IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of the Proposed Canterbury Land and Water Regional Plan

STATEMENT OF EVIDENCE OF SHIRLEY ANN HAYWARD FOR THE GROUP 1 HEARING

1. INTRODUCTION

1.1 My name is Shirley Ann Hayward. I am employed by Pattle Delamore Partners Limited as an Environmental Scientist. I hold the degrees of Bachelor of Science in Plant and Microbial Sciences and Master of Science in Environmental Science. I am a member of the New Zealand Freshwater Sciences Society.

1.2 My previous experience includes three years as a Water Quality Specialist within the Sustainability Team of DairyNZ. In this role I provided technical expertise on water quality issues relating to impacts of dairy farming, provided input into various regional policy processes with regional councils. I was co-leader of the science team for the Land Use and Water Quality Hurunui pilot limit-setting project. The science team provided technical analysis of catchment water quality, hydrological and ecological issues and options for input into stakeholder and governance group deliberations.

1.3 I was previously employed by Canterbury Regional Council for 16 years in a succession of roles including Microbiologist, Groundwater Quality Officer, Environmental Quality Analyst and Surface Water Quality Scientist. Over an 11 year period with Environment Canterbury I was involved with river water quality and stream ecology investigations and have authored numerous peer reviewed technical reports on groundwater quality, river and lake water quality and aquatic ecosystem health.

1.4 As Surface Water Quality Scientist for five years at the Canterbury Regional Council, I had responsibility for a number of surface water quality monitoring and investigation programmes. I was also involved with developing a set of recommendations to the panel hearing submissions on the Natural Resources Regional Plan in relation to river and lake management units and indicators and numeric criteria for water quality objectives and discharge standards.

1.5 I have read and am familiar with the Code of Conduct for Expert Witnesses outlined in the Environment Court's Practice Note 1 November 2011 and although this is a Regional Council hearing, I have complied with it in preparing this evidence. I also agree to follow the Code when presenting evidence to the Hearing Committee. I confirm that the issues addressed in this brief of evidence are within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from my expressed opinions.

2. SCOPE OF EVIDENCE

2.1 My evidence addresses the freshwater outcomes described in Tables 1a, b and c. In particular I discuss the choice of management units, indicators and numeric criteria for water quality in Tables 1a, b and c and implications for interpretation and implementation of these outcomes.

2.2 I also discuss Policy 4.11 as it relates to impacts of discharges on groundwater quality.

3. FRESH WATER QUALITY OUTCOMES

3.1 The proposed Land and Water Regional Plan (proposed plan) sets fresh water outcomes in Tables 1a, b and c for rivers, lakes and groundwater respectively. Tables 1a and b have been transferred with some small changes from the Natural Resources Regional Plan (NRRP) water quality Objective WQL1.1 and Table WQL5 (rivers) and Objective WQL1.2 and Table WQL6 (lakes). These objectives were based on an Environment Canterbury technical report that I part-authored.[1]. That report made recommendations on the classification of

[1] Hayward, S., Meredith, A., Stevenson, M., 2009: Review of proposed NRRP water quality objectives and standards. Environment Canterbury report R09/16

river and lake management units, indicators and numeric criteria for water quality objectives and water quality standards. Table 1c is a modified version of the NRRP groundwater quality objective WQL2.1 and a more conservative expression of the quantity objective WQN3.

Management units

3.2 The management units recommended in the report I co-authored, which were included in the NRRP and then transferred to the proposed Land and Water Regional Plan in Tables 1a and 1b, group river types according to their source of flow and catchment position, and lake types according to their size, catchment position and whether they are natural or artificially established. This provides a spatial framework based on grouping waterbodies with common key physical characteristics that are overarching controllers on the biological functioning and condition of rivers and lakes. This is similar to the general recommendations for a framework for setting water quality objectives and limits[2]. In my opinion, while the management units set in the proposed Land and Water Regional Plan usefully group rivers and lakes according to common biophysical features at a broad regional scale, they are however, quite coarse. Within each of these river/lake type categories there is considerable variability in responses and resilience of individual rivers and lakes to both natural and anthropogenic influences.

3.3 The relatively broad river and lake categories mean that the numeric criteria may not be appropriate for some individual rivers or lakes, particularly where physical characteristics deviate from the broad characteristics of the river or lake type. For example, some hill-fed rivers in the region have a high proportion of tertiary sediments in their catchment resulting in natural enrichment of phosphorus and other minerals, and generally produce naturally high periphyton biomass.

