in the matter of:	the Resource Management Act 1991
and:	submissions and further submissions in relation to proposed variation 1 to the proposed Canterbury Land and Water Regional Plan
and:	**Central Plains Water Limited** *Submitter*

Statement of evidence of Dr Gregory Ryder (ecology)

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STATEMENT OF EVIDENCE OF DR GREG RYDER

INTRODUCTION

1 My full name is Gregory Ian Ryder.

2 I am a water quality scientist and aquatic ecologist, and currently a Director of Ryder Consulting Limited, an environmental consulting business with offices in Tauranga, Christchurch and Dunedin. I have held this position for 20 years. Prior to this, I held positions at the Otago Regional Council and the University of Otago.

3 I have hold BSc. (First Class Honours) (1984) and PhD. (1989) degrees in Zoology from the University of Otago.

4 I have been involved with a wide variety of studies on freshwater ecology and water quality throughout New Zealand for over 25 years. I have assisted councils in developing and undertaking local and regional surface water monitoring programmes. I have previously been engaged by owners, regional councils and government departments to provide ecological assessments of a number of existing and proposed irrigation and hydro-electric power schemes throughout New Zealand. I have held the position of an independent commissioner on a number of major resource consent hearings associated with abstraction, irrigation, marine farms, ski-field development and wastewater discharges.

5 Between 2011 and 2013 I was engaged by Environment Southland to assist them with investigations and project coordination with the Waituna Lagoon catchment, an intensively farmed catchment that faces similar water quality issues to those found in the Te Waihora/Ellesmere catchment. This work included acting as chairman of the Waituna Catchment Technical Group, analysing and reviewing water quality data, and editing and formatting an ecological guidelines document for Waituna Lagoon. As with Te Waihora/Ellesmere, Waituna Lagoon is an intermittently closed and open lake or lagoon (ICOLL) and many of the modelling approaches used in Waituna investigations were similar to those used in the Te Waihora/Ellesmere investigations.

6 In preparing my evidence I have reviewed the technical information relating to the Environment Canterbury assessment of aquatic ecology impacts, which is contained within the following reports; Burrell 2011 (ecological flow requirements), Clark 2014 (surface water quantity), Golder 2014 (ecology), Kelly 2014 (surface water quality and ecology) and Norton *et al.* 2014 (lake).

7 I have also read relevant parts of the Officers section 42A Report prepared by McCallum-Clark *et al*. (2014).

SCOPE OF EVIDENCE

8 I have been asked by Central Plains Water Limited (CPW) to provide ecological advice and associated evidence on proposed Variation 1 (*Variation 1*) to the proposed Canterbury Land and Water Regional Plan (*pLWRP*). My evidence focuses on the following aspects associated with the Te Waihora/Lake Ellesmere catchment:

8.1 effects of flow changes on aquatic ecology in lowland waterways; and

8.2 Environment Canterbury's assessment of effects on aquatic ecology.

9 Although this is a Council hearing, I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2011. I have complied with the Code of Conduct in preparing this evidence and I agree to comply with it while giving oral evidence before the hearing committee. Except where I state that I am relying on the evidence of another person, this written evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

BACKGROUND

10 Technical information supporting and informing the Variation 1 planning process was provided by Environment Canterbury in a high level overview report (Robson 2014), 10 technical reports covering modelling and assessment work, and a compendium of supplementary technical information. The high level overview report outlined the planning process for setting nutrient, flow and allocation 'limits' for the Selwyn Waihora catchment. Recommended limits now form part of Variation 1 (and are to be included as Selwyn Waihora regional chapter of the pLWRP).

11 The technical work behind Variation 1 was guided by the priority outcomes identified by the Selwyn Waihora Zone Committee. Technical indicators were chosen against which to test outcome attainment, and models developed to test the consequences of different land use, development and water storage 'scenarios'. A final package of solutions ('Zone Committee Solutions Package') was agreed upon, and then modelled by the technical team to generate catchment limits that relate to the agreed outcomes (Robson 2014).

