaches by groundwater in some rivers. Strong seasonal pattern of flows: high flows occur in winter when precipitation is highest, and continue into spring with snow melt and north west rainfall. Spring peak flows decline quickly compared to mountain rivers Tributaries or sections of the main stem may cease to flow at the bed surface for part of the year. Marked diurnal changes in water temperature during summer low flow period. Sediment supply is high, creating unstable substrates and braided or semi- braided channels Water quality is moderately high but non point or point source discharges may lower water quality through catchments	Similar to mountain rivers. Coastal lagoon generally smaller. The lagoon outlet closes more frequently, especially during low flows. Some rivers highly prone to closure or with no natural mouth (Waihao) have engineered openings or artificial box structure mouths. NB. Ashley River mouth in sand dune never closes.	Fish communities – long- finned eel, upland bully, blue- gilled bully, torrent fish, alpine galaxiids, koaro Lower reaches – short-finned eel, inanga, common bully, smelt, black flounder – important whitebait and eel fisheries. Invertebrate communities – high diversity of mayflies, caddis flies, stoneflies. Filter feeding species common. Algal communities: diatom film communities, but also filamentous algae in unshaded downstream reaches under low flows. Biomass depends on nutrient and flow conditions. Generally too unstable for aquatic macrophytes. Riverbed vegetation – upper reaches native species replaced with exotic woody species middle to lower reaches Bird communities similarly important to mountain rivers with high numbers of waders, gulls, terns and other bird groups.. Local populations – long-tailed bat in South Canterbury	Moderate to high level of naturalness in upper reaches. Braided rivers contribute to Canterbury identity & landscape Important biodiversity values - birds, long-tailed bats, & native fish, including threatened and migratory species Salmonid habitat –commonly brown trout & locally chinook salmon and brook char. Recreation & amenity especially near urban areas. Ngai Tahu: – mauri, mahinga kai Stockwater **Kaikoura coastal streams**: Unique habitat type. Very high biodiversity values due to absence of exotic fish, native bush cover in close proximity to the sea., several threatened fish species. Ngai Tahu: mauri, mahinga kai, and many streams & springs regarded tapu for cultural or historic reasons
Intermontane basin streams and rivers E.g Hydra waters, Mary burn, Allandale stream, Cora Lynn swamp	Single thread – relatively narrow channel meandering acoss inland basins. Water generally uniformly covers stable gravel bed.	Small stable spring fed streams feeding into major rivers or lakes. Water quality variable – generally very high, but lower water quality may occur where intensive land uses have developed (e.g. Amuri plains).		Fish communities include range of salmonid species (salmon, brown trout, rainbow trout, brook char) including locally or regionally important spawning waters. Native fish include koaro, alpine galaxiids, upland bully and long-finned eels. Highly diverse and abundant invertebrate communities under cool stable flow regimes. Algal communities: diatom film	Mahinga kai from tributary streams. Important salmonid spawning and angling waters. Stockwater.

River type	Morphology	Hydrological characteristics	River mouths	Biological communities	Instream Values
				communities, but also filamentous algae in intensively developed areas. Bird communities mostly waterfowl.	
Lowland rivers & streams e.g. Cust, Cam, Avon, Heathcote, Ohapi, and Waikakahi streams.	Single thread, low gradient shallow channels generally with water fully covering the bed. Some reaches are channelised – straight channel with regular cross-section	Source of flow ranges from rainfall, through to solely springfed from groundwater. Contribution from ground water generally increases in lower reaches Rainfall dominated streams show very strong seasonal pattern of flows with highest flows in winter when precipitation is highest and evapotranspiration is low. Tributaries or sections of the main stem may be dry for part of the year. Springfed streams may show little seasonality with regular year round flows. Flow pattern can be modified by irrigation seasons. Water quality variable – from high quality spring fed to highly turbid runoff. High nutrient concentrations associated with and nutrient associated with adjacent landuses and aquifer contamination. Urban areas – low water quality particularly during rainfall. High sediment, nutrient and chemical contaminant concentrations	Rivers often open into lagoons or estuaries or connect to lower ends of major rivers.	Fish species include wide range of native species depending upon connection to the sea - common bully, smelt, giant bully, inanga, short-f inned eel. Locally, Canterbury mudfish in ephemeral streams. Invertebrates: very variable depending upon extent of fine sediments – from high insect diversity and abundance to worms, snails, midges, caddisfly. Plant communities – predominantly exotic species. Macrophytes (submerged oxygen weeds and emergent (watercress) confined to slower flowing reaches. Increased algal biomass because of higher nutrient concentrations Brown trout habitat – gravel bed, cool high quality water. Important spawning areas. Chinook salmon locally important (eg. Ohapi Creek). Bird communities – mostly waterfowl and deep water divers, with few waders	Modified landscape – level of naturalness is low. The presence of river and flowing water contributes to recreation and amenity values especially in urban areas. Fish – brown trout and native species. Canterbury mudfish threatened species Ngai Tahu: – mauri, mahinga kai Stockwater Recreation – angling, gamebird hunting, passive recreation, locally canoeing.
Volcanic (Banks Peninsula) streams .eg. Kaituna, French Farm, streams	Many steep, small short catchments. Step – pool morphology, lower reaches where channel gradient declines fine sediment substrate.	Rainfall fed, rapid flow recession, seasonally dry Rivers have long periods of low flow, low base flows and large infrequent floods of short duration. Higher flows in winter when precipitation is higher. Tributaries or sections of the main stem may be dry for part of the year. Flow regime in the summer months wholly influenced groundwater; during winter influenced by rain.	Streams exit to small estuaries situated in pocket bayhead beaches or into major lakes (Ellesmere and Forsyth). Frequency of river mouth closure influenced by exposure to wave action and stream flows.	Invertebrate communities –can have very high diversity of caddisflies, mayflies and stoneflies – highly endemic in some streams with forest remnants. Fish – mainly native fish species, such as banded kokopu, lamprey Lower reaches common bully, smelt, inanga, giant bully. Occasional brown trout populations in larger streams. Upper reaches and in native bush , diatom species important. Lower reaches higher	Moderate to high naturalness in upper reaches, remnants of indigenous vegetation. Rare or threatened native fish species, and highly endemic invertebrates. Important for passive recreation, locally swimming and picnicking. Ngai Tahu: – important centre of Maori settlement. Likely to be many wahi tapu and wahi taonga sites.

River type	Morphology	Hydrological characteristics	River mouths	Biological communities	Instream Values
				algal biomass because of higher nutrient concentrations. Bird diversity low – mostly water fowl.	Mauri and locally mahinaga kai
Lake fed Natural: e.g., North Branch of Hurunui R, Lake stream, Sisters Stream, Regulated: Pukaki R., Waitaki R., Opuha R.	Stable channel, may have braided reaches, but bed often stable and cobbles embedded in fine sediments.	Stable flow regime with no or negligible flood flows. Slow rise and fall in flood peaks. Regulated – flow regime significantly altered from unmodified state. Flow may vary in the short-term due to power demand and reverse seasonal patterns because of storage requirements. Downstream - base flows may be more stable and flood peaks are moderated. Some rivers downstream of control structures have residual flows except for recreational releases, e.g. Pukaki R. Water quality reflects lake water quality – generally high, low nutrient and low suspended load	Either join with major mountain and hill rivers, or enter sea through lagoon formed behind gravel barrier beach.	Biological communities similar to mountain rivers, but higher predominance of caddis and dipterans. Often very prolific trout and salmon populations. Middle & lower elevations river bed vegetation is dominated by exotic species, especially woody shrubs.	Overall moderate to low level of naturalness. Despite modifications rivers have high scenic values. Important recreation values; fishing, jetboating, canoeing, water fowl hunting. Tangata Whenua – mauri, mahinga kai. On the Waitaki R. long association with Maori as a route to the interior. Likely to be many wahi tapu and wahi taonga sites.

Summary of lake types

Lake type	Hydrological characteristics	Biological community	Values
Large natural; high country, unregulated eg. Lakes Sumner; Taylor	Lake levels highest in spring fed by rainfall and snow melt. Lowest levels late summer and autumn. Large deep water bodies. Little variation in water temperature or stratification with depth. Water temperature – cold. High water quality: very high levels of water clarity, bottom levels well oxygenated, low nutrient concentrations.	Fish community: long finned eel, upland bully, Koaro, brown & rainbow trout, "Lake locked salmon. Spawning in tributary streams Significant populations of wetland bird communities including open water divers, water fowl, terns. Threatened species present. Macrophyte communities predominantly native species.	Ngai Tahu values –Deed of settlement, mahinga kai eels, water fowl. Important recreation/amenity eg fishing, boating, wind surfing ;wildlife/fisheries Very high natural character, and scenic values. Significant feature in the alpine & high country landscape.
Natural; high country artificially regulated e.g Lakes Coleridge, Tekapo; Pukaki Ohau	Water quality similar to above. Except glacial fed lakes have high turbidity. Lake levels controlled for hydroelectric generation. Lowest levels in winter and highest levels in summer and autumn. Lake levels vary over a much greater range than uncontrolled lakes.	Similar to above. Significant bird populations on deltas at lake heads. Passage of migratory fish species to upper lakes is restricted.	Similar to above
Small to medium sized natural inland lakes (<8 km ^{2}) e.g. Lakes Taylor; Camp; Heron; Selfe; Grassmere; Alexandrina; tarns	Shallow relatively small waterbodies. , Lake levels highest in spring fed by rainfall and snow melt. Lowest levels late summer and autumn. Water quality influenced by surrounding land uses. Relatively unmodified catchments nutrient levels are low. Where more intensive landuses, nutrient levels higher (mesotrophic)	Fish communities – Common bully, upland bully, koaro, long & short finned eel. Brown trout, rainbow trout and salmon. Native macrophyte communities dominant. Riparian margins varied from relatively intact wetland communities to introduced grasslands. Significant native bird populations including creeted grebe, dabchick, scaup .	Similar to large, natural unregulated lakes. High biodiversity values
Lowland coastal lakes, e.g. Lake Ellesmere/ Te Waihora, Wainono, Washdyke lagoons	Inflows of water from springs, groundwater and , lowland streams. Wide shallow water bodies; some are brackish. Some lake levels are managed, with periodic openings to the sea. Water quality – water nutrient enriched (eutrophic), often turbid. Lake water well mixed as a result of wind induced waves. Blue green algal blooms ocassionally on eutrophic lakes (Lake Ellesmere/Te Waihora, Lake Forsyth).	Margins generally modified. Mix of exotic plant species and diverse wetland margins comprising salt marsh with turf species, rushes, sedges, and pasture. Fish communities include mix of freshwater & estuarine species, including long & short finned eels, inanga, galaxiids, smelt, lamprey, common bully and flounder. Important spawning habitat for many species. Brown trout in tributaries. Diverse range of bird communities including open water divers, waders, waterfowl, swamp rails, gulls and terns. Very large populations including many threatened species. Important wintering sites for waders and waterfowl and	Ngai Tahu: Long association with coastal lakes. Traditionally major source of mahinga kai for many runanga. Likely to be many wahi tapu and wahi taonga sites. Very high biodiversity values especially for birds. Lake Ellesmere / Te Waihora recognised as wetland of international importance. Lake levels controlled by Water Conservation Order Important recreation values – water fowl hunting, brown trout fishery especially in tributaries, boating, wind surfing

Lake type	Hydrological characteristics	Biological community	Values
		staging points for migratory species.	
Artificial lakes, e.g. Waitaki; Aviemore, Benmore, Opuha	Artificial waterbodies created by impounding a river. Managed for a specific purpose, such as irrigation storage or hydroelectricity generation. Large range in lake levels. Water quality variable dependent on the physical environment, such as ratio of water depth to width, wind exposure, quality of water inflows.	Habitat values for indigenous species low. Unpredictable water levels limit suitability as breeding habitats. Often managed as trout or lake-locked salmon fisheries	Amenity/recreation eg trout fishing, boating ;hydro-electricity and/or irrigation

Appendix 4. Options for numeric Objectives and Standards – Tables

Appendix 4: Tables of Options for Numeric Objectives and Rule Standards for ECan Management Units (MUs)

Key to colour coded cells in all tables:

(cyan)	Column Headings: In particular the linkage between the 'Management Unit (MU)' – 'Purpose for Management' – 'Level of Protection' - 'Numeric Objective' – 'Rule Standard' is important.
(orange)	Orange cells contain the recommended option based on our understanding of ECan's chosen purpose for management
(green)	Green cells contain options that are included to illustrate the range of options available for the 'level of protection'. They illustrate the consequences (for the objective and rule standard) of ECan choosing a different 'level of protection'.
(purple)	Purple cells indicate the water quality variables for which it has not been possible to recommend a numeric objective and/or a numeric rule standard. This necessitates the use of a narrative objective and/or standard at this stage. This is because either; c) there is insufficient information currently available to scientifically define the number for a water quality variable that will support an identified critical value (e.g. there is significant scientific uncertainty with the nutrient concentrations required to achieve the objective of <50 mg/m^2 chl. *a* that supports benthic biodiversity in 'lowland' rivers (e.g., Biggs 2000)), or, d) the number for a water quality variable that will support an identified critical value is dependent on the existing environmental state, and we currently do not know what that state is (e.g. we have not yet identified the colour or clarity required to support existing amenity value in high country lakes). These purple cells indicate opportunities for further development of the management framework by examination of existing environmental data, collection of new environmental data, and continued scientific study of the relationships between numeric water quality variables, objectives, values and purposes for management.

Key to footnotes in all tables:

1: 'Mauri and mahinga kai': This table does not include objectives or standards for mauri or mahinga kai values because this is beyond the scope of this report. The table does include consideration of some aspects of mauri and mahinga kai that relate to measurable aspects of water quality and the ecological maintenance of native fish. Other aspects of mauri and mahinga kai (e.g. spiritual and cultural) will need to be considered separately to this report.

2: 'Human drinking water': This is a 'purpose for management' that applies only to specific areas within some of the MUs defined in this report. These are areas that are used as a source for community water supplies. We have not provided a set of water quality standards for 'human drinking water' as a purpose for management. The reasons for this are explained in Section 7.2 of the report.

3: 'Natural state': We have not been able to provide a set of water quality standards that are consistent with 'natural state' as a purpose for management. The reasons for this are explained in Sections 7.1 and 11.12 of the report.