3.4 The Waipara River in North Canterbury is such an example where the presence of tertiary marine limestone and sandstones in the catchment contribute natural sources of phosphorus, which combined with a warm dry microclimate result in

[2] Norton, N., Snelder, T., Rouse, H. 2010: Technical and scientific considerations when setting measurable objectives and limits for water management. NIWA report to Ministry for the Environment

periphyton growth routinely exceeding criteria in Table 1a for hill-fed rivers (its river type classification)[3]. Such rivers may not be able to routinely achieve one or more of the water quality outcomes set for hill-fed rivers. There are other similar examples. At a minimum, provision for finer scale review of the applicability of the numeric criteria to any given situation is needed, such as provided for in the development of sub-regional chapters.

3.5 The overly broad nature of lake management units is illustrated in Table 1b where differing criteria are set for specific lakes within a broader management unit.

3.6 As with Tables 1a and b, the groundwater management units use broad categories to group groundwater based on being confined or unconfined, with unconfined aquifers further subdivided based on depth and whether the groundwater is predominantly recharged by river or soil drainage. However, in some parts of Canterbury groundwater will fall somewhere in between these units such as groundwater that is recharged from an equal mixture of river and soil drainage. Also, groundwater in some areas will fall outside these definitions such as shallow groundwater predominantly recharged by river drainage (e.g. Little Rakaia Zone[4]) or deep groundwater predominantly recharged by soil drainage (some inland areas of the plains).

3.7 The sharp contrast in water quality expectations for shallow, soil drainage dominated groundwater compared to the other two management units implies a clear delineation in these management units that does not practically occur. The implications of this are that groundwater that falls outside or in between these broad management units may be inappropriately defined and unnecessarily constrained in terms of water quality outcomes.

3.8 Broadening the definition of the sub-unit for unconfined shallow groundwater to include all groundwater that is predominantly recharged by soil drainage (and therefore is subject to changes in constituent concentrations from land uses)

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[3] Hayward, S., Meredith, A., Lavender, R. 2003: Waipara River: assessment of water quality and aquatic ecosystem monitoring, 1999 – 2003. Environment Canterbury report R03/11

[4] Grant, H, 2003: The surface and groundwater resources of the Little Rakaia Zone (Lee River, Tent Burn, and Jollies Brook). Environment Canterbury report U03/35

will help address this gap in groundwater management units. Similarly, including a subunit for shallow river-recharged groundwater (which may undergo small changes in constituent concentrations but remain largely diluted by river recharge water) will address this gap in the management units. The following management unit description could be used to replace the *'Shallow groundwater predominantly recharged by soil drainage'*:

All shallow groundwater and all groundwater predominantly recharged by soil drainage.

3.9 While the management units in Tables 1a, b and c have a logical grouping at a regional level, their overall coarseness adds a degree of uncertainty and variability to the numeric water quality outcomes that is not articulated in the proposed plan. This has implications in their use for determining allocation status of catchments or zones, which I will cover in my brief of evidence for Hearing Group 2.

Indicators

3.10 The choice of indicators used in the water quality outcomes tables for rivers and lakes collectively describe the condition of a waterway that integrate a range of human influences (water quality, flows and levels, riparian and river/lake bed management) and that can be related to community values. The justification for these indicators for water quality objectives in the NRRP was, where possible, based on their scientific defensibility, extent of use both nationally and regionally, understanding by water resource practitioners, responsiveness to activities that are being managed and relevance to purposes for management. At the time that they were originally proposed in the report that I co-authored, some indicators were novel and lacked national guidance (e.g., macrophyte cover and sedimentation) but their inclusion was considered crucial in order to provide full coverage of the main issues affecting the region's waterways[5]. Subsequent national guidance on indicator and numeric criteria for

[5] *Ibid.*

macrophytes[6] and sedimentation[7] is emerging and those recommendations need to be considered.

3.11 Indicators such as periphyton biomass (chlorophyll *a* and cover of nuisance algae), temperature, dissolved oxygen and suitability for recreation grading have been extensively used and are widely understood in New Zealand. The lake trophic level index is also widely used but with some degree of contention about its applicability to all lake types (e.g, coastal lakes) and to management responses. The quantitative macroinvertebrate community index (QMCI) was originally developed as a biomonitoring tool to assess effects of organic pollution from point source discharges[8]. However, it is now more widely accepted that QMCI also responds to other factors such as habitat quality, sedimentation, nutrient enrichment and flows.