12 Twelve lowland streams and main drains were identified as the main surface bodies within the catchment (Robson 2014). Ten were also 'modelling points' (sites that were used as reference sites where the effects of scenarios on each of the receiving water bodies were described), and approximately 90% of the flow into Lake Ellesmere passes through the nine modelled points (excluding the Kaituna River, which is not hydrologically connected to the plains area) (Robson 2014). I note that no hill-fed streams were modelled (except the Selwyn River) as it was assumed there would be no significant abstraction and no land use change associated with these.

13 My discussion around the topics listed under paragraphs 8.1 and 8.2 is couched in relation to the potential surface water quality and ecology effects of CPW supplying water for irrigation of a further 30,000 hectares of land within the Selwyn Waihora catchment. In that respect, I have focused on the differences on the water quality and ecology outcomes anticipated in scenarios 1 and 2.

14 Scenario 1 is a baseline position with the following attributes:

14.1 assumes no change to current (2011) land use.

14.2 all flow and nutrient load effects are assumed to have arrived at the lake (i.e., after all lag times).

14.3 social and economic are assumed to be the same as current.

15 Scenario 2 has an additional 30,000 ha of irrigation (via CPW):

15.1 a surface water supply providing for 60,000 ha of irrigation. This will comprise approximately 30,000 ha of new irrigation on the plains and replacement of approximately 30,000 ha of groundwater takes with surface water (from alpine rivers).

15.2 recognises that other enterprises and land uses in the catchment will also intensify where existing nitrogen loads are less than 15 kg/N/ha. All flow and nutrient load effects are assumed to have arrived at the lake (i.e. after all lag times).

16 There is a heavy reliance on the use of models and model outputs in the development of Variation 1. Concerns have been raised by **Mr McIndoe** and **Mr Conland** in their evidence for CPW where they question a number of parameters and assumptions used in models associated with hydrology and water demand.

17 I have not attempted to dissect in detail the ramifications to surface water quality and ecology of either over-estimating or under-estimating inputs of nutrients and water to lowland streams and Te

Waihora/Ellesmere, however I have assumed that the relative differences between scenario outputs are reasonable.

18 Table 11(a) of Variation 1 sets out the freshwater outcomes to be achieved in the Selwyn Waihora catchment, Table 11(b) sets out freshwater outcomes for lakes and Tables 11(c) and 11(d) set out minimum flows for permit holders.

EFFECTS OF FLOW CHANGES ON AQUATIC ECOLOGY

Predicted flow changes

19 On behalf of Environment Canterbury, Scott and Weir (2014) and Clark (2014) present modelled predictions for surface water flows under each scenario, the difference between Scenario 1 and Scenario 2 represents changes related to water inputs from the CPW irrigation scheme.

20 Increased surface flows are observed in Scenario 2 relative to Scenario 1 as a result of the additional water being added to the catchment via irrigation (Clark 2014). I have laid out these predicted changes in Tables 1 to 3 below. A net increase to the water balance is provided, and this results in increased discharge from groundwater to the lowland streams. The additional water enters the system over the irrigation season but, due to the lag time in groundwater, the increases in surface water flows are actually seen throughout the year rather than only during the irrigation season. Both low and median flows in streams are predicted to increase (**Tables 1 and 2**), and most also have increased flow permanence (**Table 3**).

21 As a result of the CPW inputs, the Selwyn River is expected to have reductions in both the extent and duration of dry reaches, which must be regarded as a positive ecological outcome. The frequency of flushing flow events in the Selwyn River decreases slightly under Scenario 2, but this is due to the higher baseflows causing some multiple small flushing events to become one single longer duration event (Clark 2014).

