IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of a submission and further submissions by **TrustPower Limited** on the **Proposed Canterbury Land and Water Regional Plan**

STATEMENT OF EVIDENCE BY GREGORY IAN RYDER
ON BEHALF OF TRUSTPOWER LIMITED

1. INTRODUCTION

1.1 My full name is Gregory Ian Ryder.

1.2 I am a Director of Ryder Consulting Limited ("**Ryder Consulting**"), an environmental consulting business with offices in Tauranga, Christchurch and Dunedin. Prior to this, I held positions at the Otago Regional Council and the University of Otago.

1.3 I am a water quality scientist and aquatic ecologist and hold BSc (First Class Honours) (1984) and PhD (1989) degrees in Zoology from the University of Otago.

1.4 For approximately 25 years, I have conducted a wide variety of studies on freshwater ecology and water quality throughout New Zealand. I have been project manager for major studies on New Zealand river ecosystems and have had a lead role in a number of multidisciplinary studies involving aquatic and terrestrial ecosystems. Regional councils and government departments have engaged me to peer review environmental studies and resource consent applications, and I have held the position of an independent commissioner on a number of major resource consent hearings associated with marine farms, ski-field development, water abstractions and wastewater discharges.

1.5 In 1995 I designed, and for a number of years ran, Environment Southland's State of the Environment Freshwater Monitoring Programme

and I am currently engaged to analyse the data generated by this programme since monitoring commenced in the mid-1990s. I have assisted both Environment Southland and Otago Regional Council in developing their respective regional water plans, and was the principal author in developing water quality standards for Southland's Draft Regional Water Plan (Ryder 2004).

1.6 I am familiar with surface waters of the Canterbury region and have undertaken assessments in the Ashburton, Hakataramea, Rakaia, Rangitata and Waimakariri catchments. This work includes assessments of water quality and surveys of benthic ecology (e.g., macroinvertebrates and periphyton) and fish habitat in relation to abstractions and discharges.

1.7 I have read the Code of Conduct for Expert Witnesses (Rule 330A, High Court Rules and Environment Court Practice Note) and I agree to comply with it. I have complied with it in the preparation of this statement of evidence.

1.8 SCOPE OF EVIDENCE

1.9 I have been asked by TrustPower to prepare evidence in relation to its submission on the Proposed Canterbury Land and Water Regional Plan ("**Plan**").

1.10 In my evidence I discuss the water quality outcomes presented in Tables 1a and 1b of the Plan and how they would apply to the Rakaia River and Lake Coleridge in relation to the operation of TrustPower's Coleridge Hydroelectric Power Scheme ("**Coleridge HEPS**").

2. TABLE 1A OUTCOMES FOR CANTERBURY RIVERS

2.1 Desired outcomes for Canterbury rivers under the Plan are presented in Table 1a. The outcomes in Table 1a are largely the same as Table WQL5 of the Canterbury National Resources Regional Plan (NRRP), and all outcomes for lower and upland alpine river management units, which includes the Rakaia River, remain unchanged. Table 1a includes seven outcomes that relate to all river management units, these are:

(i) Toxin producing cyanobacteria shall not render the river unsuitable for recreation or animal drinking water.

(ii) Fish shall not be rendered unsuitable for human consumption by contaminants in a river.

(iii) The natural colour of the water in a river shall not be altered.

(iv) Natural frequency of hapua, coastal lake, lagoon and river openings is not altered.

(v) Passage for migratory fish species is maintained unless restrictions are required to protect populations of native fish.

(vi) Natural continuity of river flow is maintained from source to sea, without reaches being induced to run dry.

(vii) Variability of flows, including floods and freshes, avoids "flat-lining", enables fish passage and mobilises bed material.

2.2 It is my opinion that the wording in outcomes (iii), (iv) and (vi) is such that they will be problematic to apply. The wordings are qualitative and therefore require a subjective assessment to determine whether the outcomes are achieved (in contrast to the quantitative outcomes in Table 1a, which have a specific reference value for comparison). In addition, some of the phrases used in these narrative outcomes are poorly defined. For example, reference is made to the 'natural colour' of the water and 'natural frequency' of river openings with no explanation of what the 'natural' baseline is.

