BEFORE THE CANTERBURY REGIONAL COUNCIL

UNDER	the Environment Canterbury (Temporary Commissioners and Improved Water Management) Act 2010
AND	
IN THE MATTER	of the Proposed Waiau Hurunui River Regional Plan

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EVIDENCE OF BRENT COWIE

ON BEHALF OF TE RŪNANGA O KAIKŌURA, TE NGĀI TŪĀHURIRI RUNANGA AND TE RŪNANGA O NGĀI TAHU INCLUDING NGĀI TAHU PROPERTIES LTD

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1. HE KUPU WHAKATAKI - INTRODUCTION

1.1 My full name is **Brent Cowie**. I hold the degrees of Bachelor of Science with Honours and a Doctorate of Philosophy in Zoology from the University of Canterbury, where I specialised in freshwater biology.

1.2 My doctorate thesis was on the ecology of stream invertebrate communities in a West Coast beech forest ecosystem. I studied both fresh water quality and fisheries while at University. I have authored or co-authored seven publications in peer reviewed scientific journals.

1.3 I have 30 years experience in resource management in New Zealand. I have worked as a private consultant, as a Fisheries and Wildlife Consultant for the former North Canterbury Catchment Board, as a Scientist for the Water and Soil Directorate of the former Ministry of Works and Development, and as a Senior Analyst for the Ministry for the Environment. I was Group Manager Resources at the Manawatu-Wanganui Regional Council from September 1989 to June 2001. In this role I was responsible for all the resource management functions of the Regional Council.

1.4 In 1997 I was the NZ representative on an International OECD team that undertook an Environmental Performance Review of Australia. Such reviews are undertaken of each OECD country about every 5-10 years. I was responsible for reporting on land, water and coastal management.

1.5 Since 2001 I have been a resource management consultant. In that role I have undertaken numerous technical tasks and hearing commissioner roles.

1.6 The technical roles have included: preparing a monitoring and reporting strategy for the Dairying and Clean Streams Accord; carrying out a review of the hearing process for the proposed TrustPower hydro scheme on the Wairau River; carrying out work on how central government, local government and industry viewed decision making on science priorities, reviewing consents processes in each of Auckland and Hawke's Bay regional councils, and being one of two reviewers of the consents processing performance of the Far North District Council.

1.7 The hearing commissioner roles have included applications for three hydro power schemes (Arnold River, Matiri River, a small scheme in Golden Bay), two water conservation order applications or variations (Oreti River, Lake Ellesmere), two major air discharges (Ravensdown Fertiliser at Hornby and Awatoto), a medium sized irrigation scheme (Rangitata South), numerous wastewater discharges (e.g. Westland Milk to the Hokitika River, Fonterra marine discharge at Clandeboye; Rangiora sewage, Kaikoura sewage) and

other large scale developments (e.g Stage 2 of the new Fonterra factory at Darfield). I have written or co-written all of the decisions on these applications.

1.8 I chaired the panel and wrote all decisions (about 6,000 of them) on Chapters 4-8 of the Canterbury Natural Resources Regional Plan (NRRP). The matters covered were water quality, water quantity, beds of lakes and rivers, wetlands and soil conservation. Accordingly I am very familiar with the current regulatory framework for resource management in the Canterbury region.

1.9 I gave expert evidence in the Environment Court on the effects of the Tongariro Power Diversion on water quality, water quantity and freshwater biota. This evidence was given on behalf of the Manawatu-Wanganui Regional Council.

1.10 I have read the code of conduct for expert witnesses set out in Environment Court practice note, and confirm that I have complied with the code in the preparation of my evidence. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

2. SCOPE OF EVIDENCE

2.1 My evidence covers:

- Ngāi Tahu Property Ltd's (NTPL) interests in the Waiau and Hurunui Catchments, including agriculture and hydro power
- The response in the officer's report to NTPL's submission
- Modelled Nitrogen Losses
- Nutrient management
- Nitrate toxicity
- Consent Duration
- Link between storage and the C block
- Minimum flows and different uses

3. SUMMARY OF POSITION

3.1 The key points in my evidence are as follows:

(i) NTPL supports many, but not all, of the officer's recommendations for changes to the Proposed Plan. In particular, further changes to Sections 10 and 11 of the rules remain necessary to ensure that NTPL does not require two consents (s9 and S14) for the use of land in Balmoral Forest for irrigation

(ii) There is a disjunction between the aims of increasing irrigation in the catchment and

managing water quality, and an assumption that part of the remedy is in managing nitrate-nitrogen discharges – none of which have been reconciled.