Table 1 *Low flows (7-day mean annual low flow, L/s) in waterways within the Te Waihora/Lake Ellesmere catchment under Scenarios 1 and 2 (CPW). From Tables 4-1 and 4-3 of Clark (2014).*

Waterway	Scenario 1: Baseline (L/s)	Scenario 2: 30,000 ha additional irrigation (L/s)	Change under Scenario 2 compared to Scenario 1 (L/s)	Percentage increase (%)
Selwyn River at Coes Ford	288.7	905.4	+ 616.7	+ 214
Waikekewai Creek at Mouth	3.7	6.9	+ 3.2	+ 86
Harts/Birdlings Creek at Lower Lake Road	560.3	741.5	+ 181.2	+ 32
Doyleston Drain at Lake Road	0	0	0	0
Boggy Creek at Lake Road	0.3	0.5	+ 0.2	+ 67
Hanmer Road Drain at Lake Road	3.6	4.2	+ 0.6	+ 17
Irwell River at Lake Road	1.7	5.9	+ 4.2	+ 247
LII River at Pannetts Road	1050.1	1370.7	+ 320.6	+ 31
Halswell River at MacCartneys Bridge	499.7	570.0	+70.3	+ 14

Table 2 *Median flows (L/s) in waterways within the Te Waihora/Lake Ellesmere catchment under Scenarios 1 and 2 (CPW). Median flow determined from graphs in Appendix D of Scott and Weir (2014).*

Waterway	Scenario 1: Baseline (L/s)	Scenario 2: 30,000 ha additional irrigation (L/s)	Change under Scenario 2 compared to Scenario 1 (L/s)	Percentage increase (%)
Selwyn River at Coes Ford	1,000	1,890	+ 890	+ 89
Tent Burn at Brooklyns Farm	414	493	+ 79	+ 19
Waikekewai Creek at Mouth	46	62	+ 16	+ 35
Harts/Birdlings Creek at Lower Lake Road	1,430	1,570	+ 140	+ 10
Doyleston Drain at Lake Road	8	66	+ 58	+ 725
Boggy Creek at Lake Road	75	95	+ 20	+ 27
Hanmer Road Drain at Lake Road	25	32	+ 7	+ 28
Irwell River at Lake Road	2	100	+ 98	+ 4,900
LII River at Pannetts Road	1,940	2,250	+ 310	+ 16
Halswell River at MacCartneys Bridge	650	740	+ 90	+ 14

Table 3 *Flow permanence (%) in waterways within the Te Waihora/Lake Ellesmere catchment under Scenarios 1 and 2 (CPW). From Tables 4-1 and 4-3 of Clark (2014).*

Waterway	Scenario 1: Baseline (%)	Scenario 2: 30,000 ha additional irrigation (%)	Change under Scenario 2 compared to Scenario 1(%)	Percentage change (%)
Selwyn River at Coes Ford	99.5	99.9	+ 0.4	+ 0.4
Waikekewai Creek at Mouth	92.9	96.3	+ 3.4	+ 3.7
Harts/Birdlings Creek at Lower Lake Road	100	100	0	0
Doyleston Drain at Lake Road	65.6	70.7	+ 5.1	+ 7.8
Boggy Creek at Lake Road	79.4	77.5	- 1.9	- 2.4
Hanmer Road Drain at Lake Road	75	75.9	+ 0.9	+ 1.2
Irwell River at Lake Road	84.7	86.4	+ 1.7	+ 2.0
LII River at Pannetts Road	99.8	100	+ 0.2	+ 0.2
Halswell River at MacCartneys Bridge	99.7	99.7	0	0

Ecological consequences of changes in flow

22 On behalf of Environment Canterbury, Burrell (2011) investigated how ecological values (including water quality and periphyton, invertebrate, fish and bird communities) in waterways in the Te Waihora/Lake Ellesmere catchment were related to flow. Burrell (2011) found that overall, flow does influence water quality in lowland waterways, with the influence being greatest in smaller rivers or headwaters that are subject to low or intermittent flow. The sensitivity of ecological values to flow changes varied depending upon the characteristics of the waterway. Burrell (2011) categorized the waterways in the catchment, predicting how sensitive instream habitat would be to flow variation. I have summarised these findings in **Table 4**.