Table 1. ALPINE SOURCE RIVERS

Management Unit (MU)	***Purpose for Management*** *(Management Outcomes as defined by ECan in the Draft NRRP)*	***Water Quality Variable*** *(related to issues with achieving the purpose for management)*	***Critical Value*** *(most sensitive value [for each water quality variable] of the chosen purposes for management)*	***Level of Protection*** *(choosing between options involves a political decision)*	***Numeric Objective*** *(states 'What' environmental outcome is required to support the 'Purpose for Management' at the desired level of protection)*	*Reference* *Used to define Numeric Objective*	*Numeric Rule Standard* *(related to the Numeric Objective and states 'How' the numeric objective is to be achieved)* *Note: All numeric rule standards apply to the receiving water beyond the 'Maximum Allowable Non-Compliance' (MANC) mixing zone for any discharge. Refer to text (Section 9) for a definition of this zone.*	*Reference* *Used to define Numeric Rule Standard*
Alpine Source (e.g. Waimakariri, Rakaia, Rangitata)	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation • irrigation • [1]mauri • [1]mahinga kai • stockwater In parts of the MU • [2]human drinking water (low-moderate health risk) • [3]natural state	*E.coli* (Note *E.coli* is the interim preferred indicator for freshwater (MfE 2003))	• contact recreation	Proposed 'maximum tolerable water contact-related illness' risk - Risk Option 1	The maximum tolerable contact-related illness risk shall be less than 0.1% (1/1000 exposures)	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003)	No single sample of receiving water should contain more than 130 *E. coli* per 100 mL, as a result of any discharge.	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003)
				Proposed nationally accepted 'maximum tolerable water contact-related illness' risk - Risk Option 2	The maximum tolerable contact-related illness risk shall be less than 1% (1/100 exposures)	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).	No single sample of receiving water should contain more than 260 *E. coli* per 100 mL, as a result of any discharge.	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).
				Proposed nationally accepted 'maximum tolerable water contact-related illness' risk - Risk Option 3	The maximum tolerable contact-related illness risk shall be less than 5% (1/20 exposures)	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).	No single sample of receiving water should contain more than 550 *E. coli* per 100 mL, as a result of any discharge.	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).
				Note 1: The MfE (2003) guidelines (as at April 2003) supercede the interim guidelines for freshwater (MfE 2002). Note 2: All the rule standard options for *E. coli* were derived from guidelines (MfE 2003) that are based on relationships between the indicator (*E.coli*) concentration and risk to human health via campylobacteriosis (Table H2 of the Explanatory Notes[MfE 2003]). As stated in the guidelines (MfE 2003) this relationship may be altered in waters affected by nearby effluent discharges, and the guidelines therefore caution that the numbers are not intended to be used as the basis for establishing conditions for discharge consents, although they may be used as a component for decision-making. In other words, based on the best information available, *on average*, illness risk rises above 1% when recreational freshwater *E. Coli* concentrations are greater than 260 per 100 mL, but this may not hold true if those waters are in close proximity to significant wastewater discharges, no matter how well treated they may be. For this reason it is important that ECan retain the discretion to require dischargers of treated effluent to meet other requirements (including lower *E.coli* limits) if this is determined to be appropriate during a consent hearing process. ECan may consider other methods of assessing health risk (e.g., the Sanitary Inspection Category in Figure H3 (MfE, 2003)) in order to make decisions during an individual consent process. Note 3: All the objective and rule standard options for *E. coli* relate to the illness risks (<0.1% to 5%) presented in Table H2 of the Explanatory Notes (MfE 2003). In the guidelines the numbers are used as trigger limits for modes of action (e.g., "Alert/Amber Mode" and "Action/Red Mode"). In the guidelines (MfE, 2003) these modes are associated with recommended actions (e.g. increased sampling frequency, erect warning signs etc.). It is important to note that these actions are separate to the use of the *E.coli* concentrations as 'rule standards' in this report. In this report the numbers simply set numeric standards that ECan intend to achieve, and they create exit/entry criteria for whether a discharge activity will be considered as 'discretionary' or 'non-complying'. The rule standards do not explicitly require that the actions presented in the guidelines be carried out in all water bodies that exceed the standard. However ECan may or may not impose such actions on a case-by case basis during a consent process. ECan may refer to the material presented in the guidelines when making such case-by-case decisions and writing consent conditions.				
		Faecal coliforms	• contact recreation	Objectives & standards have not been recommended because faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ.				

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
		Dissolved oxygen (DO)	• biodiversity (native fish and salmonids)	Support salmonid and native fish health and spawning at level of protection proposed in national guidelines	The concentration of DO shall not be limiting to the survival, growth and reproduction of salmonids and native fish. DO shall be between 90% and 110% saturation during daytime and at all times during spawning (May – September); and shall not be less than 80% at any time.	Consideration of: ANZECC & ARMCANZ 2000 (modified from SE Australian guidelines Table 3.3.2); and consistency with RMA 1991 Third Schedule standards for class FS, F, SG and AE waters.	Receiving water DO shall be between 90% and 110% saturation during daytime and at all times during spawning (May – September), and shall not be less than 80% at any time, as a result of any discharge.	Consideration of: ANZECC & ARMCANZ 2000 (modified from SE Australian guidelines Table 3.3.2); and consistency with RMA 1991 Third Schedule standards for class FS, F, SG and AE waters.
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing DO data distribution for theCanterbury "Alpine" MU.				
		Temperature	• biodiversity (native fish and salmonids)	Support salmonid and native fish health and spawning (including the food of fish – invertebrates) at level of protection proposed in national guidelines and considering NZ research papers	Water temperature shall not be limiting to the survival, growth and reproduction of salmonids and native fish. With the only exception of natural perturbations; Water temperature shall not exceed 18^{O}C as a daily mean or 20 ^{O}C as a daily maximum; and, In salmonid spawning areas during winter (May – September) the daily maximum temperature shall not exceed 11^{o}C.	Consideration of: RMA 1991, Alabaster and Lloyd 1982; Quinn et al. 1994; Simons 1984; Main 1988; Richardson *et al.* 1994; Cox 2000; Quinn and Hickey 1990; Quinn unpublished data, Elliott 1977 and 2000; Jowett 1990 and 1992; Jowett pers. comm. 2003; McDowall pers. comm. 2003.	The daily maximum ambient water temperature shall not be increased by more than 3^{o}C, as a result of any discharge; and, The receiving water temperature shall not exceed 18^{O}C as a daily mean or 20 ^{O}C as a daily maximum, as a result of any discharge; and, The receiving water daily maximum temperature shall not exceed 11^{o}C in salmonid spawning areas during winter (May-September), as a result of any discharge.	Consideration of: RMA 1991, Alabaster and Lloyd 1982; Quinn et al. 1994; Simons 1984; Main 1988; Richardson *et al*. 1994; Cox 2000; Quinn and Hickey 1990; Quinn unpublished data, Elliott 1977 and 2000; Jowett 1990 and 1992; Jowett pers. comm. 2003; McDowall pers. comm. 2003.
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing temperature data distribution for theCanterbury "Alpine" MU..				
		PH	• biodiversity (native fish and salmonids)	Support salmonid and native fish health and spawning (including the food of fish – invertebrates)	Water pH shall not be limiting to the survival, growth and reproduction of salmonids and native fish. With the only exception of natural perturbations; Water pH shall at all times be between 6.0 and 9.0 pH units.	Consideration of: ANZECC & ARMCANZ 2000 (Table 3.3.10 and page 8.2-68); Davies-Colley 2000; RMA (1991)	The ambient receiving water pH shall not change as a result of any discharge, by more than 0.5 pH units, at any time of the day on a continuous basis; and, The receiving water pH shall not be less than 6.0 or greater than 9.0 pH units, as a result of any discharge.	Consideration of: ANZECC &ARMCANZ 2000 (Table 3.3.10 and page 8.2-68); Davies-Colley 2000; RMA (1991).
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing pH data distribution for theCanterbury "Alpine" MU..				

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
		Clarity	• contact recreation • amenity	Support swimming recreation at proposed nationally accepted level of safe visibility for swimming as described in national guidelines (MfE 1994aa)	With the only exception of natural perturbations; Water shall have visible clarity that is safe for swimming, this being greater than 160 cm, as measured by black disc.	MfE 1994a ANZECC & ARMCANZ 2000	Measurements of receiving water visual clarity during summer (Dec-Mar), as measured by black disc, shall not be less than 160 cm, as a result of any discharge.	MfE 1994a, ANZECC & ARMCANZ 2000
				Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994) for waters where clarity is an important characteristic.	The existing dry weather water clarity shall be maintained to within 20%. It is also desirable to derive an 'absolute' numeric objective 'X' for clarity (see Note 1).	MfE 1994a	The ambient receiving water visual clarity, as measured by black disc, shall not be changed by more than 20%, as a result of any discharge; and, The receiving water visual clarity, as measured by black disc, shall not be less than 'X' cm, as a result of any discharge.	MfE 1994a
				Support aesthetic amenity value for 'class B' waters as described in national guidelines (MfE 1994a) for waters where clarity is a less important characteristic.	The existing dry weather water clarity shall be maintained to within 33-50% (and also see purple text above).	MfE 1994a	The ambient receiving water visual clarity, as measured by black disc, shall not be changed by more than 33-50%, as a result of any discharge; (and also see purple text above)	MfE 1994a
				Note 1: At present the numeric objectives and rule standards for clarity are 'relative' only (i.e., they relate to a percentage change from existing state) and the existing state (average 'X' cm visual clarity) has not been defined. It is desirable to develop a numeric objective and a rule standard that are 'absolute' values of 'X cm' visual clarity so that a threshold is defined against which to measure and assess cumulative effects. We recommend that this be undertaken based on examination of the existing clarity data distribution for the defined Canterbury MUs. Note 2: Ecan could also consider a less conservative percentile approach (e.g. the annual 90th percentile clarity should not be changed by more than 20%).				
		Colour	• contact recreation • amenity	Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where colour (hue) is an important characteristic.	The existing dry weather water colour shall be maintained to within 5 Munsell Units. It is also desirable to derive a numeric objective range 'X-Y' for colour (see Note 1).	MfE 1994a	The ambient receiving water colour, shall not be changed by more than 5 Munsell Units as a result of any discharge; and, The receiving water colour, shall not be less than 'X' Munsell Units or greater than 'Y' Munsell Units, as a result of any discharge.	MfE 1994a
				Support aesthetic amenity value for 'class B' waters as described in national guidelines (MfE 1994a) for waters where colour (hue) is a less important characteristic.	The existing dry weather water colour shall be maintained to within 10 Munsell Units (and also see purple text above).	MfE 1994a	The ambient receiving water colour, shall not be changed by more than 10 Munsell Units as a result of any discharge; (and also see purple text above)	MfE 1994a
				Note 1: At present the numeric objectives and rule standards for colour are 'relative' only (i.e., they relate to a percentage change from existing state) and the existing state (average 'X -Y Munsell Units' colour range) has not been defined. It is desirable to develop a numeric objective and a rule standard that are 'absolute' values of 'X-Y Munsell Units' colour range so that a threshold is defined against which to measure and assess cumulative effects. We recommend that this be undertaken based on examination of the existing colour data distribution for the defined Canterbury MUs. Note: Ecan could consider a less conservative percentile approach (e.g. the annual 90th percentile colour should not be changed by more than 5 Munsell Units).				
		Nutrients	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation	Option 1 – "High protection": Support benthic biodiversity, trout habitat, and recreation at a' high' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 50 mg/m^2 chl. *a* for diatoms, cyanobacteria and filamentous algae.	Biggs 2000 (Executive Summary Table 1)	The average annual concentration of nutrients in the receiving water shall not be greater than 10 mg/m^3 SIN or greater than 1 mg/m^3 SRP, as a result of any discharge. It would normally be expected that the annual average nutrient concentration be based on at least monthly recordings.	Biggs 2000. The Executive Summary Table 2 has been used by applying a nominal accrual period of 30 days for the 'Alpine Rivers' MU. Therefore this corresponds to the SIN and SRP criteria of <10 and <1 mg/m^3 respectively.

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
				Option 2 – "Moderate protection": Support benthic biodiversity, trout habitat, and recreation at a' moderate' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 200 mg/m^2 chl. *a* for diatoms and cyanobacteria, and less than 120 mg/m^2 chl. *a* for filamentous algae, &; The maximum cover of the whole river bed in filamentous algae shall be less than 30% (of filaments > 2 cm long).	Biggs 2000 (Executive Summary Table 1)	The average annual concentration of nutrients in the receiving water shall not be greater than 75 mg/m^3 SIN or greater than 6 mg/m^3 SRP, as a result of any discharge. It would normally be expected that the annual average nutrient concentration be based on at least monthly recordings.	Biggs 2000. The Executive Summary Table 2 has been used by applying a nominal accrual period of 30 days for the 'Alpine Rivers' MU. Therefore this corresponds to the SIN and SRP criteria of <75 and <6 mg/m^3 respectively.
				Note 1: Further options for nutrient standards can be generated from Biggs (2000) by applying different accrual periods. See discussion in Sections 11.9 and 12. Note 2: It will be very important to educate plan users (in the plan) that factors other than nutrients are important, and may in fact be critical, in achieving the objective (e.g. flood frequency, riparian shading, invertebrate grazing). The use of this numeric standard could result in a significant number of non-complying activities that may not be contrary to the linked objective (see cells to left). These factors are site-specific and can be better dealt with on a case-by-case basis during individual consent processes with reference to the appropriate guidelines (Biggs 2000) where necessary. However the value of using these nutrient concentrations in the plan is that they create exit/entry criteria for whether an activity will be considered as 'discretionary' or 'non-complying' and in this respect they provide 'intermediate' guidance to plan users (see Section 4.2 and Figure 1).				
		Ammonia	• biodiversity (macroinvertebrates, native fish, salmonids)	Support benthic biodiversity (macroinvertebrates, native fish, salmonids) at a 95% level of protection proposed in national guidelines (ANZECC & ARMCANZ 2000) and international guidelines (USEPA 1999).	The concentration of ammonia shall not be limiting to the survival, growth and reproduction of 95% of invertebrates, native fish and salmonids.	ANZECC & ARMCANZ 2000, Tables 3.4.1 and 8.3.7 have been used to derive chronic criteria. USEPA 1999, The table on page 86 has been used to derive acute criteria	CHRONIC STANDARD Receiving water sample results for total ammonia nitrogen shall not be greater than the chronic standard, as a result of any discharge. The chronic standard varies with pH and shall be defined for any particular case by using the average (30 day) receiving water pH. Chronic Standard = 0.9 mg(N)/L at pH 8.0 ACUTE STANDARD Receiving water sample results for total ammonia nitrogen shall not be greater than the acute standard, as a result of any discharge. The acute standard varies with pH and shall be defined for a particular case by using the maximum (one hour average) receiving water pH. Acute Standard = 0.885 mg(N)/L at pH 9.	ANZECC & ARMCANZ 2000, Tables 3.4.1 and 8.3.7 have been used to derive chronic criteria. USEPA 1999, The table on page 86 has been used to derive acute criteria using a pH of 9.
				Note 1: These ammonia rule standards could be presented in the plan either as tables of values calculated for a useful pH range (as provided in Table 8.3.7 of ANZECC & ARMCANZ 2000), or as pH-dependent formulae, according to ANZECC & ARMCANZ 2000 and USEPA 1999. The criteria could also be supplied as computer code that generates the appropriate criteria when the desired pH is entered. Note 2: A number of studies have shown that the fingernail clam *Sphaerium novaezelandiae* is particularly sensitive to chronic ammonia effects (Hickey and Martin 1999) and the amphipod *Paracalliope fluviatilis* is particularly sensitive to acute ammonia effects (Hickey 2000). There may be some justification for requiring more strict (lower) ammonia concentrations if there was particular concern for these species in a specific discharge case, and this is discussed in ANZECC & ARMCANZ 2000 (page 8.3-159) , Hickey 2000 (page 324) and Hickey (2001). However generally the consequence of using the rule standards proposed above, instead of some stricter standard, will be a slightly larger non-compliance zone, with some elevated local chronic effect on *S. novaezelandiae* and elevated local acute effect on *P. fluviatilis*. For the purpose of providing rule standards for the planning framework recommended in this report, and in the interest of keeping the framework as simple and user-friendly as possible, we recommend use of the single set of rule standards for ammonia proposed above. Further detail could be incorporated on a case-by-case basis by referring to ANZECC & ARMCANZ 2000 and Hickey (2000) etc. during consent processes if necessary.				
		Biochemical Oxygen Demand (BOD)	• biodiversity (native fish, birds and salmonids) • contact recreation	Maintain values associated with contact recreation and fish spawning at a level of protection proposed in national guidelines (MfE 1992)	Bacterial and/or fungal slime growths (also known as heterotrophic growths or sewage fungus) shall not be visible to the naked eye as plumose growths or mats.	MfE 1992	1) The daily average BOD_5 of GF/C filtered water shall not exceed 2 g/m^3, as a result of any discharge, or, 2) The daily average Dissolved Organic Carbon (DOC) shall not exceed 1 g/m^3 DOC, as a result of any discharge.	1) MfE 1992 2) J. Quinn, NIWA, pers. comm.
				Note 1: While this objective is not numeric, it is clear in its implication that no (i.e. zero) growths shall be visible. Note 2: Standard No. 2 above is not based on any published guidelines but is provided as an alternative for consideration by ECan as a moderately conservative additional standard by personal communication with Dr J. Quinn, NIWA.				