2.3 These issues are of particular relevance to the operation of the Coleridge and Highbank hydro-electric power schemes, which both have generation tailrace discharges into the Rakaia River. These schemes could be considered to have altered the 'natural' condition of the river, depending on how it is defined, and at times, operation of theses schemes within their consented regime may alter, for example, the water colour in the Rakaia River outside of the allowed mixing zone[1] defined in Schedule 5 of the Plan (especially if the discharge is to a small braid of the river). However, it is not clear from the Table 1a outcomes if the natural reference condition is that which existed prior to the development of

[1] "*For river and artificial watercourse locations with flowing water present at all times; (i) no longer than 200 m along the longest axis of the zone, and (ii) occupies no greater than two-thirds of the wetted channel width at the estimated 7DMALF for that location; …*"

these schemes, the consented scheme's operating regime, or some other baseline.

2.4 Given the lack of clear definitions, and the subjective assessment required to apply the qualitative outcomes, I support the TrustPower submission that the qualitative outcomes (iii), (iv) and (vi) listed in Table 1a be removed, unless their meaning is explained more explicitly. In this respect, I recommend that "*natural colour*" be defined in the Plan, to indicate when the definition is to apply from (e.g., from date the Plan is made operative). Similarly, defining "*natural frequency of hapua, coastal lake and river openings*" is something that I consider requires a rigorous definition in terms of what "natural frequency" is and over what period of time this is to be determined. In my opinion, in the absence of historic data, natural frequency may need to include the potential effects of abstractions and discharges to rivers that have occurred for many decades. For example, the Rakaia River receives major discharges of water from the Coleridge and Highbank power stations (Coleridge was commissioned in 1914), and flows in the lower Waitaki River have been strongly influenced by the operation of the Waitaki Dam (built in the 1930s) and by large impoundments in the upper catchment. In these cases, there is no useful information on what constitutes the natural water colour and river openings, prior to the development of this infrastructure.

2.5 The quantitative outcomes in Table 1a are more straightforward to apply than the qualitative outcomes, in that a reference value is available for comparison. However some outcomes (e.g., QMCI,[2] dissolved oxygen, temperature) do not provide for natural variability or have no lasting effects on aquatic communities. For example, the ecological health indicator outcome for a maximum water temperature of 20°C does not allow for the temperature to exceed 20°C in the river at any time or location. Temperatures exceeding 20°C are likely to be experienced for short periods in many Canterbury rivers during warm, dry weather, especially in the smaller channels of braided rivers. The temperature outcome would more effectively allow for normal temperature variability if it referred to the maximum <u>average daily</u> temperature during summer (December-February). Likewise dissolved oxygen and QMCI scores may

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[2] QMCI = quantitative macroinvertebrate community index. An index of the heath of benthic invertebrate communities in stony bed rivers.

on occasion vary naturally outside the minimum outcomes in Table 1a. Reference to an average or median value would therefore also be more appropriate for these indicators to account for natural variation. Further I recommend the adoption of a provision in the Table 1a that allows for changes in QMCI scores between Management Units by up to 20%. This approach has been supported by other scientists because it acknowledges that health indices like QMCI scores vary naturally over time and space, and a 20% change is able to be tested statistically with an acceptable level of effort (Stark 2010).

2.6 Quantitative outcomes for filamentous algae >20 mm in length (maximum cover of bed) in lower and upland alpine rivers are lower than New Zealand periphyton guideline values (Biggs, 2000) and are likely to be exceeded naturally in minor braids and seepages of braided rivers during warm, dry weather conditions and under stable flow conditions. The outcomes would therefore benefit from clarification of the location in rivers where periphyton indicators (and also other indicators in general) are to be achieved (e.g., in main channels only). This could be addressed by including a statement that the outcome relates to primary and secondary braids only.