23 In medium-sized, deep, and predominantly soft-bottomed rivers in the lower catchment, small flow variations have little effect on wetted channel width, and therefore habitat availability in these waterways is not considered sensitive to small or moderate variations in flow (Burrell 2011). The mainstem of the Halswell River and LII River, and Harts/Birdlings Creek are in this category. I agree with this finding given the physical characteristics of these tributaries.

24 In contrast, the Selwyn River, which is also medium sized but with a broad floodplain and stony bed, is sensitive to flow variation. The Selwyn River provides high quality habitat for invertebrates and brown trout, and small changes in flow result in a relatively large change in wetted channel area and therefore habitat availability for these communities (Burrell 2011). I also agree with this finding.

25 Small streams or 'drains' with steep sides, soft bed sediments and sluggish or ephemeral flow typically provide poor habitat for stream biota and, as they already naturally experience periods of no flow, are therefore considered tolerant of further reduced flow (Burrell 2011). Clarks Drain and Greenpark Drain fit this category, although Hanmer Road Drain does not as it has a stony bed and provides trout spawning and rearing habitat.

26 Burrell (2011) reviewed three different methods for making recommendations for minimum flows in waterways in the Te Waihora/Lake Ellesmere catchment (these were Expert Panel, National Environmental Standard (NES), and habitat modelling) and concluded that existing minimum flows are low and should be increased to improve protection of ecological values. Minimum flows of approximately 70 to 90% of MALF were recommended, with smaller rivers needing a higher percentage of the MALF to protect ecological values (Burrell 2011).

27 Flow setting is typically a controversial exercise as no one method is perfect. In this instance, I largely agree with the approach taken, although it is reliant on a number of assumptions.

28 Clark (2014) calculated the natural minimum flow statistics (7 day MALF, without abstraction) for waterways in the catchment, and the percentage time that flows were below the ecological recommendation of 70 to 90% of natural MALF (**Figure 1**). I have calculated the reduction in percentage time each waterway would spend below ecological flow as a result of irrigation (Scenario 2 compared to Scenario 1) and this is shown in **Table 4**.

29 The input of CPW irrigation water (Scenario 2) results in reductions in the percentage time spent below ecological flow for all waterways (compared to Scenario 1) (Table 4). The largest improvements are seen in the medium-sized waterways, with lesser improvements in the smaller drains. Improvements in the waterways identified as 'sensitive' to flow variation range from 3 to 28% (Table 4).

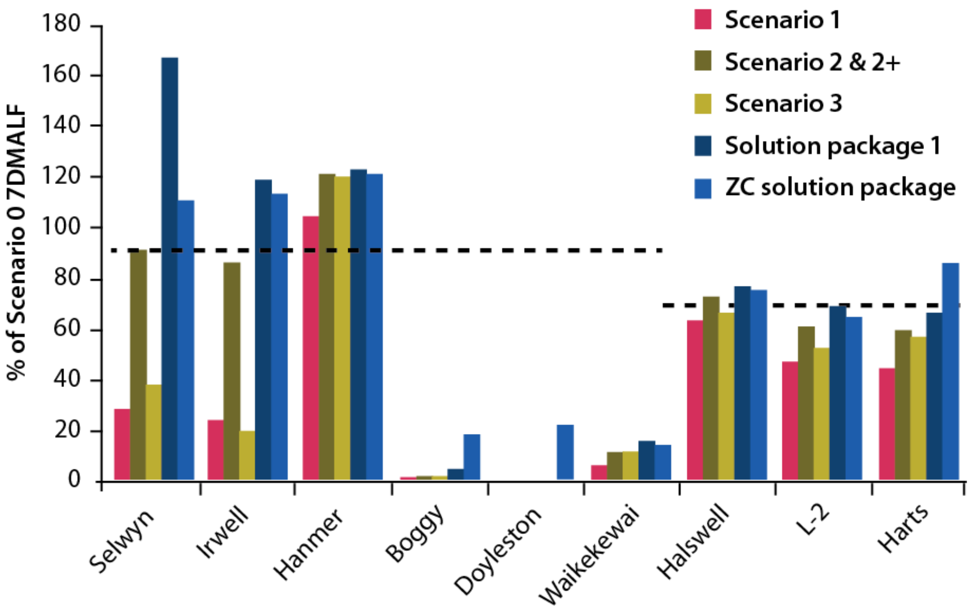

Figure 1 *Modelled 7DMALF under various scenarios and solution packages as a percentage of Scenario 0*[1] *7DMALF. Recommended ecological low flows, indicated by dashed horizontal lines, were based on Golder's (2011) rationale. Modified from Robson (2014).*