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
		Suspended Solids (SS)	• biodiversity (native fish, birds and salmonids) • contact recreation	While SS are generally recognised as having important environmental effects, there are currently no directly applicable published national guidelines. It is likely that objectives and rule standards for clarity (established to protect contact recreation and amenity values in cells above) will also protect biodiversity values from the effects of solids suspended in the water column. This is because there is a good relationship between clarity (black disc[BD]) and SS, and the objectives and standards for clarity (160 cm and <20-50% change) correspond to relatively low SS concentrations in the water column (e.g. clarity (BD) of 25 cm = c. 30 g/m^3 SS, from plots of Whatawhata data reported in Quinn and Stroud, 2002) that are likely to protect biodiversity. However this does not account for the effects that suspended solids can have on biodiversity after the solids settle on a streambed. Neither would a numeric standard for SS concentration effectively protect against such effects, unless it were very low, and applied at all times even during rainfall. Such a standard would be problematic and difficult to justify. We consider this issue is one requiring further attention for development of the framework, particularly as sedimentation is widely considered to be an important aspect of degradation of some lowland Canterbury rivers. At this stage we recommend that a narrative objective be used, based on the cover or embeddedness of substrates by fine sediments.				
		Turbidity	• biodiversity • contact recreation	The comment for SS in the cell above applies also for turbidity. There is a reasonably good relationship between clarity (black disc)/SS/turbidity (Quinn and Stroud, 2002). Turbidity should be considered as well as SS, in trying to develop numeric objectives and standards to protect biodiversity values from sedimentation effects. This issue is one requiring further attention for development of the framework.				
		Toxicants	• biodiversity (native fish, birds and salmonids)	Support benthic biodiversity (macroinvertebrates, native fish, salmonids) at a **99% level** of protection proposed in national guidelines (ANZECC & ARMCANZ 2000)	The concentration of toxicants (listed in Table 11 - Toxicants) shall not be limiting to the survival, growth and reproduction for **99%** of invertebratres, native fish and salmonids.	ANZECC & ARMCANZ 2000	The concentration of toxicants (measured as the total fraction) shall not be greater than the standard (**99%** protection) in Table 11- Toxicants, at any time, as a result of any discharge.	ANZECC & ARMCANZ 2000
				Support benthic biodiversity (macroinvertebrates, native fish, salmonids) at a **95% level** of protection proposed in national guidelines (ANZECC & ARMCANZ 2000)	The concentration of toxicants (listed in Table 11 - Toxicants) shall not be limiting to the survival, growth and reproduction for **95%** of invertebratres, native fish and salmonids.	ANZECC & ARMCANZ 2000	The concentration of toxicants (measured as the total fraction) shall not be greater than the standard (**95%** protection) in Table 11- Toxicants, at any time, as a result of any discharge.	ANZECC & ARMCANZ 2000
				Support benthic biodiversity (macroinvertebrates, native fish, salmonids) at a **80% level** of protection proposed in national guidelines (ANZECC & ARMCANZ 2000)	The concentration of toxicants (listed in Table 11 - Toxicants) shall not be limiting to the survival, growth and reproduction for **80%** of invertebratres, native fish and salmonids.	ANZECC & ARMCANZ 2000	The concentration of toxicants (measured as the total fraction) shall not be greater than the standard (**80%** protection) in Table 11- Toxicants, at any time, as a result of any discharge.	ANZECC & ARMCANZ 2000
				Note: The use of the 'total fraction' is conservative for the protection of biodiversity because the total fraction would only become soluble and therefore 'bioavailable' in some circumstances (e.g. when accumulated and re-released by particular sediment conditions in an estuary or lake). In many cases (e.g. in rivers where there is negligible accumulation of suspended solids), it would be appropriate to consider the 'soluble fraction' that is usually significantly smaller than the 'total fraction'. It is a risk management decision for ECan, whether to use the 'total fraction' for the standard (and then consider the soluble fraction for non-complying activities); or, use the 'soluble fraction' for the standard (and consider the total fraction if appropriate during consideration of discretionary activities). The former option is conservative.				
		Objectionable materials	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation	Support critical values at nationally accepted standard (i.e. s107 RMA 1991)	Waters shall be free at all times from; floating debris, oil, grease, scums and foams, excluding those of natural origin.	RMA 1991 (s107)	Waters shall be free at all times from; floating debris, oil, grease, scums and foams, excluding those of natural origin.	RMA 1991 (s107)
				Note: While the objective and rule standard (above) are not numeric, they are clear in the implication that none (i.e. zero) of these things shall be present.				
		Narrative "catch-all" statements	• amenity • biodiversity • contact recreation • irrigation • [1]mauri • [1]mahinga kai • stockwater	Support critical values at nationally accepted or proposed standards (e.g. s70, s107, Third Schedule RMA 1991)	Narrative statements should be added to the objectives to act as 'catch-all' provisions for protection from unknown contaminants and/or effects not covered by numeric objectives.	RMA 1991	Rule standards that act to determine the category or 'level of discretion' of an activity in a plan may <u>not</u> contain narrative standards that are broad and uncertain (see Report Section 4.5). However these narrative standards must be incorporated elsewhere in the plan.	Refer Report Section 4.

Table 2. HILL SOURCE RIVERS

Note: Where the 'purpose for management' and options for 'numeric objectives' and 'rule standards' are the same as for Table 1. Alpine Source Rivers, the rows have not been repeated. This table only includes rows where options are different, or the recommended option is different.

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
	(Management Outcomes as defined by ECan in the Draft NRRP)	*(related to issues with achieving the purpose for management)*	*(most sensitive value [for each water quality indicator] of the chosen purposes for management)*	*(choosing between options involves a political decision)*	*(states 'What' environmental outcome is required to support the 'Purpose for Management' at the desired level of protection)*	*Used to define Numeric Objective*	*(related to the Numeric Objective and states 'How' the numeric objective is to be achieved)* *Note: All numeric rule standards to apply beyond the 'Maximum Allowable Non-Compliance' (MANC) mixing zone. Refer to text (Section 9) for a definition of this zone.*	*Used to define Numeric Rule Standard*
Hill Source (e.g. Ashley, Pareora, Waipara, Puhi Puhi, Kahutara, Kowhai))	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation • irrigation • [1]mauri • [1]mahinga kai • stockwater In parts of the MU • [2]human drinking water (low-moderate health risk) • [3]natural state	*E.coli* (Note *E.coli* is the interim preferred indicator for freshwater (MfE 2003))	• contact recreation	Proposed nationally accepted 'maximum tolerable water contact-related illness' risk - Risk Option 2	The maximum tolerable contact-related illness risk shall be less than 1% (1/100 exposures)	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).	No single sample of receiving water should contain more than 260 *E. coli* per 100 mL, as a result of any discharge.	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).
				Notes: Refer to the same notes (Notes 1, 2 and 3) provided for the *E.coli* (contact recreation) row in Table 1 for "Alpine Rivers".				
		Faecal coliforms	• contact recreation	Objectives & standards have not been recommended because faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ.				
		Dissolved oxygen (DO)	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing DO data distribution for the Canterbury "Hill Source" MU.				
		Temperature	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing temperature data distribution for the Canterbury "Hill Source" MU.				
		pH	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing pH data distribution for the Canterbury "Hill Source" MU.				
		Clarity	• contact recreation • amenity	Support swimming recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.			
				Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where clarity is an important characteristic.	The existing dry weather water clarity shall be maintained to within 20%. It is also desirable to derive an 'absolute' numeric objective 'X' for clarity in the "Hill" MU.	MfE 1994a	The ambient receiving water visual clarity, as measured by black disc, shall not be changed by more than 20%, as a result of any discharge; and, The receiving water visual clarity, as measured by black disc, shall not be less than 'X' cm, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Clarity (amenity) row in Table 1 for "Alpine Rivers".				

Management Unit (MU)	Purpose for Management	Water Quality Variable	Critical Value	Level of Protection	Numeric Objective	Reference	Numeric Rule Standard	Reference
		Colour	• contact recreation • amenity	Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where colour (hue) is an important characteristic.	The existing dry weather water colour shall be maintained to within 5 Munsell Units. It is also desirable to derive a numeric objective range 'X-Y' for colour in the "Hill" MU).	MfE 1994a	The ambient receiving water colour, shall not be changed by more than 5 Munsell Units as a result of any discharge; and, The receiving water colour, shall not be less than 'X' Munsell Units or greater than 'Y' Munsell Units, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Colour (amenity) row in Table 1 for "Alpine Rivers".				
		Nutrients	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation	Option 1 – "High protection": Support benthic biodiversity, trout habitat, and recreation at a' high' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 50 mg/m^2 chl. *a* for diatoms, cyanobacteria and filamentous algae.	Biggs 2000 (Executive Summary Table 1)	The average annual concentration of nutrients in the receiving water shall not be greater than 10 mg/m^3 SIN or greater than 1 mg/m^3 SRP, as a result of any discharge. It would normally be expected that the annual average nutrient concentration be based on at least monthly recordings.	Biggs 2000. The Executive Summary Table 2 has been used by applying a nominal accrual period of 50 days for the 'Hill Rivers' MU. Therefore this corresponds to the SIN and SRP criteria of <10 and <1 mg/m^3 respectively.
				Option 2 – "Moderate protection": Support benthic biodiversity, trout habitat, and recreation at a' moderate' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 200 mg/m^2 chl. *a* for diatoms and cyanobacteria, and less than 120 mg/m^2 chl. *a* for filamentous algae, &; The maximum cover of the whole river bed in filamentous algae shall be less than 30% (of filaments > 2 cm long).	Biggs 2000 (Executive Summary Table 1)	The average annual concentration of nutrients in the receiving water shall not be greater than 19 mg/m^3 SIN or greater than 1.7 mg/m^3 SRP, as a result of any discharge. It would normally be expected that the annual average nutrient concentration be based on at least monthly recordings.	Biggs 2000. The Executive Summary Table 2 has been used by applying a nominal accrual period of 50 days for the 'Hill Rivers' MU. Therefore this corresponds to the SIN and SRP criteria of <19 and <1.7 mg/m^3 respectively.
				Notes: Refer to the same notes provided for the 'Nutrients' row in Table 1 for "Alpine Rivers".				
		Ammonia	• biodiversity (macroinvertebrates, native fish, salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Ammonia (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of ammonia is the same, regardless of the type of river, and therefore there is no reason for the ammonia objectives and rule standards to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as for the "Alpine Rivers" MU.				
		Biochemical Oxygen Demand (BOD)	• biodiversity (as above) • contact recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the BOD (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Suspended Solids (SS)	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the SS (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Turbidity	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the Turbidity (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Toxicants	• biodiversity (as above)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes provided for the Toxicants (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of toxicants in Table 11 is the same, regardless of the type of river, and therefore there is no reason for the objectives and rule standards for toxicants to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as for the "Alpine Rivers" MU.				
		Objectionable material	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					
		Narrative statements	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					

Table 3. LAKE SOURCE RIVERS

Note: Where the 'purpose for management' and options for 'numeric objectives' and 'rule standards' are the same as for Table 1. Alpine Source Rivers, the rows have not been repeated. This table only includes rows where options are different, or the recommended option is different.

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
	(Management Outcomes as defined by ECan in the Draft NRRP)	*(related to issues with achieving the purpose for management)*	*(most sensitive value [for each water quality indicator] of the chosen purposes for management)*	*(choosing between options involves a political decision)*	*(states 'What' environmental outcome is required to support the 'Purpose for Management' at the desired level of protection)*	*Used to define Numeric Objective*	*(related to the Numeric Objective and states 'How' the numeric objective is to be achieved)* *Note: All numeric rule standards to apply beyond the 'Maximum Allowable Non-Compliance' (MANC) mixing zone. Refer to text (Section 9) for a definition of this zone.*	*Used to define Numeric Rule Standard*
Lake Source (e.g. natural - North Branch Hurunui, Lake Stream, Sisters Stream) (e.g. regulated – Pukaki River, Waitaki River, Opuha River)	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation • irrigation • [1]mauri • [1]mahinga kai • stockwater In parts of the MU • [2]human drinking water (low-moderate health risk) • [3]natural state	*E.coli* (Note *E.coli* is the interim preferred indicator for freshwater (MfE 2003))	• contact recreation	Proposed nationally accepted 'maximum tolerable water contact-related illness' risk - Risk Option 2	The maximum tolerable contact-related illness risk shall be less than 1% (1/100 exposures)	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).	No single sample of receiving water should contain more than 260 *E. coli* per 100 mL, as a result of any discharge.	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).
				Notes: Refer to the same notes (Notes 1, 2 and 3) provided for the *E.coli* (contact recreation) row in Table 1 for "Alpine Rivers".				
		Faecal coliforms	• contact recreation	Objectives & standards have not been recommended because faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ.				
		Dissolved oxygen (DO)	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing DO data distribution for the Canterbury "Lake Source" MU.				
		Temperature	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing temperature data distribution for the Canterbury "Lake Source" MU.				
		pH	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing pH data distribution for the Canterbury "Lake Source" MU.				
		Clarity	• contact recreation • amenity	Support swimming recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.			
				Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where clarity is an important characteristic.	The existing dry weather water clarity shall be maintained to within 20%. It is also desirable to derive an 'absolute' numeric objective 'X' for clarity in the Lake MU.	MfE 1994a	The ambient receiving water visual clarity, as measured by black disc, shall not be changed by more than 20%, as a result of any discharge; and, The receiving water visual clarity, as measured by black disc, shall not be less than 'X' cm, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Clarity (amenity) row in Table 1 for "Alpine Rivers".				

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
		Colour	• contact recreation • amenity	Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where colour (hue) is an important characteristic.	The existing dry weather water colour shall be maintained to within 5 Munsell Units. It is also desirable to derive a numeric objective range 'X-Y' for colour in the Lake MU).	MfE 1994a	The ambient receiving water colour, shall not be changed by more than 5 Munsell Units as a result of any discharge; and, The receiving water colour, shall not be less than 'X' Munsell Units or greater than 'Y' Munsell Units, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Colour (amenity) row in Table 1 for "Alpine Rivers".				
		Nutrients	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation	Option 1 – "High protection": Support benthic biodiversity, trout habitat, and recreation at a' high' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 50 mg/m^2 chl. *a* for diatoms, cyanobacteria and filamentous algae.	Biggs 2000 (Executive Summary Table 1)	Note: We have not recommend a rule standard limiting nutrient concentrations for the 'Lake Source' rivers MU. This is because there is significant scientific uncertainty in defining the nutrient concentrations required to achieve the numeric objective in lake source rivers. We consider that inclusion of such a rule standard would create unacceptable problems. Instead it will be very important to educate plan users (in the plan) that nutrients as well as other factors (e.g. flood frequency, riparian shading, invertebrate grazing) are important in determining whether the objective can be achieved.	Biggs 2000. The use of Executive Summary Table 2 requires an estimate of 'accrual' period. There is significant uncertainty in estimating accrual period for the 'Lake Source' MU and therefore a rule standard has not been recommended.
				Option 2 – "Moderate protection": Support benthic biodiversity, trout habitat, and recreation at a' moderate' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 200 mg/m^2 chl. *a* for diatoms and cyanobacteria, and less than 120 mg/m^2 chl. *a* for filamentous algae, &; The maximum cover of the whole river bed in filamentous algae shall be less than 30% (of filaments > 2 cm long).	Biggs 2000 (Executive Summary Table 1)	Note: We have not recommend a rule standard limiting nutrient concentrations for the 'Lake Source' rivers MU. See note above.	Biggs 2000. The use of Executive Summary Table 2 requires an estimate of 'accrual' period. There is significant uncertainty in estimating accrual period for the 'Lake Source' MU and therefore a rule standard has not been recommended.
				Notes: Also refer to the same notes provided for the 'Nutrients' row in Table 1 for "Alpine Rivers".				
		Ammonia	• biodiversity (macroinvertebrates, native fish, salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Ammonia (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of ammonia is the same, regardless of the type of river, and therefore there is no reason for the ammonia objectives and rule standards to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as for the "Alpine Rivers" MU.				
		Biochemical Oxygen Demand (BOD)	• biodiversity (as above) • contact recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the BOD (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Suspended Solids (SS)	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the SS (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Turbidity	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the Turbidity (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Toxicants	• biodiversity (as above)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes provided for the Toxicants (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of toxicants in Table 11 is the same, regardless of the type of river, and therefore there is no reason for the objectives and rule standards for toxicants to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as for the "Alpine Rivers" MU.				
		Objectionable material	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					
		Narrative statements	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					

Table 4(a). INTERMONTANE RIVERS (excluding rivers of the Amuri Basin)

Note: Where the 'purpose for management' and options for 'numeric objectives' and 'rule standards' are the same as for Table 1. Alpine Source Rivers, the rows have not been repeated. This table only includes rows where options are different, or the recommended option is different.