2.7 I also think it is important to note in Table 1a that the percentage cover values for periphyton are to apply to the part of the bed that can be seen from the bank during summer low flows (usually <0.75 m deep) or walked on. Also, the biomass guidelines should be expressed in terms of biomass per unit of exposed substrata (i.e., tops and sides of stones) averaged across the full width of the stream or river in a reach. These important points of clarification come straight out of the MfE periphyton guideline document (Biggs 2000), upon which the Table 1a indicators are based, and can strongly affect how periphyton biomass and cover are monitored and interpreted.

2.8 Periphyton indicators in Table 1a are based in part on periphyton guideline values (Biggs, 2000), which were developed prior to the introduction of the nuisance algae Didymo (*Didymosphenia geminata*) to New Zealand. A recent review of the periphyton guidelines observed that Didymo does not appear to respond to some environmental variables in the same manner as other common periphyton species, and consequently the authors stated that the periphyton risk assessment tool developed as part of their review did not apply in Didymo infested

watercourses (Matheson *et al.,* 2012). The chlorophyll *a* outcomes in Table 1a are likely to be exceeded in rivers where Didymo is well established and therefore should not be applicable in this situation. I would recommend that Table 1a includes a caveat associated with the 'Periphyton indicators' part stating that the chlorophyll *a* component does not apply in Didymo-infested waters.

3. TABLE 1B OUTCOMES FOR CANTERBURY LAKES

3.1 Desired outcomes for Canterbury lakes under the Plan are presented in Table 1b. An indication of visual quality is to be provided though a colour outcome, which states, "*The natural colour of the lake is not altered by more than five Munsell Units.*" The outcome relates to all lake management units except 'natural state' lakes, which are to be " … *maintained in a natural state*".

3.2 The outcome to be applied to 'large high country lakes', which includes Lake Coleridge, refers to the natural colour of the lake. However, an explanation of what constitutes natural colour is not provided. Therefore, in relation to Lake Coleridge, it is not clear if this refers to the colour of the lake prior to the Coleridge HEPS or the colour under the existing operation of the HEPS. If it were to apply to the lake prior to receiving flow diversions from the Harper and Wilberforce rivers, it would be difficult to accurately determine what this might be in terms of Munsell colour units as there is no historic information on lake colour (as expressed in this way).

3.3 The water quality standards table in Schedule 5 has the requirement that colour change in large high country lakes shall not exceed 5% (measured in Munsell units). Again, however, it is not clear what baseline this change is to be measured against, particularly in relation to the Coleridge HEPS where there is an existing discharge to the head of a lake and therefore no reference location (e.g., like an upstream control) for comparison.

3.4 The need to clarify in the Plan the baseline against which changes are to be measured against is an important point as it is generally recognised that the diversions of turbid waters from the Harper and Wilberforce rivers into Lake Coleridge (via the Harper and Oakden canals) for the HEPS have led to a reduction in the clarity of the lake water (eg Biggs *et al*.,

1987). A study by Schwarz *et al.* (1994) supports the view of Biggs *et al.* (1987) that the impact of increasing the load of sediment to Lake Coleridge via the HEPS diversion has impacted on the lake's appearance. This has predominantly been by increasing the brightness of the water, reducing the clarity, and, at high sediment concentrations, changing the colour from blue-green towards blue-grey.

3.5 Although it is accepted that diversions associated with the Coleridge HEPS have altered water colour in Lake Coleridge there has been no regular monitoring from which to determine the magnitude of any colour changes. A single measurement of colour was made in the lake in 1997 using the Munsell method (Davies-Colley *et al.,* 1997), and Environment Canterbury's Lake Coleridge water quality monitoring does not include colour measurement, although observations of colour are sometimes made.

3.6 In the absence of any existing information on Munsell unit colour changes in Lake Coleridge, the Ministry for the Environment (1994) guidelines for colour and clarity provide some direction by indicating that a colour change from blue-green (Munsell No. 50) to bluish-green (Munsell No. 55) would be equivalent to a five point change in Munsell units. Based on this guideline interpretation, the observed change of colour in Lake Coleridge at higher sediment inflow concentrations from blue-green towards blue-grey is likely to exceed the five unit threshold under the Plan outcome.