(iii) In addition, the plan has introduced a regime for managing water quality without assessing the costs and benefits, including the impacts on landholders who are developing properties. This approach does not achieve the purpose of the RMA, nor discharge the duties under s32, and creates an issue of natural justice.

(iv) The water quality outcomes sought for the Hurunui catchment now recommended by the officer are supported in part, but whether Schedule 1 remains necessary is questionable, particularly in regard to nitrogen.

(v) Water storage will be essential if the B and C blocks in the Waiau and Hurunui Rivers are to be used to provide reliable water for irrigation, so storage is incentivised. However, the approach in the proposed plan of making water from the C block available only once large scale storage is provided, is flawed for two reasons:

(vi) (i) The environmental effects of taking water from the C block occur irrespective of whether water is stored or not.

(vii) (ii) The plan assumes all C block water will be taken for consumptive uses so effects occur from the point of take down the length of the river. Run of the river HEP generation returns water to the river, so the effects of taking that water occur only on a discrete section of a river

4. BACKGROUND

Development of Balmoral Forest for Agriculture

4.1 Early in 2011 Mr Edwin Jansen of NTPL approached me to prepare resource consent applications to enable the conversion of Balmoral Forest to agriculture, including irrigated milking platforms, irrigated dairy support and drystock. Applications for four resource consents, along with nine certificates of compliance, were lodged with Environment Canterbury in September 2011 under the provisions of the operative NRRP, and granted as non-notified applications in February 2012.

4.2 The four resource consents are for: the storage of dairy effluent in ponds, the discharge of dairy effluent to land, the discharge of spray dairy effluent to air and the storage of hazardous chemicals (including for instance petrol, diesel and agrichemicals). All four consents are for a term of 35 years, and expire in 2047. The consents can be exercised anywhere on the property, subject to constraints relating to maintaining a 100-300m buffer zone along the margin of the Hurunui River and to boundaries with neighbours, roads, the camping ground near SH7 and the Balmoral faultline.

4.3 NTPL intends to irrigate about 7,000ha of the Balmoral property. This will be a long term

project, with gradual conversion of the forest to irrigated agriculture over about 25 years.[1] The total cost of this conversion is estimated to be about $310 million (excluding purchase of stock and Fonterra shares).

4.4 Irrigation is highly desirable for farming in this area as seasonal water deficits are high. At the nearby Culverden weather station, monthly water deficits for November to February average 55mm, 72mm, 86mm and 56mm respectively. Water storage will also be highly desirable, because run of the river irrigation from the proposed "B" allocation block from either the Waiau and/or Hurunui Rivers is not very reliable. Total storage needs on the property for the proposed land uses are estimated to be about 8-10 million cubic metres of live storage; this should provide about 98.5% reliability.

4.5 Under the NRRP the use of water for irrigation on the property complied with the rules for a permitted activity. Similarly no consent was required for the discharge of nitrate-nitrogen to land. This is because both effluent spreading and fertiliser application complied with the rule in the NRRP for concentrations of contaminants in drainage water under irrigated pasture. Using the Overseer model (as required by the NRRP) the consultancy Pattle Delamore Partners (PDP) calculated that concentrations of nitrogen in drainage water from agricultural development would be in the order of 5-9 mg/l. This is comfortably within the threshold for permitted activities under the NRRP (nitrogen in drainage water would have to exceed 16mg/l for consent to be necessary). Phosphate leaching was predicted to be negligible.