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
	(Management Outcomes as defined by ECan in the Draft NRRP)	*(related to issues with achieving the purpose for management)*	*(most sensitive value [for each water quality indicator] of the chosen purposes for management)*	*(choosing between options involves a political decision)*	*(states 'What' environmental outcome is required to support the 'Purpose for Management' at the desired level of protection)*	*Used to define Numeric Objective*	*(related to the Numeric Objective and states 'How' the numeric objective is to be achieved)* *Note: All numeric rule standards to apply beyond the 'Maximum Allowable Non-Compliance' (MANC) mixing zone. Refer to text (Section 9) for a definition of this zone.*	*Used to define Numeric Rule Standard*
Intermontane Source (excluding rivers of the Amuri Basin only)	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation • irrigation • [1]mauri • [1]mahinga kai • stockwater In parts of the MU • [2]human drinking water (low-moderate health risk) • [3]natural state	*E.coli* (Note *E.coli* is the interim preferred indicator for freshwater (MfE 2003))	• contact recreation	Proposed nationally accepted 'maximum tolerable water contact-related illness' risk - Risk Option 2	The maximum tolerable contact-related illness risk shall be less than 1% (1/100 exposures)	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).	No single sample of receiving water should contain more than 260 *E. coli* per 100 mL, as a result of any discharge.	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).
				Notes: Refer to the same notes (Notes 1, 2 and 3) provided for the *E.coli* (contact recreation) row in Table 1 for "Alpine Rivers".				
		Faecal coliforms	• contact recreation	Objectives & standards have not been recommended because faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ.				
		Dissolved oxygen (DO)	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing DO data distribution for the Canterbury "Intermontane" MU.				
		Temperature	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of existing temperature data distribution for the Canterbury "Intermontane" MU.				
		pH	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing pH data distribution for the Canterbury "Intermontane" MU.				
		Clarity	• contact recreation • amenity	Support swimming recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.			
				Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where clarity is an important characteristic.	The existing dry weather water clarity shall be maintained to within 20%. It is also desirable to derive an 'absolute' numeric objective 'X' for clarity in the <u>"Intermontane" MU</u>.	MfE 1994a	The ambient receiving water visual clarity, as measured by black disc, shall not be changed by more than 20%, as a result of any discharge; and, The receiving water visual clarity, as measured by black disc, shall not be less than 'X' cm, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Clarity (amenity) row in Table 1 for "Alpine Rivers".				

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
		Colour	• contact recreation • amenity	Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where colour (hue) is an important characteristic.	The existing dry weather water colour shall be maintained to within 5 Munsell Units. It is also desirable to derive a numeric objective range 'X-Y' for colour in the 'Intermontane' MU).	MfE 1994a	The ambient receiving water colour, shall not be changed by more than 5 Munsell Units as a result of any discharge; and, The receiving water colour, shall not be less than 'X' Munsell Units or greater than 'Y' Munsell Units, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Colour (amenity) row in Table 1 for "Alpine Rivers".				
		Nutrients	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation	Option 1 – "High protection": Support benthic biodiversity, trout habitat, and recreation at a' high' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 50 mg/m^2 chl. *a* for diatoms, cyanobacteria and filamentous algae.	Biggs 2000 (Executive Summary Table 1)	Note: We have not recommend a rule standard limiting nutrient concentrations for the 'Intermontane' rivers MU. This is because there is significant scientific uncertainty in defining the nutrient concentrations required to achieve the numeric objective in intermontane rivers. We consider that inclusion of such a rule standard would create unacceptable problems. Instead it will be very important to educate plan users (in the plan) that nutrients as well as other factors (e.g. flood frequency, riparian shading, invertebrate grazing) are important in determining whether the objective can be achieved.	Biggs 2000. The use of Executive Summary Table 2 requires an estimate of 'accrual' period. There is significant uncertainty in estimating accrual period for the 'Intermontane' MU and therefore a rule standard has not been recommended.
				Option 2 – "Moderate protection": Support benthic biodiversity, trout habitat, and recreation at a' moderate' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 200 mg/m^2 chl. *a* for diatoms and cyanobacteria, and less than 120 mg/m^2 chl. *a* for filamentous algae, &; The maximum cover of the whole river bed in filamentous algae shall be less than 30% (of filaments > 2 cm long).	Biggs 2000 (Executive Summary Table 1)	Note: We have not recommend a rule standard limiting nutrient concentrations for the 'Intermontane' rivers MU. See note above.	Biggs 2000. The use of Executive Summary Table 2 requires an estimate of 'accrual' period. There is significant uncertainty in estimating accrual period for the 'Intermontane' MU and therefore a rule standard has not been recommended.
				Notes: Refer to the same notes provided for the 'Nutrients' row in Table 1 for "Alpine Rivers".				
		Ammonia	• biodiversity (macroinvertebrates, native fish, salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. Notes: Refer to the same notes (Notes 1 and 2) provided for the Ammonia (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of ammonia is the same, regardless of the type of river, and therefore there is no reason for the ammonia objectives and rule standards to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as for the "Alpine Rivers" MU.				
		Biochemical Oxygen Demand (BOD)	• biodiversity (as above) • contact recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. Notes: Refer to the same notes (Notes 1 and 2) provided for the BOD (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Suspended Solids (SS)	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the SS (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Turbidity	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the Turbidity (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Toxicants	• biodiversity (as above)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. Notes: Refer to the same notes provided for the Toxicants (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of toxicants in Table 11 is the same, regardless of the type of river, and therefore there is no reason for the objectives and rule standards for toxicants to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as for the "Alpine Rivers" MU.				
		Objectionable material	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					
		Narrative statements	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					

Table 4(b). INTERMONTANE RIVERS (of the Amuri Basin only)

Note: Where the 'purpose for management' and options for 'numeric objectives' and 'rule standards' are the same as for Table 1. Alpine Source Rivers, the rows have not been repeated. This table only includes rows where options are different, or the recommended option is different.

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
	(Management Outcomes as defined by ECan in the Draft NRRP)	*(related to issues with achieving the purpose for management)*	*(most sensitive value [for each water quality indicator] of the chosen purposes for management)*	*(choosing between options involves a political decision)*	*(states 'What' environmental outcome is required to support the 'Purpose for Management' at the desired level of protection)*	*Used to define Numeric Objective*	*(related to the Numeric Objective and states 'How' the numeric objective is to be achieved)* *Note: All numeric rule standards to apply beyond the 'Maximum Allowable Non-Compliance' (MANC) mixing zone. Refer to text (Section 9) for a definition of this zone.*	*Used to define Numeric Rule Standard*
Intermontane Source (of Amuri Basin only)	• biodiversity (native fish, birds and salmonids) • irrigation • [1]mauri • [1]mahinga kai • stockwater	*E.coli*	• stockwater	Support stock drinking purposes at level of protection proposed in national guidelines (ANZECC &ARMCANZ 2000). Note: The level of risk of impaired livestock production is not quantified in ANZECC & ARMCANZ 2000. Therefore the level of protection afforded by the rule standard proposed in this row is unable to be quantified here.	Water shall be suitable for drinking water for livestock It would be desirable to quantify the maximum tolerable consumption-related illness risk for stock (i.e.less than X% , X/1000 exposures), however it seems unlikely that this will be possiblein the foreseeable future.	ANZECC &ARMCANZ 2000 (section 9.3.3.2)	The running median of receiving water sample results for *E.coli* shall not be greater than 100 *E. coli*/100ml, with four out of five samples not greater than 400 *E. coli*/100ml, as a result of any discharge. It would normally be expected that the running median would be calculated on the basis of at least weekly samples.	ANZECC &ARMCANZ 2000 (section 9.3.3.2) has been used but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as in section 9.3.3.2 of the guidelines (see explanatory Note 1 below).
				Note 1: The ANZECC &ARMCANZ 2000 guidelines (section 9.3.3.2) have been used, but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as presented in section 9.3.3.2 of the guidelines. This has been done for consistency with the use of *E. coli* as the preferred indicator for freshwater contact recreation (MfE 2003) as used elsewhere in these tables. The numbers have not been reduced to reflect the fact that *E.coli* concentrations are generally lower than faecal coliform concentrations because it is often found that *E.coli* concentrations are not much lower, and therefore to drop the standard (e.g., from 100 to 84 *E. coli*/100ml) would imply a precision in the indicator/risk relationship that does not exist (McBride pers. comm.). The rounding of numbers is also consistent with MfE (2003) guidelines.				
		Faecal coliforms	• stockwater	Objectives & standards have not been recommended to be consistent with the fact that faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ and, for consistency, *E.coli* has been used as the indicator for rule standards to protect water used for stockwater (see row above).				
		Dissolved oxygen (DO)	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing DO data distribution for the Canterbury "Intermontane" MU.				
		Temperature	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of existing temperature data distribution for the Canterbury "Intermontane" MU.				
		pH	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing pH data distribution for the Canterbury "Intermontane" MU.				
		Clarity	At this stage contact recreation and amenity values do not appear in the 'purposes for management' for this MU. Therefore no objectives and standards are presented for clarity. If this is reviewed in future, the options for Ecan will be the same as those those presented for Clarity (contact recreation and amenity) in the 'Alpine Source' rivers in Table 1.					
		Colour	At this stage contact recreation and amenity values do not appear in the 'purposes for management' for this MU. Therefore no objectives and standards are presented for clarity. If this is reviewed in future, the options for Ecan will be the same as those those presented for Colour (contact recreation and amenity) in the 'Alpine Source' rivers in Table 1.					

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
		Nutrients	• amenity • biodiversity (native fish, birds and salmonids)	Option 1 – "High protection": Support benthic biodiversity, trout habitat, and recreation at a' high' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 50 mg/m^2 chl. *a* for diatoms, cyanobacteria and filamentous algae.	Biggs 2000 (Executive Summary Table 1)	Note: We have not recommend a rule standard limiting nutrient concentrations for the 'Intermontane' MU. See note below.	Biggs 2000. The use of Executive Summary Table 2 requires an estimate of 'accrual' period. There is significant uncertainty in estimating accrual period for the 'Intermontane' MU and therefore a rule standard has not been recommended.
				Option 2 – "Moderate protection": Support benthic biodiversity, trout habitat, and recreation at a' moderate' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 200 mg/m^2 chl. *a* for diatoms and cyanobacteria, and less than 120 mg/m^2 chl. *a* for filamentous algae, &; The maximum cover of the whole river bed in filamentous algae shall be less than 30% (of filaments > 2 cm long).	Biggs 2000 (Executive Summary Table 1)	Note: We have not recommend a rule standard limiting nutrient concentrations for the 'Intermontane' rivers MU. This is because there is significant scientific uncertainty in defining the nutrient concentrations required to achieve the numeric objective in intermontane rivers. We consider that inclusion of such a rule standard would create unacceptable problems. Instead it will be very important to educate plan users (in the plan) that nutrients as well as other factors (e.g. flood frequency, riparian shading, invertebrate grazing) are important in determining whether the objective can be achieved.	Biggs 2000. The use of Executive Summary Table 2 requires an estimate of 'accrual' period. There is significant uncertainty in estimating accrual period for the 'Intermontane' MU and therefore a rule standard has not been recommended.
				Notes: Refer to the same notes provided for the 'Nutrients' row in Table 1 for "Alpine Rivers".				
		Ammonia	• biodiversity (macroinvertebrates, native fish, salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. Notes: Refer to the same notes (Notes 1 and 2) provided for the Ammonia (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of ammonia is the same, regardless of the type of river, and therefore there is no reason for the ammonia objectives and rule standards to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as for the "Alpine Rivers" MU.				
		Biochemical Oxygen Demand (BOD)	• biodiversity (as above)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. Notes: Refer to the same notes (Notes 1 and 2) provided for the BOD (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Suspended Solids (SS)	• biodiversity (as above)	Refer to the same notes provided for the SS (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Turbidity	• biodiversity (as above)	Refer to the same notes provided for the Turbidity (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Toxicants	• biodiversity (as above)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. Notes: Refer to the same notes provided for the Toxicants (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of toxicants in Table 11 is the same, regardless of the type of river, and therefore there is no reason for the objectives and rule standards for toxicants to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as for the "Alpine Rivers" MU.				
		Objectionable materials	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					
		Narrative statements	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					

Table 5. LOWLAND RIVERS

Note: Where the ‘purpose for management’ and options for ‘numeric objectives’ and ‘rule standards’ are the same as for Table 1. Alpine Source Rivers, the rows have not been repeated. This table only includes rows where options are different, or the recommended option is different.