3.12 The benefit of the range of indicators used is that they are interrelated and that there is often more than one management intervention available to achieve improvements where needed. For example, increases in fine sediment deposited on a stream bed has a strong negative influence on other indicators such as QMCI, macrophytes and in some cases suitability for contact recreation grades. Booker and Snelder (2012)[9] noted, for example, that management of fine sediment could be more important than nutrient inputs in managing nuisance macrophyte growth. Overall I support the selection of indicators as a pragmatic choice that integrate effects of a broad range of activities and management strategies, although it is important to recognise their imperfect nature. Because they integrate effects of a range of activities and factors, care

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[6] Matheson, F., Quinn, J., Hickey, C. (2012): Review of the New Zealand instream plant and nutrient guidelines and development of an extended decision making framework: Phases 1 and 2 final report. Prepared for Ministry of Science and Innovation Envirolink Fund.

[7] Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M., Death, R.G. (2011) Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute, Nelson, New Zealand.

[8] Stark, J.D. 1985. A macroinvertebrate community index of water quality for stony streams. Water and Soil Miscellaneous Publication 87. (National Water and Soil Conservation Authority, Wellington New Zealand).

[9] Booker, D., Snelder, T. 2012: Development of nutrient criteria for managing macrophytes in lowland and spring-fed Canterbury streams. Environment Canterbury report R12/29.

is needed when they are used to determine nutrient allocation status, which I will address in my brief of evidence for Hearing Group 2.

Numeric criteria

3.13 The use of absolute numeric criteria has considerable merits over narrative statements in that they provide clarity and certainty about the outcomes sought, allow evaluation of the effectiveness of plans and provide criteria for reporting and communicating compliance with the community. However, the downside of numeric criteria is that specific (often single) numbers are developed against which a simple comply/fail assessment may be made at a range of temporal and spatial scales including down to the scale of a single sample at one site. Single number criteria such as those in the water quality outcome tables of the proposed plan imply critical thresholds of compliance/failure and a level of precision in defining indicator criteria that does not occur in reality. Water quality indicators such as those in the proposed plan are inherently variable spatially and temporally owing to both natural and anthropogenic factors. This variability occurs both within a waterbody reach, and between waterbodies and in many cases, short term aberrations in waterway condition do not have long-term consequences in terms of ecosystem and community values.

3.14 The numeric criteria set for each indicator and river/lake type was developed with the aim of setting 'aspirational but achievable' objectives[10]. It was acknowledged that for some water body types (particularly urban and rural spring-fed streams), the recommended criteria were higher (better) than that found currently in many sites and that longer timeframes (longer than the life-time of the plan) would be needed for the majority of streams to achieve the objectives. The NRRP also noted that '*Although the improvement may take longer than the 10 years before all the provisions of NRRP have been reviewed, it is expected that substantial progress will be made during that time*.' While the recommended numeric criteria aimed to set objectives that were for the most part 'technically' achievable, the full cost and consequences of achieving the objectives were not determined in the course of determining the provisions of the NRRP. The 'aspirational' nature of these criteria is further reinforced in

[10] Hayward, S., Meredith, A., Lavender, R. 2003: Waipara River: assessment of water quality and aquatic ecosystem monitoring, 1999 – 2003. Environment Canterbury report R03/11

Appendix 1 of the Section42A report, written by one of the co-authors of the original technical report[11].

3.15 Figures 1 and 2 illustrate the current state of the major river types in relation to the water quality outcomes set for QMCI and sedimentation. These figures illustrate the relatively high numeric criteria set for spring-fed streams compared to the overall current state of these river types. While it is desirable to see many of these waterways improve their condition in respect of these and other indicators, in reality it may take long timeframes (years to decades) for some of the waterways to achieve the criteria set, especially for indicators such as sedimentation. The social and economic implications of all waterways achieving these criteria have not been determined.