4.6 The planning regime has changed under the provisions of the Proposed Hurunui and Waiau River Regional Plan ("the Proposed Plan"). Resource consent is now needed for a restricted discretionary activity to use water for irrigation under Rule 2.3. Among matters to be considered in deciding such applications are "any effects on water quality, including whether the activity in combination with all other activities will result in the nutrient limits in Schedule 1 being exceeded". Further, depending on the interpretation of Policies 9.1 and 9.2 in the Proposed Plan, resource consent for this activity could be limited to a term of 10 years.

4.7 I note here that under the Proposed Plan resource consent also appears to be required under Rule 11.2 to enable a change of land use on Balmoral. I will return to this matter later in my evidence.

4.8 NTPL is about to lodge two resource consent applications with Environment Canterbury to provide for further development on Balmoral. Both are for restricted discretionary activities under Rule 2.3 of the Proposed Plan. These are to:

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[1] This long time frame is necessary because ETS liabilities associated with forest harvesting limit the economic rate of conversion to agriculture.

(i) Take up to 4.2m^3/s of "B" block water from the Waiau River at the Twin Bridges Intake owned and operated by the Amuri Irrigation Company Limited (AICL), and use that water to irrigate up to 5,000ha of the Balmoral property. This water will be conveyed along the existing AICL irrigation canal, which will need to have its capacity increased and be extended slightly, along the 190m RL contour to a point on the north side of Balmoral near SH7. Water will then be either gravity fed to irrigate land east of SH7, or pumped up-gradient to irrigate land below about the 220m contour on Balmoral.

(ii) Use of water for irrigation of up to 7,000ha of Balmoral.

4.9 NTPL has other long term options to provide for irrigation development of Balmoral Forest. This relies on water from the Hurunui River. These options include:

(i) Taking water from the Hurunui River and storing that water to irrigate some part of Balmoral west of about SH7. This water could either be sourced by NTPL, or could be water stored using the existing AICL consent to divert and take up to 5 m^3/s of water from the river at Mandamus for the existing Balmoral Irrigation Scheme (BIS). AICL will need to provide storage to ensure reliability of its "A" block allocation if the "C" block storage regime comes into effect on the Hurunui River, because at that point the minimum flows in the Hurunui River increase..

(ii) Taking water provided by the Hurunui Water Project (HWP). This would require HWP discharging water back to the Hurunui River to provide for an NTPL take at Mandamus. As I understand it this option is not provided for in the current HWP consent applications to take water and store it in the Waitohi catchment.

(iii) Constructing a dam in the upper Mandamus or Glenrae catchments to provide storage, with water released down the river to be taken at Mandamus. This would be an application for a non-complying activity under Rule 4.1 of the Proposed Plan, This proposal is only in the pre-feasibility stage.

(iv) Taking water at Mandamus and replenishing the Hurunui River via a "water swap" of up to about 2 m^3/s sourced from the Waiau River. The Proposed Plan does not provide for this option, and at present it appears to be a prohibited activity under Rule 5.2. NTPL did not submit to provide for such an option.

(v) I note for completeness here that groundwater yields in and around Balmoral are much too low to provide a reliable source of water for irrigation

Hydro Power Schemes on the Waiau and Hurunui Rivers

4.10 NTPL are joint applicants with Meridian Energy Limited for the Amuri Hydro Project, which proposes to take up to 50 m^3/s from the Waiau River at the Leslie Hills Bridge, and discharge it back to the river up to 29km downstream. NTPL has also been exploring with Meridian a Balmoral Hydro Project, which would involve a take of up to 15 m^3/s from the Hurunui River just downstream of the Mandamus River confluence and discharging this water back to the river up to 28km downstream, about 8.2 km downstream of the SH7 bridge. These proposed hydro schemes are described in the evidence of Mr Nick Eldred for Meridian.

4.11 Suffice to say that NTPL generally supports the evidence and submissions of Meridian except where they are contrary to the views of Te Rūnanga and ngā rūnanga. We also support:

- The environmental flow and allocation regimes in the Proposed Plan, with the exception of the 2 m^3/s B block gap for the Waiau River and the different minimum flows in the Hurunui River during June to August for water used for non- consumptive purposes.
- The removal of the requirement to provide at least 20 million cubic metres of storage in order to access the C block.