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
	(Management Outcomes as defined by ECan in the Draft NRRP)	*(related to issues with achieving the purpose for management)*	*(most sensitive value [for each water quality indicator] of the chosen purposes for management)*	*(choosing between options involves a political decision)*	*(states ‘What’ environmental outcome is required to support the ‘Purpose for Management’ at the desired level of protection)*	*Used to define Numeric Objective*	*(related to the Numeric Objective and states ‘How’ the numeric objective is to be achieved)* *Note: All numeric rule standards to apply beyond the ‘Maximum Allowable Non-Compliance’ (MANC) mixing zone. Refer to text (Section 9) for a definition of this zone.*	*Used to define Numeric Rule Standard*
Lowland Source (e.g. Cust, Cam, Avon, Heathcote, Ohapi, Waikakahi)	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation • irrigation • [1]mauri • [1]mahinga kai • stockwater	*E.coli* (Note *E.coli* is the interim preferred indicator for freshwater (MfE 2003))	• contact recreation	Proposed nationally accepted ‘maximum tolerable water contact-related illness’ risk - Risk Option 3	The maximum tolerable contact-related illness risk shall be less than 5% (1/20 exposures)	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE at April 2003).	No single sample of receiving water should contain more than 550 *E. coli* per 100 mL, as a result of any discharge.	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).
				Notes: Refer to the same notes (Notes 1, 2 and 3) provided for the *E.coli* (contact recreation) row in Table 1 for “Alpine Rivers”.				
		E.coli	• stockwater	Support stock drinking purposes at level of protection proposed in national guidelines (ANZECC &ARMCANZ 2000). Note: The level of risk of impaired livestock production is not quantified in ANZECC & ARMCANZ 2000. Therefore the level of protection afforded by the rule standard proposed in this row is not quantified here.	Water shall be suitable for drinking water for livestock. It would be desirable to quantify the maximum tolerable consumption-related illness risk for stock (i.e.less than X% , X/1000 exposures), however it seems unlikely that this will be possiblein the foreseeable future.	ANZECC &ARMCANZ 2000 (section 9.3.3.2)	The running median of receiving water sample results for *E.coli* shall not be greater than 100 *E. coli*/100ml, with four out of five samples not greater than 400 *E. coli*/100ml, as a result of any discharge. It would normally be expected that the running median would be calculated on the basis of at least weekly samples.	ANZECC &ARMCANZ 2000 (section 9.3.3.2) has been used but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as in section 9.3.3.2 of the guidelines (see explanatory Note 1 below).
				Note 1: The ANZECC &ARMCANZ 2000 guidelines (section 9.3.3.2) have been used, but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as presented in section 9.3.3.2 of the guidelines. This has been done for consistency with the use of *E. coli* as the preferred indicator for freshwater contact recreation (MfE 2003) as used elsewhere in these tables. The numbers have not been reduced to reflect the fact that *E.coli* concentrations are generally lower than faecal coliform concentrations because it is often found that *E.coli* concentrations are not much lower, and therefore to drop the standard (e.g., from 100 to 84 *E. coli*/100ml) would imply a precision in the indicator/risk relationship that does not exist (McBride pers. comm.). The rounding of numbers is also consistent with MfE (2003) guidelines.				
		Faecal coliforms	• contact recreation	Objectives & standards have not been recommended because faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ.				
		Faecal coliforms	• stockwater	Objectives & standards have not been recommended to be consistent with the fact that faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ and, for consistency, *E.coli* has been used as the indicator for rule standards to protect water used for stockwater (see row above).				
		Dissolved oxygen (DO)	• biodiversity	The recommended objectives and rule standards are the same as those presented for the ‘Alpine Source’ rivers in Table 1. However see note below.				
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as ‘interim’ and that Canterbury–specific numbers be considered for further development, based on examination of the existing DO data distribution for the Canterbury “Lowland” MU.				
		Temperature	• biodiversity	The recommended objectives and rule standards are the same as those presented for the ‘Alpine Source’ rivers in Table 1. However see note below.				
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as ‘interim’ and that Canterbury–specific numbers be considered for further development, based on examination of existing temperature data distribution for the Canterbury “Lowland” MU.				
		pH	• biodiversity	The recommended objectives and rule standards are the same as those presented for the ‘Alpine Source’ rivers in Table 1. However see note below.				
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as ‘interim’ and that Canterbury–specific numbers be considered for further development, based on examination of the existing pH data distribution for the Canterbury “Lowland” MU.				
		Clarity		Support swimming recreation	The recommended objectives and rule standards are the same as those presented for the ‘Alpine Source’ rivers in Table 1.			

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*<u>Numeric Rule Standard</u>*	*Reference*
			• contact recreation • amenity	Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where clarity is an important characteristic.	The existing dry weather water clarity shall be maintained to within 20%. It is also desirable to derive an 'absolute' numeric objective 'X' for clarity in <u>Lowland MU</u>.	MfE 1994a	The ambient receiving water visual clarity, as measured by black disc, shall not be changed by more than 20%, as a result of any discharge; and, The receiving water visual clarity, as measured by black disc, shall not be less than 'X' cm, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Clarity (amenity) row in Table 1 for "Alpine Rivers".				
		Colour	• contact recreation • amenity	Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where colour (hue) is an important characteristic.	The existing dry weather water colour shall be maintained to within 5 Munsell Units. It is also desirable to derive a numeric objective range 'X-Y' for colour in Lowland <u>MU</u>).	MfE 1994a	The ambient receiving water colour, shall not be changed by more than 5 Munsell Units as a result of any discharge; and, The receiving water colour, shall not be less than 'X' Munsell Units or greater than 'Y' Munsell Units, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Colour (amenity) row in Table 1 for "Alpine Rivers".				
		Nutrients	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation	Option 1 – 'High protection': Support benthic biodiversity, trout habitat, and recreation at a' high' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 50 mg/m^2 chl. *a* for diatoms, cyanobacteria and filamentous algae.	Biggs 2000 (Executive Summary Table 1)	Note: We have not recommend a rule standard limiting nutrient concentrations for the 'Lowland' rivers MU. See note below.	Biggs 2000 (See explanation in cell below) .
				Option 2 – "Moderate protection": Support benthic biodiversity, trout habitat, and recreation at a' moderate' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 200 mg/m^2 chl. *a* for diatoms and cyanobacteria, and less than 120 mg/m^2 chl. *a* for filamentous algae, &; The maximum cover of the whole river bed in filamentous algae shall be less than 30% (of filaments > 2 cm long).	Biggs 2000 (Executive Summary Table 1)	Note: We have not recommend a rule standard limiting nutrient concentrations for the 'Lowland' rivers MU. This is because there is significant scientific uncertainty in defining the nutrient concentrations required to achieve the numeric objective in lowland rivers. We consider that inclusion of such a rule standard would create unacceptable problems. Instead it will be very important to educate plan users (in the plan) that nutrients as well as other factors (e.g. flood frequency, riparian shading, invertebrate grazing) are important in determining if an objective can be achieved.	Biggs 2000. The use of Executive Summary Table 2 requires an estimate of 'accrual' period. There is significant uncertainty in estimating accrual period for the 'Lowland' MU and therefore a rule standard has not been recommended.
				Also refer to the same notes provided for the 'Nutrients' row in Table 1 for "Alpine Rivers".				
		Ammonia	• biodiversity (macroinvertebrates, native fish, salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Ammonia (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of ammonia is the same, regardless of the type of river, and therefore there is no reason for the ammonia objectives and rule standards to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as for the "Alpine Rivers" MU.				
		Biochemical Oxygen Demand (BOD)	• biodiversity (as above) • contact recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. Notes: Refer to the same notes (Notes 1 and 2) provided for the BOD (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Suspended Solids (SS)	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the SS (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Turbidity	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the Turbidity (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Toxicants	• biodiversity (as above)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes provided for the Toxicants (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of toxicants in Table 11 is the same, regardless of the type of river, and therefore there is no reason for the objectives and rule standards for toxicants to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as for the "Alpine Rivers" MU.				
		Objectionable material	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					
		Narrative statements	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					

Table 6. VOLCANIC RIVERS

Note: Where the 'purpose for management' and options for 'numeric objectives' and 'rule standards' are the same as for Table 1. Alpine Source Rivers, the rows have not been repeated. This table only includes rows where options are different, or the recommended option is different.

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
	(Management Outcomes as defined by ECan in the Draft NRRP)	*(related to issues with achieving the purpose for management)*	*(most sensitive value [for each water quality indicator] of the chosen purposes for management)*	*(choosing between options involves a political decision)*	*(states 'What' environmental outcome is required to support the 'Purpose for Management' at the desired level of protection)*	*Used to define Numeric Objective*	*(related to the Numeric Objective and states 'How' the numeric objective is to be achieved)* *Note: All numeric rule standards to apply beyond the 'Maximum Allowable Non-Compliance' (MANC) mixing zone. Refer to text (Section 9) for a definition of this zone.*	*Used to define Numeric Rule Standard*
Volcanic Source (e.g. Kaituna, French Farm Stream)	• biodiversity (native fish, birds and salmonids) • irrigation • [1]mauri • [1]mahinga kai • stockwater In parts of the MU • [2]human drinking water (low-moderate health risk)	*E.coli*	• stockwater	Support stock drinking purposes at level of protection proposed in national guidelines (ANZECC &ARMCANZ 2000). Note: The level of risk of impaired livestock production is not quantified in ANZECC & ARMCANZ 2000. Therefore the level of protection afforded by the rule standard proposed in this row is not quantified here.	Water shall be suitable for drinking water for livestock It would be desirable to quantify the maximum tolerable consumption-related illness risk for stock (i.e.less than X% , X/1000 exposures), however it seems unlikely that this will be possiblein the foreseeable future.	ANZECC &ARMCANZ 2000 (section 9.3.3.2)	The running median of receiving water sample results for *E.coli* shall not be greater than 100 *E. coli*/100ml, with four out of five samples not greater than 400 *E. coli*/100ml, as a result of any discharge. It would normally be expected that the running median would be calculated on the basis of at least weekly samples.	ANZECC &ARMCANZ 2000 (section 9.3.3.2) has been used but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as in section 9.3.3.2 of the guidelines (see explanatory Note 1 below).
				Note 1: The ANZECC &ARMCANZ 2000 guidelines (section 9.3.3.2) have been used, but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as presented in section 9.3.3.2 of the guidelines. This has been done for consistency with the use of *E. coli* as the preferred indicator for freshwater contact recreation (MfE 2003) as used elsewhere in these tables. The numbers have not been reduced to reflect the fact that *E.coli* concentrations are generally lower than faecal coliform concentrations because it is often found that *E.coli* concentrations are not much lower, and therefore to drop the standard (e.g., from 100 to 84 *E. coli*/100ml) would imply a precision in the indicator/risk relationship that does not exist (McBride pers. comm.). The rounding of numbers is also consistent with MfE (2003) guidelines.				
		Faecal coliforms	• stockwater	Objectives & standards have not been recommended to be consistent with the fact that faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ and, for consistency, *E.coli* has been used as the indicator for rule standards to protect water used for stockwater (see row above).				
		Dissolved oxygen (DO)	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing DO data distribution for the Canterbury "Volcanic" MU.				
		Temperature	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of existing temperature data distribution for the Canterbury "Volcanic" MU.				
		pH	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing pH data distribution for the Canterbury "Volcanic" MU.				
		Clarity	At this stage contact recreation and amenity values do not appear in the 'purposes for management' for this MU. Therefore no objectives and standards are presented for clarity. If this is reviewed in future, the options for Ecan will be the same as those those presented for Clarity (contact recreation and amenity) in the 'Alpine Source' rivers in Table 1.					
		Colour	At this stage contact recreation and amenity values do not appear in the 'purposes for management' for this MU. Therefore no objectives and standards are presented for clarity. If this is reviewed in future, the options for Ecan will be the same as those those presented for Colour (contact recreation and amenity) in the 'Alpine Source' rivers in Table 1.					

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
		Nutrients	• amenity • biodiversity (native fish, birds and salmonids)	Option 1 – "High protection": Support benthic biodiversity, trout habitat, and recreation at a' high' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 50 mg/m^2 chl. *a* for diatoms, cyanobacteria and filamentous algae.	Biggs 2000 (Executive Summary Table 1)	Note: We have not recommend a rule standard limiting nutrient concentrations for the 'Volcanic' MU. See note below.	Biggs 2000. The use of Executive Summary Table 2 requires an estimate of 'accrual' period. There is significant uncertainty in estimating accrual period for the 'Volcanic' MU and therefore a rule standard has not been recommended.
				Option 2 – "Moderate protection": Support benthic biodiversity, trout habitat, and recreation at a' moderate' level of protection derived from national guidelines (Biggs 2000)	The maximum biomass of growths on the river bed shall be less than 200 mg/m^2 chl. *a* for diatoms and cyanobacteria, and less than 120 mg/m^2 chl. *a* for filamentous algae, &; The maximum cover of the whole river bed in filamentous algae shall be less than 30% (of filaments > 2 cm long).	Biggs 2000 (Executive Summary Table 1)	Note: We have not recommend a rule standard limiting nutrient concentrations for the 'Volcanic' rivers MU. This is because there is significant scientific uncertainty in defining the nutrient concentrations required to achieve the numeric objective in volcanic rivers. We consider that inclusion of such a rule standard would create unacceptable problems. Instead it will be very important to educate plan users (in the plan) that nutrients as well as other factors (e.g. flood frequency, riparian shading, invertebrate grazing) are important in determining whether the objective can be achieved.	Biggs 2000. The use of Executive Summary Table 2 requires an estimate of 'accrual' period. There is significant uncertainty in estimating accrual period for the 'Volcanic' MU and therefore a rule standard has not been recommended.
				Notes: Also refer to the same notes provided for the 'Nutrients' row in Table 1 for "Alpine Rivers".				
		Ammonia	• biodiversity (macroinvertebrates, native fish, salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. Notes: Refer to the same notes (Notes 1 and 2) provided for the Ammonia (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of ammonia is the same, regardless of the type of river, and therefore there is no reason for the ammonia objectives and rule standards to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as for the "Alpine Rivers" MU.				
		Biochemical Oxygen Demand (BOD)	• biodiversity (as above)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. Notes: Refer to the same notes (Notes 1 and 2) provided for the BOD (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Suspended Solids (SS)	• biodiversity (as above)	Refer to the same notes provided for the SS (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Turbidity	• biodiversity (as above)	Refer to the same notes provided for the Turbidity (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Toxicants	• biodiversity (as above)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. Notes: Refer to the same notes provided for the Toxicants (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of toxicants in Table 11 is the same, regardless of the type of river, and therefore there is no reason for the objectives and rule standards for toxicants to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as for the "Alpine Rivers" MU.				
		Objectionable materials	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					
		Narrative statements	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					

Table 7. HIGH COUNTRY (LARGE) LAKES

Note: Where the 'purpose for management' and options for 'numeric objectives' and 'rule standards' are the same as for Table 1. Alpine Source Rivers, the rows have not been repeated. This table only includes rows where options are different, or the recommended option is different.