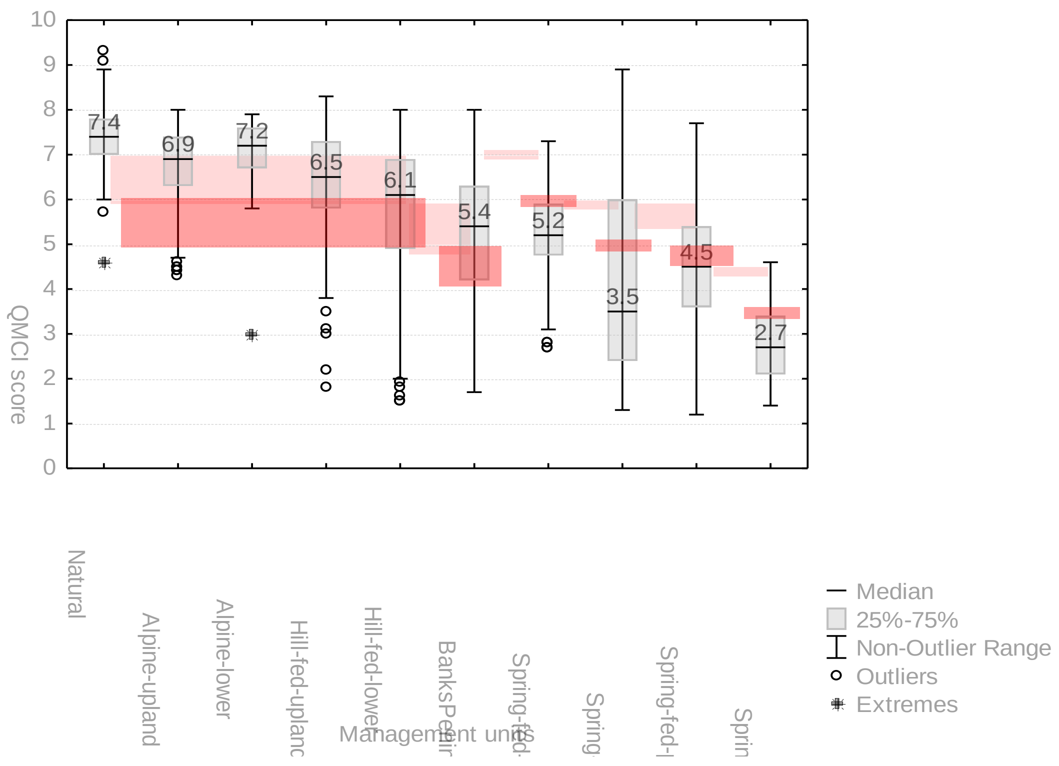

Figure 1. Box and whisker plots of QMCI values for 140 sites sampled in Canterbury rivers and streams from 1999 to 2007. Red bars show the QMCI criteria set in Table 1a of the proposed Land and Water Regional Plan for the relevant river type. Values

[11] Ibid.

below the red bars are worse than the criteria set in the plan (Modified from Hayward *et. al*. 2009).