5. THE OFFICER'S RESPONSE TO NTPL'S SUBMISSION

5.1 In her planning report prepared for Environment Canterbury Ms White has responded to many of the submissions made by NTPL.

5.2 In general terms NTPL is satisfied that many of its concerns about the Proposed Plan have been responded to positively by the officer in her recommended changes. However, there are still some issues which are of concern to NTPL; in general around how water quality issues have been identified and the approach to managing them; and to some of the wording of specific objectives, polices and rules in the proposed plan.

5.3 The changes recommended to Objective 2 and the associated policies meet most of NTPL's main submission points Looking solely from the perspective of NTPL securing water for its development proposals, in my view it would be of greatest advantage to have Objective 2 reworded to '*avoid, remedy or mitigate adverse effects…'* as requested in NTPL's submission. However, I understand ngā rūnanga's position that in alpine rivers such as the Hurunui there should be sufficient water to provide for abstraction and avoid adverse effects on in-stream values. May be the more crucial factor is the provisions in the plan for the

allocation blocks themselves, in particular the C Block. Ms Begley will address this further in her evidence. Other recommended changes to clauses (a) to (h) of the Objective, and to Policies 2.5, 2.7, 2.8 and 2.9 are supported by NTPL.

5.4 Similarly the changes recommended to Objective 3 and its associated policies meet most of NTPL's submission points. NTPL does however think further amendments would be helpful:

(i) Objective 3(e) is very clumsy. It could be more elegantly drafted as "ensuring that native fish, salmon and trout can traverse the river from the marine environment to upstream habitats".

(ii) In Policy 3.5(e) the word "food" should be removed. What is sought to be maintained is the invertebrate community, not its "food', which is primarily periphyton in larger braided rivers. This is now correctly expressed in Policy 3.6(a).

5.5 While NTPL considers that the changes recommended to Objective 5 and its associated policies are an improvement over those in the Proposed Plan, it has ongoing reservations about the approach being advocated. These are discussed further under "Nutrient Management" below.

5.6 NTPL continues to oppose parts of Policy 6.5 as follows.

(i) The Policy should focus on irrigation, not hydro power, as hydro should not have to provide for storage. The words "where the proposal involves using water for irrigation" should be added to the start of clauses (a) (i) and (ii). This is discussed further in Section 8 below.

(ii) The last clause in Policy 6.5(c) should be deleted. NTPL will need to provide about 8-10 million cubic metres of storage to provide sufficient reliability (~98%) for irrigation on Balmoral. This will be provided in about 3-5 storage reservoirs, possibly supplemented by on-farm storage. Water levels in these reservoirs will vary greatly, and they will not be suitable for any form of multiple use.

5.7 While NTPL did not seek any change to Policy 6.11, it supports the change recommended by the officer.

5.8 NTPL remains concerned that shorter duration consents, as contemplated by Policy 9.1 may be a disincentive to the development of large infrastructure within the catchment. NTPL considers that there is no good reason to fetter the discretion of the consent authority to consider each application on a case by case basis.

5.9 However NTPL does consider the changes recommended to Policy 9.2 meet most of its specific concerns in relation to the development of Balmoral for irrigated agriculture.

5.10 NTPL remains strongly of the view expressed in its submission that it not is necessary or appropriate to link possible hydro development utilising the C block in either the Waiau or Hurunui River with the mandatory provision of storage. In this regard it adopts the legal submissions of Ms Appleyard, and the evidence of Ms Dawson, Mr Page and Mr Potts for Meridian Energy. This matter is also addressed briefly later in this evidence.

5.11 In Rule 2.5 NTPL opposed Matter of Discretion (v). It notes that if this is to be consistent it should now refer to Objective 5.1 and/or Policy 5.3, not Schedule 1. Alternatively it could simply refer to "any effects on water quality", as recommended for instance in Matter of Discretion (ii) in Rule 7.2.