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
	(Management Outcomes as defined by ECan in the Draft NRRP)	*(related to issues with achieving the purpose for management)*	*(most sensitive value [for each water quality indicator] of the chosen purposes for management)*	*(choosing between options involves a political decision)*	*(states 'What' environmental outcome is required to support the 'Purpose for Management' at the desired level of protection)*	*Used to define Numeric Objective*	*(related to the Numeric Objective and states 'How' the numeric objective is to be achieved)* *Note: All numeric rule standards to apply beyond the 'Maximum Allowable Non-Compliance' (MANC) mixing zone. Refer to text (Section 9) for a definition of this zone.*	*Used to define Numeric Rule Standard*
High Country (Large) Lakes (e.g. unregulated Sumner, Taylor) (e.g. regulated Coleridge, Tekapo, Pukaki, Ohau)	• [3]natural state • natural character and scenic value • amenity • [1]mauri • [1]mahinga kai • contact recreation • biodiversity (native fish, birds and salmonids) • irrigation • stockwater	*E.coli* (Note *E.coli* is the interim preferred indicator for freshwater (MfE 2003))	• contact recreation	Proposed 'maximum tolerable water contact-related illness' risk - Risk Option 1	The maximum tolerable contact-related illness risk shall be less than 0.1% (1/1000 exposures)	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003)	No single sample of receiving water should contain more than 130 *E. coli* per 100 mL, as a result of any discharge.	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003)
				Notes: Refer to the same notes (Notes 1, 2 and 3) provided for the *E.coli* (contact recreation) row in Table 1 for "Alpine Rivers".				
		E.coli	• stockwater	Support stock drinking purposes at level of protection proposed in national guidelines (ANZECC &ARMCANZ 2000). Note: The level of risk of impaired livestock production is not quantified in ANZECC & ARMCANZ 2000. Therefore the level of protection afforded by the rule standard proposed in this row is not quantified here.	Water shall be suitable for drinking water for livestock It would be desirable to quantify the maximum tolerable consumption-related illness risk for stock (i.e.less than X% , X/1000 exposures), however it seems unlikely that this will be possiblein the foreseeable future.	ANZECC &ARMCANZ 2000 (section 9.3.3.2)	The running median of receiving water sample results for *E.coli* shall not be greater than 100 *E. coli*/100ml, with four out of five samples not greater than 400 *E. coli*/100ml, as a result of any discharge. It would normally be expected that the running median would be calculated on the basis of at least weekly samples.	ANZECC &ARMCANZ 2000 (section 9.3.3.2) has been used but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as in section 9.3.3.2 of the guidelines (see explanatory Note 2 below).
				Note: If the 'maximum tolerable water contact-related illness' risk - Risk Option 1 is selected by ECan, then the associated rule standard (see row *E.coli* [contact recreation] above) is likely to also protect stockwater use. Therefore the rule standard in this cell would be unnecessary. On the other hand if ECan were to select the contact-related illness risk option 2 or 3 (see *E.coli* (contact recreation) row in Table 1 for "Alpine Rivers"), then it would be appropriate to also include the rule standard for stockwater to protect stockwater use. Note 2: The ANZECC &ARMCANZ 2000 guidelines (section 9.3.3.2) have been used, but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as presented in section 9.3.3.2 of the guidelines. This has been done for consistency with the use of *E. coli* as the preferred indicator for freshwater contact recreation (MfE 2003) as used elsewhere in these tables. The numbers have not been reduced to reflect the fact that *E.coli* concentrations are generally lower than faecal coliform concentrations because it is often found that *E.coli* concentrations are not much lower, and therefore to drop the standard (e.g., from 100 to 84 *E. coli*/100ml) would imply a precision in the indicator/risk relationship that does not exist (McBride pers. comm.). The rounding of numbers is also consistent with MfE (2003) guidelines.				
		Faecal coliforms	• contact recreation	Objectives & standards have not been recommended because faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ.				
		Faecal coliforms	• stockwater	Objectives & standards have not been recommended to be consistent with the fact that faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ and, for consistency, *E.coli* has been used as the indicator for rule standards to protect water used for stockwater (see row above).				
		Dissolved oxygen (DO)	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing DO data distribution for the Canterbury "High Country Lake" MU.				
		Temperature	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of existing temperature data for the Canterbury "High Country Lake" MU.				
		pH	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing pH data distribution for the Canterbury "High Country Lake" MU.				
		Clarity	• contact recreation • amenity • natural character and scenic value	Support swimming recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.			
				Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where clarity is an important characteristic.	The existing dry weather water clarity shall be maintained to within 20%. It is also desirable to derive an 'absolute' numeric objective 'X' for clarity in the "High Country Lake" MU.	MfE 1994a	The ambient receiving water visual clarity, as measured by black disc, shall not be changed by more than 20%, as a result of any discharge; and, The receiving water visual clarity, as measured by black disc, shall not be less than 'X' cm, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Clarity (amenity) row in Table 1 for "Alpine Rivers".				
		Colour	• contact recreation • amenity • natural character and scenic value	Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where colour (hue) is an important characteristic.	The existing dry weather water colour shall be maintained to within 5 Munsell Units. It is also desirable to derive a numeric objective range 'X-Y' for colour in the "High Country Lake" MU).	MfE 1994a	The ambient receiving water colour, shall not be changed by more than 5 Munsell Units as a result of any discharge; and, The receiving water colour, shall not be less than 'X' Munsell Units or greater than 'Y' Munsell Units, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Colour (amenity) row in Table 1 for "Alpine Rivers".				
		Nutrients	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation	Support biodiversity (native fish, birds and salmonids) and amenity values at a level of protection recommended in national guidelines (ANZECC 2000) for slightly disturbed ecosystems.	The maximum biomass of phytoplankton shall be less than 5 mg/m^3 chl. *a*	ANZECC 2000 (From SE Australian Guidelines Table 3.3.2)	Note: We have not recommend a rule standard limiting nutrient concentrations for the High Country Lakes MU. We recommend that this issue be re-visited when the existing lake classification is reviewed (see Conclusions, Section 12).	
				Notes: Also refer to the same notes provided for the 'Nutrients' row in Table 1 for "Alpine Rivers".				
		Ammonia	• biodiversity (macroinvertebrates, native fish, salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Ammonia (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of ammonia is the same, regardless of the type of river or lake, and therefore there is no reason for the ammonia objectives and rule standards to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as 'Alpine Rivers' MU.				
		Biochemical Oxygen Demand (BOD)	• biodiversity (as above) • contact recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the BOD (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Suspended Solids (SS)	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the SS (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Turbidity	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the Turbidity (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Toxicants	• biodiversity (as above)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes provided for the Toxicants (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of toxicants in Table 11 is the same, regardless of the type of river or lake, and therefore there is no reason for the objectives and rule standards for toxicants to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as 'Alpine Rivers' MU.				
		Objectionable material	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					
		Narrative statements	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					

Table 8. HIGH COUNTRY (SMALL) LAKES

Note: Where the 'purpose for management' and options for 'numeric objectives' and 'rule standards' are the same as for Table 1. Alpine Source Rivers, the rows have not been repeated. This table only includes rows where options are different, or the recommended option is different.

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
	(Management Outcomes as defined by ECan in the Draft NRRP)	*(related to issues with achieving the purpose for management)*	*(most sensitive value [for each water quality indicator] of the chosen purposes for management)*	*(choosing between options involves a political decision)*	*(states 'What' environmental outcome is required to support the 'Purpose for Management' at the desired level of protection)*	*Used to define Numeric Objective*	*(related to the Numeric Objective and states 'How' the numeric objective is to be achieved)* *Note: All numeric rule standards to apply beyond the 'Maximum Allowable Non-Compliance' (MANC) mixing zone. Refer to text (Section 9) for a definition of this zone.*	*Used to define Numeric Rule Standard*
High Country (Small) Lakes (e.g. Camp, Heron, Selfe, Grassmere, Alexandrina)	• natural character and scenic value • amenity • [1]mauri • [1]mahinga kai • contact recreation • biodiversity (native fish, birds and salmonids) • irrigation • stockwater	*E.coli* (Note *E.coli* is the interim preferred indicator for freshwater (MfE 2003))	• contact recreation	Proposed 'maximum tolerable water contact-related illness' risk - Risk Option 1	The maximum tolerable contact-related illness risk shall be less than 0.1% (1/1000 exposures)	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003)	No single sample of receiving water should contain more than 130 *E. coli* per 100 mL, as a result of any discharge.	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003)
				Notes: Refer to the same notes (Notes 1, 2 and 3) provided for the *E.coli* (contact recreation) row in Table 1 for "Alpine Rivers".				
		E.coli	• stockwater	Support stock drinking purposes at level of protection proposed in national guidelines (ANZECC &ARMCANZ 2000). Note: The level of risk of impaired livestock production is not quantified in ANZECC & ARMCANZ 2000. Therefore the level of protection afforded by the rule standard proposed in this row is not quantified here.	Water shall be suitable for drinking water for livestock It would be desirable to quantify the maximum tolerable consumption-related illness risk for stock (i.e.less than X% , X/1000 exposures), however it seems unlikely that this will be possiblein the foreseeable future.	ANZECC &ARMCANZ 2000 (section 9.3.3.2)	The running median of receiving water sample results for *E.coli* shall not be greater than 100 *E. coli*/100ml, with four out of five samples not greater than 400 *E. coli*/100ml, as a result of any discharge. It would normally be expected that the running median would be calculated on the basis of at least weekly samples.	ANZECC &ARMCANZ 2000 (section 9.3.3.2) has been used but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as in section 9.3.3.2 of the guidelines (see explanatory Note 2 below).
				Note: If the 'maximum tolerable water contact-related illness' risk - Risk Option 1 is selected by ECan, then the associated rule standard (see row *E.coli* [contact recreation] above) is likely to also protect stockwater use. Therefore the rule standard in this cell would be unnecessary. On the other hand if ECan were to select the contact-related illness risk option 2 or 3 (see *E.coli* (contact recreation) row in Table 1 for "Alpine Rivers"), then it would be appropriate to also include the rule standard for stockwater to protect stockwater use. Note 2: The ANZECC &ARMCANZ 2000 guidelines (section 9.3.3.2) have been used, but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as presented in section 9.3.3.2 of the guidelines. This has been done for consistency with the use of *E. coli* as the preferred indicator for freshwater contact recreation (MfE 2003) as used elsewhere in these tables. The numbers have not been reduced to reflect the fact that *E.coli* concentrations are generally lower than faecal coliform concentrations because it is often found that *E.coli* concentrations are not much lower, and therefore to drop the standard (e.g., from 100 to 84 *E. coli*/100ml) would imply a precision in the indicator/risk relationship that does not exist (McBride pers. comm.). The rounding of numbers is also consistent with MfE (2003) guidelines.				
		Faecal coliforms	• contact recreation	Objectives & standards have not been recommended because faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ.				
		Faecal coliforms	• stockwater	Objectives & standards have not been recommended to be consistent with the fact that faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ and, for consistency, *E.coli* has been used as the indicator for rule standards to protect water used for stockwater (see row above).				
		Dissolved oxygen	• biodiversity (native fish	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
		(DO)	and salmonids)	Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing DO data distribution for the "High Country (Samll) Lake" MU.				
		Temperature	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of existing temperature data for the "High Country (Small) Lake" MU.				
		pH	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing pH data distribution for the "High Country (Small) Lake" MU.				
		Clarity	• contact recreation • amenity • natural character and scenic value	Support swimming recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.			
				Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where clarity is an important characteristic.	The existing dry weather water clarity shall be maintained to within 20%. It is also desirable to derive an 'absolute' numeric objective 'X' for clarity in the <u>High Country Small Lake MU</u>.	MfE 1994a	The ambient receiving water visual clarity, as measured by black disc, shall not be changed by more than 20%, as a result of any discharge; and, The receiving water visual clarity, as measured by black disc, shall not be less than 'X' cm, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Clarity (amenity) row in Table 1 for "Alpine Rivers".				
		Colour	• contact recreation • amenity • natural character and scenic value	Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where colour (hue) is an important characteristic.	The existing dry weather water colour shall be maintained to within 5 Munsell Units. It is also desirable to derive a numeric objective range 'X-Y' for colour in the <u>High Country Small Lake MU</u>	MfE 1994a	The ambient receiving water colour, shall not be changed by more than 5 Munsell Units as a result of any discharge; and, The receiving water colour, shall not be less than 'X' Munsell Units or greater than 'Y' Munsell Units, as a result of any discharge	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Colour (amenity) row in Table 1 for "Alpine Rivers".				
		Nutrients	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation	Support biodiversity (native fish, birds and salmonids) and amenity values at a level of protection recommended in national guidelines (ANZECC 2000) for slightly disturbed ecosystems.	The maximum biomass of phytoplankton shall be less than 5 mg/m^3 chl. *a*	ANZECC 2000 (From SE Australian Guidelines Table 3.3.2)	Note: We have not recommend a rule standard limiting nutrient concentrations for the High Country Small Lakes MU. We recommend that this issue be re-visited when the existing lake classification is reviewed (see Conclusions, Section 12).	
				Notes: Also refer to the same notes provided for the 'Nutrients' row in Table 1 for "Alpine Rivers".				
		Ammonia	• biodiversity (macroinvertebrates, native fish, salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Ammonia (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of ammonia is the same, regardless of the type of river or lake, and therefore there is no reason for the ammonia objectives and rule standards to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as Alpine Rivers MU.				
		Biochemical Oxygen Demand (BOD)	• biodiversity (as above) • contact recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the BOD (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Suspended Solids (SS)	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the SS (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Turbidity	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the Turbidity (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Toxicants	• biodiversity (as above)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes provided for the Toxicants (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of toxicants in Table 11 is the same, regardless of the type of river or lake, and therefore there is no reason for the objectives and rule standards for toxicants to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as Alpine Rivers MU.				
		Objectionable material	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					
		Narrative statements	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					

Table 9. LOWLAND (LARGE AND SMALL) LAKES

Note: Where the 'purpose for management' and options for 'numeric objectives' and 'rule standards' are the same as for Table 1. Alpine Source Rivers, the rows have not been repeated. This table only includes rows where options are different, or the recommended option is different.

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
	(Management Outcomes as defined by ECan in the Draft NRRP)	*(related to issues with achieving the purpose for management)*	*(most sensitive value [for each water quality indicator] of the chosen purposes for management)*	*(choosing between options involves a political decision)*	*(states 'What' environmental outcome is required to support the 'Purpose for Management' at the desired level of protection)*	*Used to define Numeric Objective*	*(related to the Numeric Objective and states 'How' the numeric objective is to be achieved)* *Note: All numeric rule standards to apply beyond the 'Maximum Allowable Non-Compliance' (MANC) mixing zone. Refer to text (Section 9) for a definition of this zone.*	*Used to define Numeric Rule Standard*
Lowland (Large and Small) Lakes	• amenity • [1]mauri • [1]mahinga kai • contact recreation • biodiversity (native fish, birds and salmonids) • stockwater	*E.coli* (Note *E.coli* is the interim preferred indicator for freshwater (MfE 2003))	• contact recreation	Proposed nationally accepted 'maximum tolerable water contact-related illness' risk - Risk Option 2	The maximum tolerable contact-related illness risk shall be less than 1% (1/100 exposures)	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).	No single sample of receiving water should contain more than 260 *E. coli* per 100 mL, as a result of any discharge.	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).
				Notes: Refer to the same notes (Notes 1, 2 and 3) provided for the *E.coli* (contact recreation) row in Table 1 for "Alpine Rivers".				
		E.coli	• stockwater	Support stock drinking purposes at level of protection proposed in national guidelines (ANZECC &ARMCANZ 2000). Note: The level of risk of impaired livestock production is not quantified in ANZECC & ARMCANZ 2000. Therefore the level of protection afforded by the rule standard proposed in this row is not quantified here.	Water shall be suitable for drinking water for livestock It would be desirable to quantify the maximum tolerable consumption-related illness risk for stock (i.e.less than X% , X/1000 exposures), however it seems unlikely that this will be possiblein the foreseeable future.	ANZECC &ARMCANZ 2000 (section 9.3.3.2)	The running median of receiving water sample results for *E.coli* shall not be greater than 100 *E. coli*/100ml, with four out of five samples not greater than 400 *E. coli*/100ml, as a result of any discharge. It would normally be expected that the running median would be calculated on the basis of at least weekly samples.	ANZECC &ARMCANZ 2000 (section 9.3.3.2) has been used but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as in section 9.3.3.2 of the guidelines (see explanatory Note 2 below).
				Note 1: The ANZECC &ARMCANZ 2000 guidelines (section 9.3.3.2) have been used, but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as presented in section 9.3.3.2 of the guidelines. This has been done for consistency with the use of *E. coli* as the preferred indicator for freshwater contact recreation (MfE 2003) as used elsewhere in these tables. The numbers have not been reduced to reflect the fact that *E.coli* concentrations are generally lower than faecal coliform concentrations because it is often found that *E.coli* concentrations are not much lower, and therefore to drop the standard (e.g., from 100 to 84 *E. coli*/100ml) would imply a precision in the indicator/risk relationship that does not exist (McBride pers. comm.). The rounding of numbers is also consistent with MfE (2003) guidelines.				
		Faecal coliforms	• contact recreation	Objectives & standards have not been recommended because faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ.				
		Faecal coliforms	• stockwater	Objectives & standards have not been recommended to be consistent with the fact that faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ and, for consistency, *E.coli* has been used as the indicator for rule standards to protect water used for stockwater (see row above).				
		Dissolved oxygen (DO)	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing DO data distribution for the "Lowland Lake" MU.				
		Temperature	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of existing temperature data for the "Lowland Lake" MU.				
		pH		The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
			• biodiversity (native fish and salmonids)	Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing pH data distribution for the "Lowland Lake" MU.				
		Clarity	• contact recreation • amenity • natural character and scenic value	Support swimming recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.			
				Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where clarity is an important characteristic.	The existing dry weather water clarity shall be maintained to within 20%. It is also desirable to derive an 'absolute' numeric objective 'X' for clarity in the Lowland Lake MU.	MfE 1994a	The ambient receiving water visual clarity, as measured by black disc, shall not be changed by more than 20%, as a result of any discharge; and, The receiving water visual clarity, as measured by black disc, shall not be less than 'X' cm, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Clarity (amenity) row in Table 1 for "Alpine Rivers".				
		Colour	• contact recreation • amenity • natural character and scenic value	Support aesthetic amenity value for 'class A' waters as described in national guidelines (MfE 1994a) for waters where colour (hue) is an important characteristic.	The existing dry weather water colour shall be maintained to within 5 Munsell Units. It is also desirable to derive a numeric objective range 'X-Y' for colour in the Lowland Lake MU).	MfE 1994a	The ambient receiving water colour, shall not be changed by more than 5 Munsell Units as a result of any discharge; and, The receiving water colour, shall not be less than 'X' Munsell Units or greater than 'Y' Munsell Units, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Colour (amenity) row in Table 1 for "Alpine Rivers".				
		Nutrients	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation	Support biodiversity (native fish, birds and salmonids) and amenity values at a level of protection recommended in national guidelines (ANZECC 2000) for slightly disturbed ecosystems.	The maximum biomass of phytoplankton shall be less than 5 mg/m^3 chl. *a*	ANZECC 2000 (From SE Australian Guidelines Table 3.3.2)	Note: We have not recommend a rule standard limiting nutrient concentrations for the Lowland Lakes MU. We recommend that this issue be re-visited when the existing lake classification is reviewed (see Conclusions, Section 12).	
				Notes: Also refer to the same notes provided for the 'Nutrients' row in Table 1 for "Alpine Rivers".				
		Ammonia	• biodiversity (macroinvertebrates, native fish, salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Ammonia (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of ammonia is the same, regardless of the type of river or lake, and therefore there is no reason for the ammonia objectives and rule standards to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as 'Alpine Rivers' MU.				
		Biochemical Oxygen Demand (BOD)	• biodiversity (as above) • contact recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the BOD (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Suspended Solids (SS)	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the SS (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Turbidity	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the Turbidity (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Toxicants	• biodiversity (as above)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes provided for the Toxicants (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of toxicants in Table 11 is the same, regardless of the type of river or lake, and therefore there is no reason for the objectives and rule standards for toxicants to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as 'Alpine Rivers' MU.				
		Objectionable material	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					
		Narrative statements	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					

Table 10. COASTAL LAKES

Note: Where the 'purpose for management' and options for 'numeric objectives' and 'rule standards' are the same as for Table 1. Alpine Source Rivers, the rows have not been repeated. This table only includes rows where options are different, or the recommended option is different.