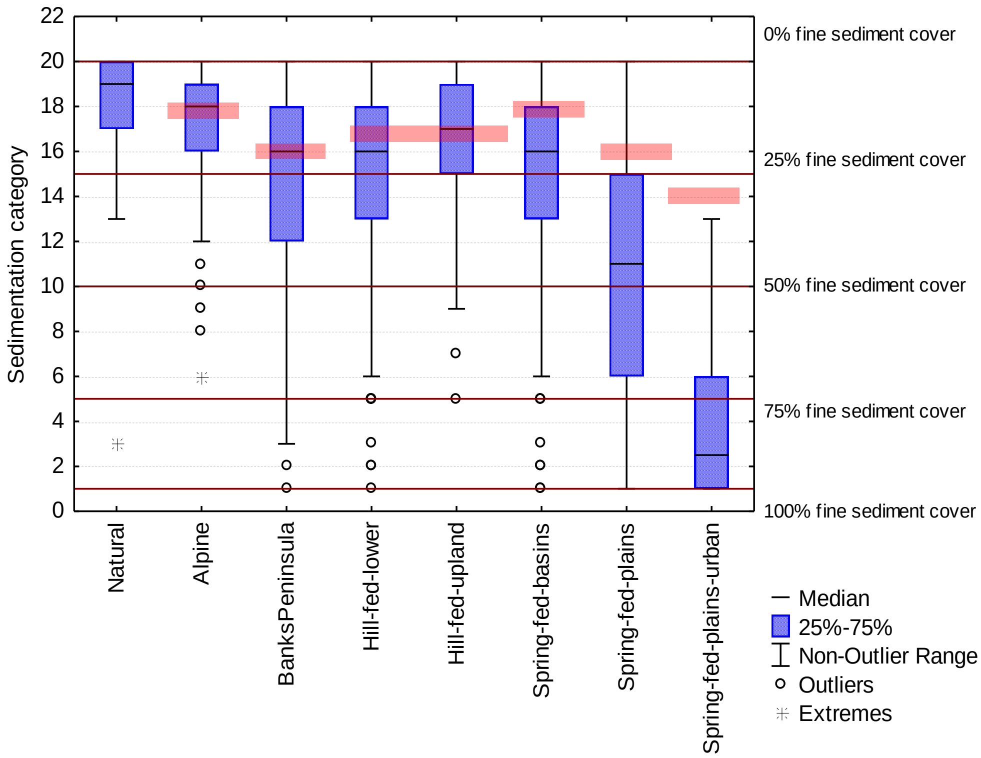

Figure 2. Box and whisker plots of the % fine sediment data for 140 sites sampled in Canterbury rivers and streams from 1999 to 2007. Red bars show the fine sediment criteria set in Table 1a of the proposed Land and Water Regional Plan for the relevant river type. Values below the bar are worse than the criteria set in the plan (Modified from Hayward *et. al*. 2009).

3.16 The regulatory framework in which the water quality objectives for the NRRP were developed differs from that subsequently established by the NPSFM. As described by Mr Willis, under the NPSFM, if a freshwater quality objective is not being met, then that water body is deemed over-allocated, and the council will need to establish methods for improving the degraded state of that waterbody and is not likely to allocate further resource use in such catchments. However, my understanding (through my involvement in developing recommendations on water quality objectives that were incorporated into the NRRP) is that this was not the intended application of the water quality objectives at the time they were included in the NRRP. Because of the changed overlying policy framework, it is not a case where those provisions can simply be 'rolled over' without giving them and their content a careful re-examination.

3.17 The NPSFM aims in Objective A2 that ‘The overall quality of fresh water within a region is maintained or improved while:…’. This is discussed in detail by Mr Willis. I am of the view that the ‘overall’ quality of fresh water within a spatial management unit (e.g., catchment or allocation zone) can be maintained or improved by ensuring the ‘average’ condition of its waterways meet the criteria set out in Tables 1a, b and c. This approach allows for some ‘unders’ and ‘overs’ that inevitably occurs. Such an approach is also likely to ensure that not all waterbodies deteriorate down to the criteria as some sites are needed to be better than the criteria in order to balance sites that are unlikely to be remediated up to the criteria level. This approach appears to be used in the development of the nutrient allocation zones as indicated in Appendix 6 of the Section 32 report, which states that ‘*The proposed classification system describes the total [average] catchment nutrient status*’[12].

3.18 Therefore, while I support the water quality outcomes in Tables 1a, b and c as interim water quality objectives that can be used to evaluate the implications of activities it is, in my view, unrealistic to expect that these criteria must be met at all locations all of the time (as implied in policy 4.1). In my opinion, applying the outcomes in terms of overall condition or averages within the scale of catchments or zones is an appropriate and pragmatic approach for these interim criteria. This is particularly important if they are to be used to determine the allocation status of catchments or zones. It would be helpful if this was explicitly stated in the headings and/or footnote of Tables 1a, b and c.

3.19 I also note that the plan contemplates that the water quality outcomes may be reviewed at the sub-regional plan level and may develop different objectives at that level. Therefore, in supporting Tables 1a, b and c as interim regional level objectives, I anticipate and consider it desirable that the sub-regional chapters are able to review and refine these numeric criteria as appropriate for the waterbodies in that subregion.

[12] Meredith, A., Stevenson, M., Kelly, D. 2012: Appendix 6: Derivation of nutrient status zones. Environment Canterbury memorandum Appendix 6 in Section 32 report for the Proposed Canterbury Land and Water Regional Plan

4. POLICIES - DISCHARGES

Policy 4.11 – Discharges to land

4.1 Policies 4.9 to 4.11 set out the overall basis for consideration of discharge matters. Policy 4.11 deals with discharges that may affect land and groundwater quality. The Fonterra submission was concerned that interpretation of 4.11(c)(v) could mean that any increase in a groundwater constituent could be considered an 'adverse effect' on the drinking-water quality of the groundwater, whether or not the constituent concentration actually exceeded relevant criteria in the drinking-water standards. If this is the interpretation of the policy, I am of the view that such a requirement is unnecessarily conservative given the safety factors incorporated into drinking-water standards criteria. A requirement that effects of discharges should not result in groundwater exceeding criteria for drinking water standards is adequately protective.