30 The most marked improvement is in the Selwyn River (28%). Burrell (2007) concluded that, for shallow rivers such as the Selwyn River, small changes in low flow in the order of ±10% of MALF generally result in minor changes in habitat availability for the most sensitive species and life stages (e.g., trout spawning and rearing). More significant flow changes (e.g., ±30% of MALF) result in correspondingly greater changes in habitat. Based on this information and my experience, I concluded that the predicted 28% reduction in time spent below the ecological flow as a result of irrigation can therefore be expected to have a positive effect on aquatic communities. An 8% reduction is predicted for the 'sensitive' Doyleston Drain and this is also expected to result in a positive effect in this drain, which has periods of intermittent flow.

[1] Scenario 0 is a modelled scenario representing flows with no abstraction in the catchment. Scenario 0 results are used to approximate natural flows (Robson 2014).

Table 4 *Characteristics and sensitivity of instream habitat to small or moderate flow variation. Table compiled from information in Burrell (2011), and in Clark (2014) Figure 5-5.*

Waterway	Characteristics	Sensitivity to flow variation	Decrease in percentage time spent below ecological flow as a result of irrigation (Scenario 2 compared to Scenario 1)
Selwyn River	Medium-sized, broad floodplain, stony-bottomed. High trout values.	Sensitive.	28
Harts/Birdlings Creek	Medium-sized, deep, predominantly soft-bottomed.	Not/minimal.	14
Doyleston Drain	Small, intermittent flow, high macrophyte cover, low dissolved oxygen, high water temperatures.	Sensitive.	8
Boggy Creek	Small, high macrophyte cover, high macrophyte cover, low dissolved oxygen, high water temperatures.	Sensitive.	4
Hanmer Road Drain	Small, steep sides, low summer flows, stony-bottomed. High water temperatures.	Sensitive.	3
Irwell River	Small, intermittent flow, high macrophyte cover, low dissolved oxygen, high water temperatures.	Sensitive.	3
LII River	Medium-sized, deep, predominantly soft-bottomed. High native fish and trout values.	Not/minimal.	11
Halswell River	Medium-sized, deep, predominantly soft-bottomed. High native fish and trout values.	Not/minimal.	6

31 Periods of intermittent flow are characteristic of the middle reaches of the Selwyn River and the headwaters of the Halswell and LII Rivers (Burrell 2011). Flow permanence has been shown to impact fish diversity and abundance in the Selwyn River, with an increase of 1.9 invertebrate taxa per m^2 and 0.3 fish species having been associated with every 10% increase in flow permanence. Increased flows also provide greater opportunities for migratory fish to move upstream and downstream.

32 Clark (2014) predicts that inputs from the CPW irrigation scheme will increase flow permanence in the Selwyn River at Coes Ford by 0.4%, and in other waterways predicted changes range from -2.4 to 7.8% (Table 3). Clark's (2014) predictions are however for actual node points, and do not represent conditions upstream or downstream of these sites. However, the information can be used to predict the direction of change in the extent and duration of stream drying (Golder 2014). Under CPW (Scenario 2), groundwater levels and stream flows are greater and river drying is more likely to

approximate natural conditions. Also, due to improved passage opportunities, longfin eel, brown trout and other migratory fish species numbers are predicted to increase in the Selwyn River headwaters.

33 In summary, as some of the modelled flow changes described above are quite minor in magnitude and questionable in terms of being able to quantify the improvement to the associated individual waterway's ecosystem, I think it is more appropriate to consider the overall predicted improvement in surface flow character within the catchment. This is because there is a degree of uncertainty associated with how subsurface and groundwater flows will behave within some individual catchments. On that basis, I consider the net effect of CPW on flows is likely to be largely positive for aquatic ecology in lowland waterways.