3.7 Existing consents for the Harper and Oakden canals have no mixing zone provisions, however if these diversions were to be consented under the Plan provisions, Schedule 5 requires that the mixing zone[3] would be a circle with a diameter of 50 m from the lake water edge. Colour changes as a result of the Coleridge HEPS diversions have been observed extending well out into the lake. The Table 1b outcomes (change not more than 5 Munsell units) and Schedule 5 standards (change shall not exceed 5%) are therefore highly likely to be exceeded on occasions under the existing operation of the Coleridge HEPS, particularly at the northern end of the lake.

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[3] The area and underlying volume where the standards in Schedule 5 do not have to be met.

3.8 The diversions to Lake Coleridge have been in existence for many years now and I am not aware of any evidence to suggest that colour is degrading over time. Therefore, in the absence of any explanation as to what constitutes Lake Coleridge's natural colour, and also a lack of previous Munsell unit measurements of lake colour, I support TrustPower's submission that the colour outcome in Table 1b be amended to refer to lake colour as it is under current operation of the Coleridge HEPS. I recommend that the lake's water colour be assessed at the time plan becomes operative (i.e., over representative sections of the entire lake and to account for possible seasonal effects). I realise this may not be a satisfactory approach, but I see no other way of setting a realistic benchmark.

3.9 I also suggest that reference to the Munsell unit[4] in Table 1b and Schedule 5 of the Plan be clarified as referring to just hue and not value and/or chroma. Hue is usually the most important aspect of colour, but it is not specifically explained that this is the aspect of colour that the Plan outcomes and standards relate to. I suggest the following wording: "*The colour of the lake is not altered by more than five Munsell Hue Units from that which existed at the time this Plan became operative*".

4. SECTION 42A REPORT

4.1 I have reviewed Section 3.3 (Water Quality States) and the technical memorandum in Appendix 1 of the Section 42A report, which are both relevant to Tables 1a and b. The Section 42A report recommends that Tables 1a and 1b be retained with some minor amendments.

4.2 Section 3.3 summarises the changes sought by a variety of submitters, however in my review of this section I find no specific reference to the issues covered in the TrustPower submission that I have discussed in my evidence, or to the changes sought.

4.3 The Appendix 1 memorandum prepared by Dr Adrian Meredith (Principal Water Quality Scientist, Environment Canterbury) summarises the findings of his review of the Tables 1a and b submissions. However, again no reference is made to the specific issues raised in the TrustPower submission.

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[4] The Munsell colour system specifies colours based on three colour dimensions: hue, value (lightness), and chroma (colour purity).

4.4 Dr Meredith suggests that some submitters have failed to identify that Tables 1a and b are 'outcomes' for Canterbury rivers and lakes and are not intended as water quality guidelines or standards that set numerical limits at specific points as for consent compliance purposes. However, he goes on to say that deletion of Tables 1a and b (as requested by some submitters) would leave the Plan without a context of measureable outcomes to be achieved over the life of the Plan.

4.5 I have identified in my evidence several reasons why I consider the values in Tables 1a and b as they currently stand are not appropriate as measurable outcomes for the Rakaia River and Lake Coleridge, including the subjective assessment required for qualitative outcomes and the lack of a definition of a baseline against which to measure existing discharges. In recommending that Tables 1a and b be retained without amendment, the Section 42A report provides no resolution to these issues.

5. CONCLUSION

5.1 It is my opinion that some of the outcomes in Tables 1a and 1b of the Plan lack sufficient clarification and this will result in difficulties in applying them to 'real-world' situations. The wording is qualitative and therefore requires a subjective assessment to determine whether outcomes are achieved. There is a lack of clarification on how 'natural' is to be interpreted, particularly in relation to abstractions and discharges that have been in place for many years, and I have suggested some additional wording to address this for some water quality attributes.

Greg Ryder
4 February 2013

6. REFERENCES

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