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
	(Management Outcomes as defined by ECan in the Draft NRRP)	*(related to issues with achieving the purpose for management)*	*(most sensitive value [for each water quality indicator] of the chosen purposes for management)*	*(choosing between options involves a political decision)*	*(states 'What' environmental outcome is required to support the 'Purpose for Management' at the desired level of protection)*	*Used to define Numeric Objective*	*(related to the Numeric Objective and states 'How' the numeric objective is to be achieved)* *Note: All numeric rule standards to apply beyond the 'Maximum Allowable Non-Compliance' (MANC) mixing zone. Refer to text (Section 9) for a definition of this zone.*	*Used to define Numeric Rule Standard*
Coastal Lakes (e.g. Ellesmere/Te Waihora, Wainono, Washdyke Lagoons, Forsythe)	• amenity • [1]mauri • [1]mahinga kai • contact recreation • biodiversity (native fish, birds and salmonids) • stockwater	*E.coli* (Note *E.coli* is the interim preferred indicator for freshwater (MfE 2003))	• contact recreation	Proposed nationally accepted 'maximum tolerable water contact-related illness' risk - Risk Option 2	The maximum tolerable contact-related illness risk shall be less than 1% (1/100 exposures)	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).	No single sample of receiving water should contain more than 260 *E. coli* per 100 mL, as a result of any discharge.	Draft Freshwater Microbiological Water Quality Guidelines – Explanatory Notes (MfE as at April 2003).
				Note: Although contact recreation is included as a purpose for management, it may be difficult to achieve the objective and rule standard to support the contact-related illness' risk -Risk Option 2, because of the large number of birds inhabiting coastal lakes and the related elevated concentrations of *E.coli*. In this case ECan could consider selecting contact-related illness' risk -Risk Option 3 (see the *E.coli* (contact recreation) row in Table 1 for "Alpine Rivers". Also refer to the same notes (Notes 1, 2 and 3) provided for the *E.coli* (contact recreation) row in Table 1 for "Alpine Rivers".				
		E.coli	• stockwater	Support stock drinking purposes at level of protection proposed in national guidelines (ANZECC &ARMCANZ 2000). Note: The level of risk of impaired livestock production is not quantified in ANZECC & ARMCANZ 2000. Therefore the level of protection afforded by the rule standard proposed in this row is not quantified here.	Water shall be suitable for drinking water for livestock It would be desirable to quantify the maximum tolerable consumption-related illness risk for stock (i.e.less than X% , X/1000 exposures), however it seems unlikely that this will be possiblein the foreseeable future.	ANZECC &ARMCANZ 2000 (section 9.3.3.2)	The running median of receiving water sample results for *E.coli* shall not be greater than 100 *E. coli*/100ml, with four out of five samples not greater than 400 *E. coli*/100ml, as a result of any discharge. It would normally be expected that the running median would be calculated on the basis of at least weekly samples.	ANZECC &ARMCANZ 2000 (section 9.3.3.2) has been used but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as in section 9.3.3.2 of the guidelines (see explanatory Note 2 below).
				Note 2: The ANZECC &ARMCANZ 2000 guidelines (section 9.3.3.2) have been used, but the numbers have been applied directly to *E. coli* instead of using thermotolerant coliforms as presented in section 9.3.3.2 of the guidelines. This has been done for consistency with the use of *E. coli* as the preferred indicator for freshwater contact recreation (MfE 2003) as used elsewhere in these tables. The numbers have not been reduced to reflect the fact that *E.coli* concentrations are generally lower than faecal coliform concentrations because it is often found that *E.coli* concentrations are not much lower, and therefore to drop the standard (e.g., from 100 to 84 *E. coli*/100ml) would imply a precision in the indicator/risk relationship that does not exist (McBride pers. comm.). The rounding of numbers is also consistent with MfE (2003) guidelines.				
		Faecal coliforms	• contact recreation	Objectives & standards have not been recommended because faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ.				
		Faecal coliforms	• stockwater	Objectives & standards have not been recommended to be consistent with the fact that faecal coliforms are no longer the preferred freshwater indicator of contact-related illness risk in NZ and, for consistency, *E.coli* has been used as the indicator for rule standards to protect water used for stockwater (see row above).				
		Dissolved oxygen (DO)	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below. Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing DO data distribution for the "Coastal Lake" MU.				
		Temperature		The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				

Management Unit (MU)	***Purpose for Management***	***Water Quality Variable***	***Critical Value***	***Level of Protection***	***Numeric Objective***	*Reference*	*Numeric Rule Standard*	*Reference*
			• biodiversity (native fish and salmonids)	Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of existing temperature data for the "Coastal Lake" MU.				
		pH	• biodiversity (native fish and salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1. However see note below.				
				Note: Because the objectives and rules presented here are based on general guidelines, it is desirable that these are treated as 'interim' and that Canterbury–specific numbers be considered for further development, based on examination of the existing pH data distribution for the "Coastal Lake" MU.				
		Clarity	• contact recreation • amenity • natural character and scenic value	Support swimming recreation	Note: Although contact recreation is included as a purpose for management it is unlikely that the objective and rule standard (<160 cm black disc clarity) to support this purpose will be achievable in the Coastal Lake MU.			
				Support aesthetic amenity value for 'class B' waters as described in national guidelines (MfE 1994a) for waters where clarity is an important characteristic.	The existing dry weather water clarity shall be maintained to within 40%. It is also desirable to derive an 'absolute' numeric objective 'X' for clarity in the <u>Coastal Lake MU</u>.	MfE 1994a	The ambient receiving water visual clarity, as measured by black disc, shall not be changed by more than 40%, as a result of any discharge; and, The receiving water visual clarity, as measured by black disc, shall not be less than 'X' cm, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Clarity (amenity) row in Table 1 for "Alpine Rivers".				
		Colour	• contact recreation • amenity • natural character and scenic value	Support aesthetic amenity value for 'class B' waters as described in national guidelines (MfE 1994a) for waters where colour (hue) is an important characteristic.	The existing dry weather water colour shall be maintained to within 10 Munsell Units. It is also desirable to derive a numeric objective range 'X-Y' for colour in the <u>Coastal Lake MU</u>).	MfE 1994a	The ambient receiving water colour, shall not be changed by more than 10 Munsell Units as a result of any discharge; and, The receiving water colour, shall not be less than 'X' Munsell Units or greater than 'Y' Munsell Units, as a result of any discharge.	MfE 1994a
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Colour (amenity) row in Table 1 for "Alpine Rivers".				
		Nutrients	• amenity • biodiversity (native fish, birds and salmonids) • contact recreation	Support biodiversity (native fish, birds and salmonids) and amenity values at a level of protection recommended in national guidelines (ANZECC 2000) for slightly disturbed ecosystems.	The maximum biomass of phytoplankton shall be less than 5 mg/m^3 chl. *a*	ANZECC 2000 (From SE Australian Guidelines Table 3.3.2)	Note: We have not recommend a rule standard limiting nutrient concentrations for the Lowland Lakes MU. We recommend that this issue be re-visited when the existing lake classification is reviewed (see Conclusions, Section 12).	
				Notes: Also refer to the same notes provided for the 'Nutrients' row in Table 1 for "Alpine Rivers".				
		Ammonia	• biodiversity (macroinvertebrates, native fish, salmonids)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the Ammonia (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of ammonia is the same, regardless of the type of river or lake, and therefore there is no reason for the ammonia objectives and rule standards to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as 'Alpine Rivers' MU.				
		Biochemical Oxygen Demand (BOD)	• biodiversity (as above) • contact recreation	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1.				
				Notes: Refer to the same notes (Notes 1 and 2) provided for the BOD (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Suspended Solids (SS)	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the SS (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Turbidity	• biodiversity (as above) • contact recreation	Refer to the same notes provided for the Turbidity (biodiversity & contact recreation) row in Table 1 for "Alpine Rivers".				
		Toxicants	• biodiversity (as above)	The recommended objectives and rule standards are the same as those presented for the 'Alpine Source' rivers in Table 1				
				Notes: Refer to the same notes provided for the Toxicants (biodiversity) row in Table 1 for "Alpine Rivers". The toxicity of toxicants in Table 11 is the same, regardless of the type of river or lake, and therefore there is no reason for the objectives and rule standards for toxicants to change between MUs, except if the 'purpose for management' is changed, or if a different 'level of protection' option is selected by ECan. The options for ECan are the same as 'Alpine Rivers' MU.				
		Objectionable material	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					
		Narrative statements	The 'critical values', 'level of protection', and recommended 'objectives' and 'rule standards' are the same as those presented for the 'Alpine Source' rivers in Table 1.					

TABLE 11. - TOXICANTS

Note 1: This table is referred to in Tables 1-10 for all ECan Management Units (MUs).

Note 2: The numbers in this table have been taken from 'trigger levels' provided in Table 3.4.1 of the ANZECC & ARMCANZ 2000 Guidelines. In order to use these numbers as 'rule standards' in the planning framework for the NRRP proposed in this report, we have removed a large number of qualifying footnotes from the table (e.g. variations to the numbers with changing water pH, hardness, species present etc). While this is necessary for clarity and certainty of the numbers used in the framework (as discussed in the report), it is very important that plan-users are educated about the source of these numbers. While these 'rule standards' will determine whether a discharge falls into the 'permitted', 'discretionary' or 'non-complying' activity categories in the NRRP, the source of these numbers (ANZECC & ARMCANZ 2000 Guidelines) and the appropriate qualifications contained in the guidelines, will be used by ECan during case-by-case considerations, to assess the likely effects of a discharge on attainment of the related 'objective'. Therefore a discharge that does not meet the standards in this table may or may not be granted consent as a 'non-complying' activity, depending on site-specific characteristics and reference to the guidelines.

	Options for ECan Standards (μgL^{-1})		
	Level of protection (% species)		
Chemical	**99%**	**95%**	**80%**
METALS AND METALLOIDS			
Aluminium	27	55	150
Arsenic (As III)	1	24	360
Arsenic (AsV)	0.8	13	140
Boron	90	370	1300
Cadmium	0.06	0.2	0.8
Chromium (CrVI)	0.01	1.0	40
Copper	1.0	1.4	2.5
Lead	1.0	3.4	9.4
Manganese	1200	1900	3600
Mercury (inorganic)	0.06	0.6	5.4
Nickel	8	11	17
Selenium (Total)	5	11	34
Silver	0.02	0.05	0.2
Zinc	2.4	8.0	31
NON-METALLIC INORGANICS			
Ammonia (as NH_4-N)	See rule standards for ammonia in Tables 1-10		
Chlorine	0.4	3	13
Cyanide	4	7	18

Chemical	Options for ECan Standards (µgL^{-1})		
	Level of protection (% species)		
	99%	**95%**	**80%**
Nitrate (as NO_3-N)	4900	7200	12000
Hydrogen sulfide	0.5	1.0	2.6
AROMATIC HYDROCARBONS			
Benzene	600	950	2000
o-xylene	200	350	640
p-xylene	140	200	340
Polycyclic Aromatic Hydrocarbons			
Naphthalene	2.5	16	85
ORGANOCHLORINE PESTICIDES			
Chlordane	0.03	0.08	0.27
DDT	0.006	0.01	0.04
Endosulfan	0.03	0.2	1.8
Endrin	0.01	0.02	0.06
Heptachlor	0.01	0.09	0.7
Lindane	0.07	0.2	1.0
Toxaphene	0.1	0.2	0.5
ORGANOPHOSPHORUS PESTICIDES			
Azinphos methyl	0.01	0.02	0.11
Chloropyrifos	0.00004	0.01	1.2
Diazinon	0.000003	0.01	2
Dimethoate	0.1	0.15	0.3
Fenitrothion	0.1	0.2	0.4
Malathion	0.002	0.05	1.1
Parathion	0.0007	0.004	0.04
CARBAMATE AND OTHER PESTICIDES			
Carbofuran	0.06	1.2	15
Methomyl	0.5	3.5	23
HERBICIDES AND FUNGICIDES			
Brpyridilium herbicides			
Diquat	0.01	1.4	80

Chemical	Options for ECan Standards (μgL^{-1})		
	Level of protection (% species)		
	99%	**95%**	**80%**
Phenoxyacetic acid herbicides			
2,4-D	140	280	830
2,4,5-T	3	36	290
Thiocarbamate herbicides			
Molinate	0.1	3.4	57
Thiobencart	1	2.8	8
Thiram	0.01	0.2	3
Triazine herbicides			
Atrazine	0.7	13	150
Simazine	0.2	3.2	35
Urea herbicides			
Tebuthiuron	0.02	2.2	160
Miscellaneous herbicides			
Glyphosate	370	1200	3600
Trifluralin	2.6	4.4	9
GENERIC GROUPS OF CHEMICALS			
Surfactants			
Linear alkylbenzene sulfonates (LAS)	65	280	1000
Alcohol ethoxyolated sulfate (AES)	340	650	1100
Alcoholethoxylated surfactants (AE)	50	140	360

Appendix 5. Table listing ‘Type 1’ and ‘Type 2’ contaminants

Note 1: This table contains a classification of contaminants and water quality variables (physical and chemical stressors) into those that have generally direct or acute effects (Type 1) and those that have generally indirect or chronic effects (Type 2), as discussed in Section 9.9.2. The assignment of contaminants to the two classes is a pragmatic decision, based on the known characteristics of each contaminant, with the intention of creating a very simple classification for the purpose of defining MANC zones in the NRRP (see Section 9.9.2). The implication of this simple classification is that the MANC zone for Type 1 contaminants will be more restrictive than the MANC zone for ‘Type 2’ contaminants. We have considered dividing contaminants into more than two classes but have opted for simplicity for the purpose of the NRRP, as discussed in Section 11.6. We note that for other purposes it may be appropriate to consider more complex differences between types of physical and chemical stressors, as described in section 3.3.2 of the ANZECC 2000 Guidelines.