ENVIRONMENT CANTERBURY'S ASSESSMENT OF EFFECTS ON AQUATIC ECOLOGY

Stream water quality and ecology

34 A catchment model was developed by Environment Canterbury and used by Kelly (2014) to predict effects of the different land use scenarios on stream dissolved nutrient concentrations and therefore on aquatic ecology. Elevated concentrations of phosphorus and nitrate in streams can increase nuisance growths of periphyton and macrophytes, while nitrate may also be toxic to aquatic organisms at elevated levels. Results were compared to NRRP outcomes for maximum cover of macrophytes (50%) and long filamentous algae cover (30%). Hickey and Martin's (2009) guideline recommendations for nitrate-nitrogen concentrations (1.0 – 3.6 mg/L) to support various levels of aquatic biodiversity protection (80-99%) were used to assess nitrate toxicity.

35 Phosphorus was, however, not included in the catchment modelling and therefore assumptions instead had to be made for how these contaminants would impact in each scenario (Robson 2014). Assumptions regarding phosphorus were based on the understanding that groundwater is not thought to be a significant transporter of dissolved reactive phosphorus (DRP). Phosphorus levels in the lowland streams (except the Selwyn River) are a result of run off/shallow sub-surface leaching and/or drainage from proximate land use. Land use change above SH1 is therefore considered not to affect DRP concentrations in groundwater or lowland streams (Robson 2014).

36 This conclusion was supported by the observation of Robson (2014, Appendix 7) that despite increased irrigation and land use intensification over the past 10-20 years, phosphorus losses in most lowland streams in the catchment have either been constant or

marginally improved. This observation suggested that increased irrigation under CPW would also not increase phosphorus concentrations. This conclusion was tested by Environment Canterbury by modelling a range of increased DRP concentrations under Scenario 2. Kelly (2014) confirmed that increasing phosphorus loss by 10% or 25% under Scenario 2 did not increase the risk of periphyton and macrophyte growth outcomes from being achieved.

37 This is an important conclusion, as phosphorus is known to increase the risk of nuisance periphyton and macrophyte growths although relationships between P concentration and biomass of these plant forms are highly variable. I consider there is a good deal of uncertainty associated with the Environment Canterbury estimates of nutrients (both N and P) in surface waters under the various land use scenarios evaluated and also how these might influence plant growth.

38 However, it is arguable that focusing just on nutrients to manage plant growths is too simplistic and I consider this reflected in Variation 1 through acknowledgement of the need to employ a range of management tools to achieve freshwater outcomes in the catchment. For example, sediment deposition and riparian shading also affect plant growth in streams (Booker and Snelder 2012). Policy 11.4.19 of Variation 1 reflects this through its wording: "*Enable catchment restoration activities that protect springheads, protect, establish or enhance plant riparian margins, create restore or enhance wetlands and target removal of macrophytes or fine sediment from waterways.*".

39 Freshwater outcomes for streams and rivers are included in Table 11(a) of Variation 1, and I consider the periphyton and macrophyte indicators for the various streams in the Selwyn Waihora catchment are appropriate albeit relatively onerous for some waters. No 'outcomes' or limits are proposed for nutrients (either N or P), however, this is not necessary in my opinion if the ecological outcomes for invertebrate communities, macrophytes, periphyton and general water quality are met. This approach is similar to the one I recommended to Environment Southland in developing its regional water plan (Ryder 2004).

40 In summary, regardless of whether or not the technical assessments associated with Variation 1 accurately predict nutrient concentrations in streams and rivers of the Selwyn Waihora catchment, CPW is not expected to provide a significantly greater contribution of P to surface waters and, further, in my opinion, the proposed freshwater outcomes for rivers and streams (Table 11(a)) are relatively conservative from an ecological stand point given the dominance of agriculture as a land use activity.