4.2 Clause 4.11(c)(iii) also refers to drinking water quality expectations by stating that:

(a) *(iii) not result in the accumulation of pathogens, or a persistent or toxic contaminant that would render the land unsuitable for agriculture, commercial, domestic or recreational use or* ***water unsuitable as a source of potable water*** *or for agriculture;* (my emphasis).

4.3 The Drinking Water Standards for New Zealand[13] define 'potable' as:

(a) ***Drinking water*** *that does not contain or exhibit any* ***determinand*** *to any extent that exceeds the* ***maximum acceptable values*** *specified in the* ***Drinking-water Standards for New Zealand (DWSNZ)****. See also* ***wholesome drinking-water****.* (their emphasis)

4.4 Maximum acceptable values are set for contaminants that pose a human health risk. Therefore, clause 4.11(c)(iii) already ensures that discharges will not result in groundwater being unsafe to drink. There are also some constituents

[13] Ministry of Health (2008): *Drinking-water Standards for New Zealand 2005 (Revised 2008).* Wellington: Ministry of Health.

in water that, while not posing a health risk (and therefore not affecting potability), may affect the aesthetic condition of a drinking-water source. The DWSNZ provide guideline values for constituents that affect aesthetic quality of drinking-waters. It is reasonable to expect discharges will also avoid contamination of drinking water sources that render the water unpleasant to drink.

4.5 The s 42A report recommends elevating clause 4.11(c)(iii) to clause 4.11(c). However, elevation of this statement does not appear logical. This is because if clauses 4.11(a) and (b) are met, that is, if the soil can treat or remove the contaminant and the discharge does not exceed the available water storage capacity, then contaminant loss to the underlying groundwater will not occur. The additional requirement of proposed clause 4.11(c) that discharges will not result in accumulation of contaminants in the soils that render land unsuitable for a range of purposes seems reasonable. The requirements about groundwater quality are only relevant if those requirements for land effects cannot be met.

4.6 Therefore, clauses that relate to water quality that may be affected by discharges when the soil cannot completely treat contaminants appropriately fit as a secondary level. The s 42A recommendation could be re-worded as follows:

Any discharge of a contaminant into or onto land where it may enter groundwater:

(a) will not exceed the natural capacity of the soil to treat or remove the contaminant; and

(b) will not exceed available water storage capacity of the soil; and

(c) will not result in the accumulation of pathogens, or a persistent or toxic contaminant that would render the land unsuitable for agriculture, commercial, domestic or recreational use ~~or water unsuitable as a source of potable water or for agricultural;~~.

(d) where meeting (a), (b) and (c) is not practicable the discharge will:

(i) meet any nutrient allowance in Sections 6-15 of this Plan;

(ii) utilise the best practicable option to ensure the size of any contaminant plume is as small as is reasonably practicable, and

(iii) ensure there is sufficient distance between the point of discharge, any other discharge and drinking water supplies to allow for the natural decay or attenuation of pathogenic micro-organisms in the contaminant plume;

(v) not raise groundwater levels so that land drainage is impeded; and

(vi) not result in groundwater quality exceeding maximum acceptable values for determinands of health significance or guideline values for aesthetic determinands

5. CONCLUSION

5.1 The water quality outcomes provided in Tables 1a, b and c provide specific (numeric) regional criteria describing the condition of water bodies that integrate a range of activities and can be related to community values. As such they are a useful set of integrated indicators and criteria against which to evaluate and communicate waterway condition and effects of activities. However, I have a number of concerns about their application as absolute criteria for all water bodies across the region. These concerns relate to:

(a) The coarseness of the management units and inherent variability amongst water bodies within each management unit.

(b) The imperfect nature of indicators used, which in some cases are novel and lacking widespread use or understanding and for which national guidance are only beginning to be developed.

(c) Numeric criteria being set for some water bodies as long term goals and originating from a different regulatory context (pre NPSFM in the NRRP).

(d) The inherent spatial and temporal variability in waterway condition, for which short term aberrations do not result in long-term changes.

5.2 For these reasons, applying the outcomes in terms of overall condition or averages within the scale of catchments or zones is an appropriate and pragmatic approach for these interim criteria.

5.3 Policy 4.11(c)(v) could be reworded to describe expectations that discharges will not result in groundwater exceeding drinking water standards for health based and aesthetic based criteria.