Type 1	*Type 2*
Dissolved oxygen (DO)	*E.coli*
Temperature	Faecal coliforms
pH	Clarity
Ammonia	Colour
All toxicants in Table 11	Nutrients
Objectionable materials (visible)	Biochemical Oxygen Demand (BOD)
	Suspended Solids (SS)
	Turbidity

Appendix 6. Preliminary comparison with ECan data

The following graphs have been adapted from *An Overview of the Surface Water Quality of the Rivers and Streams of the Canterbury Region* (Meredith and Hayward, 2002). The graphs show box plots of the concentrations of ammonia nitrogen, faecal coliforms, nitrate/nitrite nitrogen and dissolved reactive phosphorus for eight river type classes in Canterbury. The data was from the ECan water quality database (1990-2001) and was assembled as described in Meredith and Hayward (2002). The eight river type classes defined by Meredith and Hayward (2002) relate approximately to the six river management units (MUs) defined in this report as shown in Table A6.1 below.

Table A6.1: Relationship between Canterbury Management Units (MUs) in this report and the river type classes used in Meredith and Hayward (2002)

Management Unit	River type classes used in Meredith and Hayward (2002)
Mountain	Mountain (upper) – upstream of State Highway 1
	Mountain (lower) – downstream of State Highway 1
Hill	Hill (upper) – upstream of State Highway 1
	Hill (lower) – downstream of State Highway 1
Lake-fed	Lake-fed
Intermontane	Intermontane
Lowland	Lowland
Volcanic	Banks Peninsula

The plots from Meredith and Hayward (2002) have been reproduced with the addition of horizontal lines indicating the position of the options for numeric water quality rule standards proposed in this report. From this preliminary comparison it can be seen whether the existing water quality data indicates compliance with the proposed options for rule standards for the four water quality variables shown. From this type of comparison an analysis can be made on whether the proposed rule standards are likely to be restrictive (conservative) or enabling of resource use for most rivers within a particular MU, and therefore the likely consequences for management of selecting a particular option. This kind of analysis can be used by ECan in making decisions about which 'level of protection' options to select from the tables in Appendix 4. It is recommended in the report (Sections 11.9 and 12) that such analysis be taken further, as part of implementing the options for numeric objectives and rule standards provided in this report.

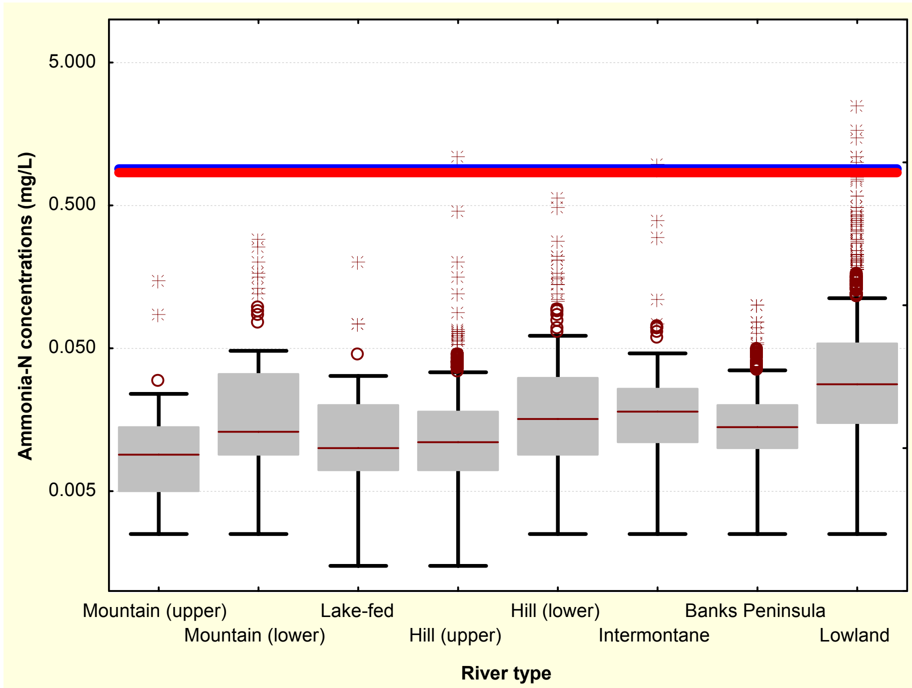


Figure 5 (from Meredith and Hayward, 2002). Box Plots of Total Ammonia-N concentration for eight river type classes in Canterbury. (Note: horizontal bar = median, shaded box = 75 and 25 percentiles, whiskers = 5 and 95 percentiles, o and * indicate outliers and extreme values respectively)

Blue line indicates the proposed <u>chronic</u> total ammonia rule standard (0.9 mg(N)/L at pH 8.0), common for all MUs (derived from ANZECC & ARMCANZ (2000) 95% trigger value)

Red line indicates the proposed <u>acute</u> total ammonia rule standard (0.885 mg(N)/L at pH 9.0), common for all MUs (derived from USEPA (1999)).

Comment: These plots suggest that all rivers for which data was available for this analysis currently comply with the proposed chronic and acute ammonia standards. It is likely that some reaches of some rivers do not consistently meet the proposed standards because data associated with point-source discharges was removed from this data-set (Meredith and Hayward 2002).

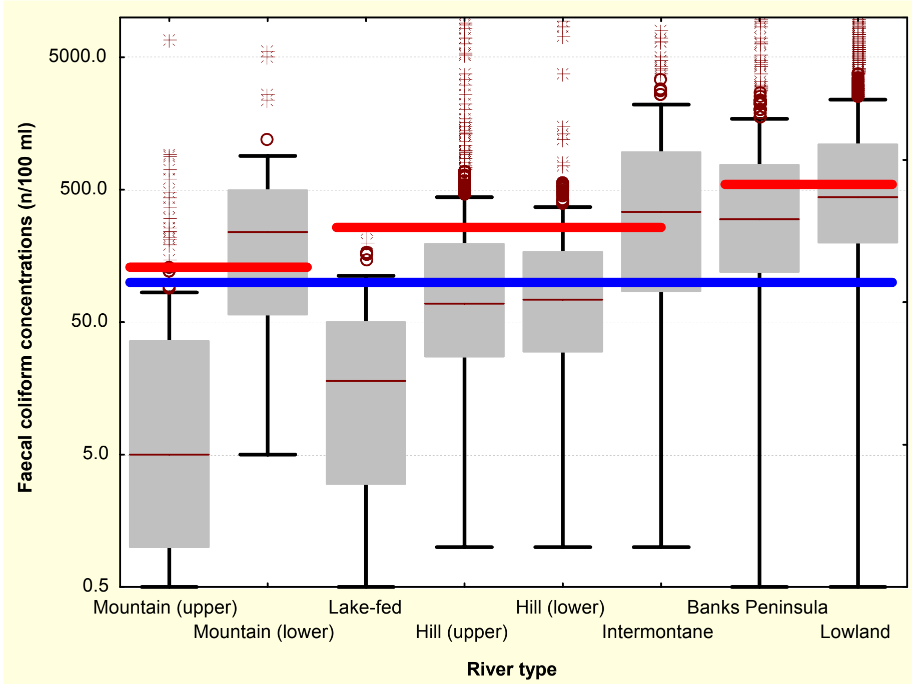


Figure 6 (from Meredith and Hayward, 2002). Box Plots of faecal coliform concentration for eight river type classes in Canterbury. (Note 1: horizontal bar = median, shaded box = 75 and 25 percentiles, whiskers = 5 and 95 percentiles, o and * indicate outliers and extreme values respectively) (Note 2: The *E. coli* standard has been plotted against faecal coliform concentration with the assumption that the faecal coliform / *E. coli* ratio is close to one)

Blue line indicates the proposed (derived from ANZECC & ARMCANZ 2000) stockwater *E. coli* standard (running median of 100 *E. coli* per 100 mL [with 80% samples < 400]).

Red line indicates the proposed contact recreation *E. coli* standard for three different contact related illness risk objectives for three groups of MUs (derived from MfE (2003)). For the mountain rivers the objective is less than 1 illness per 1000 exposures (standard = maximum 130 *E. coli* per 100 mL). For lake source, hill and intermontane rivers (excluding rivers of the Amuri Basin) the objective is less than 1 illness per 100 exposures (standard = maximum 260 *E. coli* per 100 mL). For lowland and volcanic rivers the objective is less than 1 illness per 20 exposures (standard = maximum 550 *E. coli* per 100 mL).

Comment: These plots suggest that only rivers in the mountain (upper) and lake source MUs consistently meet both standards. The hill rivers generally meet the proposed contact recreation standard, but would not do so if the lower risk (0.1%) option was chosen. Similarly many lowland and Banks Peninsula rivers meet the proposed contact recreation standard, but would not do so if the lower risk (1%) option was chosen.

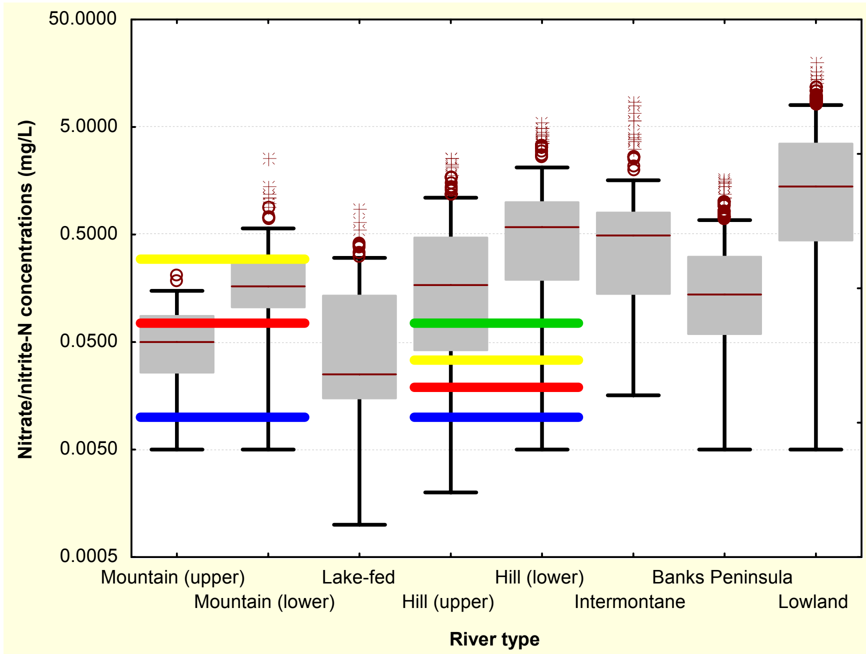


Figure 3 (from Meredith and Hayward, 2002). Box Plots of Nitrate/Nitrite-N concentration for eight river type classes in Canterbury. (Note 1: horizontal bar = median, shaded box = 75 and 25 percentiles, whiskers = 5 and 95 percentiles, o and * indicate outliers and extreme values respectively)

Blue line indicates the proposed soluble inorganic nitrogen (SIN) standard (0.01 mg/L SIN) for 'High' (Option 1) level of protection for mountain and hill rivers only (derived from Biggs (2000)).

Red line indicates proposed soluble inorganic nitrogen (SIN) standard for 'Moderate' (Option 2) level of protection, using a nominated 30 'days of accrual' for mountain rivers (0.075 mg/L SIN) and 50 days for hill rivers (0.019 mg/L SIN) (derived from Biggs (2000)).

Yellow line indicates the proposed soluble inorganic nitrogen (SIN) standard for 'Moderate' (Option 2) level of protection, using a nominated 'days of accrual' of 20 days for mountain rivers (0.295 mg/L SIN) and 40 days for hill rivers (0.034 mg/L SIN) (derived from Biggs (2000)).

Green line indicates the proposed soluble inorganic nitrogen (SIN) standard for 'Moderate' (Option 2) level of protection, using a nominated 30 'days of accrual' for hill rivers (0.075 mg/L SIN) (derived from Biggs (2000)).

Comment: These plots show that the choice of options has significant consequences for management. Choosing more protective options will be less enabling of resource use, while a choice to be more enabling of resource use will be less protective. It is recommended in the report (Sections 11.9 and 12) that such analysis be taken further, as part of implementing the options for numeric objectives and rule standards provided in this report into the NRRP.

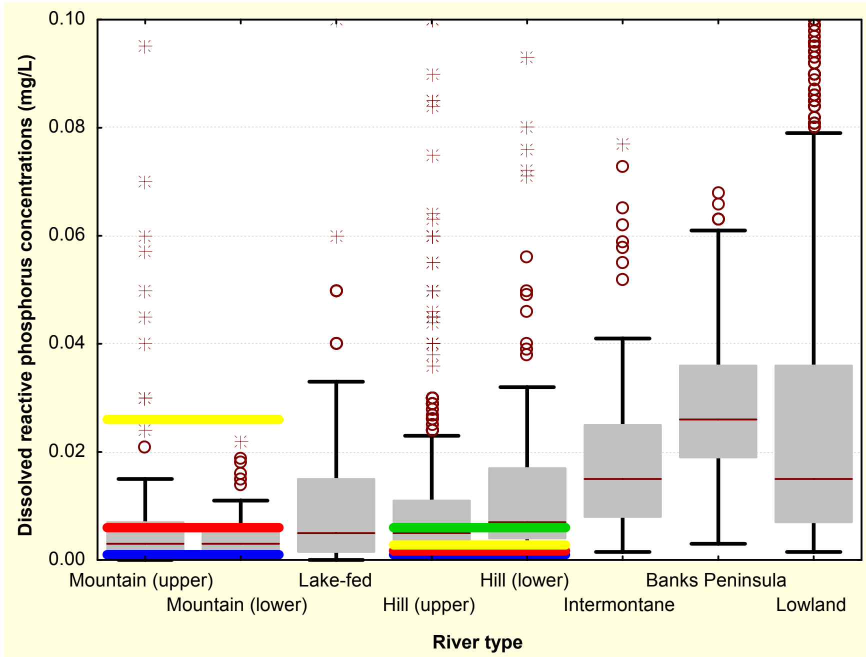


Figure 4 (from Meredith and Hayward, 2002). Box Plots of Dissolved Reactive Phosphorus concentration for eight river type classes in Canterbury. (Note 1: horizontal bar = median, shaded box = 75 and 25 percentiles, whiskers = 5 and 95 percentiles, o and * indicate outliers and extreme values respectively)

Blue line indicates the proposed dissolved reactive phosphorus (DRP) standard (0.001 mg/L DRP) for 'High' (Option 1) level of protection for mountain and hill rivers only (derived from Biggs (2000)).

Red line indicates proposed dissolved reactive phosphorus (DRP) standard for 'Moderate' (Option 2) level of protection, using a nominated 30 'days of accrual' for mountain rivers (0.006 mg/L DRP) and 50 days for hill rivers (0.0017 mg/L DRP) (derived from Biggs (2000)).

Yellow line indicates the proposed dissolved reactive phosphorus (DRP) standard for 'Moderate' (Option 2) level of protection, using a nominated 'days of accrual' of 20 days for mountain rivers (0.026 mg/L DRP) and 40 days for hill rivers (0.0028 mg/L DRP) (derived from Biggs (2000)).

Green line indicates proposed dissolved reactive phosphorus (DRP) standard for 'Moderate' (Option 2) level of protection, using a nominated 30 'days of accrual' for hill rivers (0.006 mg/L DRP) (derived from Biggs (2000)).

Comment: These plots show that the choice of options has significant consequences for management. Choosing more protective options will be less enabling of resource use, while a choice to be more enabling of resource use will be less protective. It is recommended in the report (Sections 11.9 and 12) that such analysis be taken further, as part of implementing the options for numeric objectives and rule standards provided in this report into the NRRP.