41 While phosphorus limits (either as concentration limits in waters or loads from the land) do not form part of Variation 1, the need to manage phosphorus is inferred. Paragraph 11.33 of the s42a report states: "*As a matter of practicality, the Variation does differentiate the management of nitrogen and phosphorus, due to the tools and techniques for nitrogen leaching estimation being more developed. Phosphorus management is primarily through exclusion of stock from waterways, the actions in Schedule 24 and a number of the non-regulatory actions. Over time, particularly with the development of good management practice loss rates, phosphorous loss estimation is likely to be improved.*". Schedule 24 relates to Farm Practices and includes nutrient management, irrigation management, intensive winter grazing, cultivation and the collection of animal effluent.

Te Waihora/Ellesmere

42 Variation 1 seeks to improve the water quality and ecological state of Te Waihora (and Muriwai/Coopers Lagoon), and lists a number of freshwater outcomes in Table 11(b). Arguably, the most controversial of these are the proposed TLI outcomes of 6.6 (mid lake) and 6.0 (lake margins). Currently, the annual average TLI for Te Waihora is 6.8 mid-lake (hypertrophic) and this is predicted to increase with the nutrient load still to come from current land use. Given the TLI scale can range from between less than 1 (very low nutrients – ultra-microtrophic) to more than 7 (very high nutrients - hypertrophic), the proposed improvement in lake trophic state under Variation 1 is relatively modest.

43 However, achievement of a much lower TLI is not necessarily a practical outcome to aim for in the case of Te Waihora. As pointed out by Schallenberg (2013), reliance on water quality indicators such as TLI for ICOLLs should proceed with caution as undesirable outcomes, such as macroalgae blooms, can in fact result in lower TLI scores indicative of a more healthy trophic state than is the case. Further, in his peer review of the Environment Canterbury lake modelling (Norton *et al.* 2014), Schallenberg (2014) expressed concern that the use of the TLI approach and its variant TLI3 may not be the most useful indicator to monitor or to set targets for a (shallow) lake like Te Waihora. He based this concern on the influence that wind-driven sediment re-suspension has on TLI variables.

44 Consequently, I think it is wise not to get too 'hung up' on the TLI outcome proposed under Variation 1 except to note that it is a step in the right direction in terms of halting the decline in the ecological state of Te Waihora.

45 It is my understanding that CPW intends to work towards meeting the 6.0 and 6.6 TLI regime proposed for Te Waihora under Variation

1. To achieve a TLI score indicative of a less eutrophic state would require significant reductions in the N and P loads to the lake. Norton *et al.* (2014) predicted that a 50% decrease in the current load of both nitrogen and phosphorus is required to improve water quality sufficiently to achieve a TLI score of 6.0. As I stated in paragraph 46, while the proposed TLI outcome is relatively modest, I note that the lake currently supports productive fisheries and large bird populations, and there is no regular severe oxygen depletion (Gibbs and Norton 2013). Therefore, there is no reason why these desirable attributes should not continue with TLIs ranging between 6.0 and 6.6. In my opinion, maintaining these readily identifiable ecological attributes is more important than meeting a generic water quality index score.

46 To achieve the TLI outcome of 6.0-6.6 will also require successful implementation of lake intervention measures (i.e., a lake level and opening management structure, P-inactivation measures, macrophyte bed and marginal wetland restoration, and construction of floating wetlands). Together, in my opinion, the ecological benefits of these interventions are greater than just achieving a reduced TLI through nutrient reduction.

CONCLUSION

47 Enabling the CPW Scheme will have benefits for stream flows and flow permanence, which will have positive effects for fish and invertebrate communities. However, I understand that this outcome is reliant on CPW being fully developed and the flow benefits to individual streams may vary depending on how CPW water is distributed throughout the wider Selwyn Waihora catchment. The Scheme is relatively neutral in terms of effects on phosphorus loads to surface waters and will increase nitrogen loads to streams and Te Waihora/Ellesmere.

48 CPW on its own is unlikely to improve the ecological health of Te Waihora/Ellesmere, however I do not consider it appropriate to view these potential adverse effects in isolation without giving wider consideration to the components of the plan change and the Zone Committee process and associated Solutions Package.

49 In this regard, it is important to acknowledge that Variation 1 will not of itself achieve the outcomes sought by the Zone Committee, in particular the freshwater outcomes of Tables 11(a) and 11(b). This is acknowledged in the section 42A report at paragraph 4.81. The section 42A report goes on to identify the following non-regulatory interventions as being particularly important in achieving the outcomes sought with the plan change, including the reduced TLI outcome for the lake:

49.1 lake rehabilitation interventions (including managing legacy phosphorus, improved lake-control management, floating wetlands, macrophyte restoration and lake-margin wetlands);

49.2 waterway interventions (including effective riparian margins on streams and drains; sediment removal; improved drain management);

49.3 catchment interventions (including wetland protection and enhancement; sediment retention dams; and potentially targeted stream augmentation and broader-scale managed aquifer recharge (MAR) in the upper/mid plains(both of which could only be delivered by CPW); and

49.4 the actual development of the Central Plains Scheme (providing new irrigation, allowing replacement of current groundwater takes on 30,000ha; and potentially providing alpine water for targeted stream augmentation and MAR).

50 Thus, to tease out the potential effects of CPW on surface water quality and ecology in the Selwyn Waihora catchment requires an assessment of all regulatory and non-regulatory mechanisms.

Dated 29 August 2014

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Gregory Ian Ryder

REFERENCES

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

Burrell, G. 2011. Te Waihora/Lake Ellesmere Catchment: Ecological Values and Flow Requirements. Report prepared for Environment Canterbury by Golder Associates. Report No. R11/124

Clark, D. 2014. Technical report to support the water quality and water quantity limit setting process in the Selwyn Waihora catchment. Predicting consequences of future scenarios: Surface water quantity. Environment Canterbury Technical Report.

Environment Canterbury. 2014. Proposed Variation 1 to the proposed Canterbury Land and Water Regional Plan: Section 32 Evaluation Report. Environment Canterbury Report No. R14/6. February 2014.

Gibbs, M. and Norton, N. 2013. Te Waihora/Lake Ellesmere: Water quality remediation and ecosystem restoration opportunities. CHC2012-138, NIWA report prepared for Environment Canterbury.

Golder Associates. 2014. Technical report to support water quality and water quantity limit setting process in Selwyn Waihora catchment. Predicting consequences of future scenarios: Ecology. Report prepared for Environment Canterbury by Golder Associates. Report number 0978110119_008_R_Rev0.

Kelly, D.W. 2014. Technical report to support water quality and water quantity limit setting process in Selwyn-Waihora catchment. Predicting consequences of future scenarios: surface water quality and ecology in lowland streams. Environment Canterbury Technical Report No. R14/13. February 2014.

Larned, S. and Schallenberg, M. 2006. Constraints on phytoplankton production in Lake Ellesmere/ Te Waihora. Environment Canterbury Technical Report No. U06/38. 37pp.

Norton N., Allan M., Hamilton D., Horell G., Sutherland D. and Meredith A. 2014. Technical report to support the Limit Setting Process in the Selwyn Waihora catchment. Predicting consequences of future scenarios: Te Waihora/Lake Ellesmere. Report prepared for Environment Canterbury by NIWA. Report number CHC2012-141.

Robson, M. 2014. Technical report to support water quality and water quantity limit setting process in Selwyn Waihora catchment. Predicting consequences of future scenarios: Overview Report. Environment Canterbury Technical Report.

Ryder, G.I. 2004. Environment Southland□water quality and the Draft Regional Water Plan: An examination of possible water quality standards. Prepared for Environment Southland.

Schallenberg, M. 2013. Nutrient loading thresholds relevant to Te Waihora/Lake Ellesmere. Appendix D to Norten *et al*. (2014).

Schallenberg, M. 2014. Appendix E to Norten *et al*. (2014). Peer review by Dr Marc Schallenberg.