5.12 NTPL also notes that there now appears to be a significant error in Rule 5.2 as redrafted by the officer. Rules 3.1 and 3.2 provide for takes from the C allocation block from the Waiau and Hurunui Rivers respectively as discretionary activities. However, as these rules are not listed in Rule 5.2, they could be inferred to be prohibited activities. Another clause (d) is necessary to exclude Rules 3.1 to 3.3 from the prohibited activity status.

5.13 NTPL continues to oppose the general framework of Rules 10 and 11. This is discussed further under the heading "Nutrient Management" in Section 6 below. In particular, the way the rules are now drafted NTPL would need two consents at different times for the same activity.

6. MODELLING OF NITROGEN LOSSES

Background

6.1 NTPL had has two sets of modelling undertaken using the "Overseer" model to predict how full development of the forest for dairy platforms and dairy support will contribute to nitrogen mass loading in the Hurunui River. These were by the consultancies Pattle Delamore Partners (PDP) and AgResearch. The results of the modelling were different, with AgResearch predicting somewhat higher nutrient losses.

6.2 PDP estimated that the full development of the forest, which comprises 6,000 ha of dairy platforms and 900 ha of dairy support (630ha of which is irrigated) at a stocking rate of 3.7 cows/ha would contribute an estimated 255 tonnes per year (t/y) of nitrogen to the river. This mass loading can be reduced by the use of nitrogen inhibitors (which NTPL will use) to 207 t/y. Wetland planting could reduce this by about another 14% to 177 t/y. With a stocking rate of 2.6 cows/ha these numbers reduce to 193, 159 and 136 t/y respectively.

6.3 AgResearch estimated that net losses of nitrogen from the Balmoral Property, once about 7,000ha are fully converted to irrigated agriculture, would be in the order of 225 – 250 t/y.

This took account of the existing estimated nitrate losses from the forest (which PDP did not) and the use of nitrogen inhibitors. My understanding is that these differences are largely due to AgResearch using a later model (Version 6) of "Overseer", which has increased predicted leaching rates of nitrogen from pasture by about 20% over previous versions.

6.4 Both PDP and AgResearch agree that phosphate leaching from the conversion of Balmoral to agriculture will be negligible. This is because the main mechanism for loss of phosphate is via overland flow to surface water bodies, and there are no surface streams in that part of Balmoral that will be converted to agriculture.

6.5 Schedule 1 of the Proposed Plan allows mass nitrogen levels to increase by 20% until 2017. The current mass loading is estimated to be 698 tonnes; a 20% increase is 140 tonnes. I note the officer recommends this now be increased to 25%, which is 175 tonnes. Either of these limits would prevent the full development of about 7,000 ha in Balmoral Forest for irrigated agriculture. Rather this would allow for irrigation of about 4,000 to 5,000 ha in Balmoral, but with no further new irrigation development elsewhere in the Hurunui catchment. This is a new regulatory requirement in the proposed plan that potentially confounds NTPL's ability to exercise the consents necessary to develop the forest for agriculture, that were granted in 2012.

6.6 It appears that the intent of the Proposed Plan is that this extra nutrient allowance would not continue past 2017. Unless there are major reductions in nutrient losses from catchments north of Balmoral, this creates major difficulties for NTPL and other potential new irrigation developments.

6.7 NTPL certainly supports Environment Canterbury's intention to work towards reducing nutrient loadings in the Pahau River, Dry Stream and St Leonard's stream catchments. With the way the Proposed Plan is presently drafted, such endeavours are essential to enable further land use change in the Hurunui catchment. However, as expressed by Ms Begley in Paragraphs 6.24 to 6.26 of her evidence, this needs to be backed up by some regulatory requirements to limit nutrient discharges from existing users. In this sense NTPL supports that part of Mr Norton officer's report which suggests that in the long term, Nutrient Discharge Allowances are necessary for all large scale farming activities in the Amuri Basin. This would put existing and new users on an equal footing.

6.8 What is evident however is that the desire of the Zone Committee to promote a further 100,000ha of irrigated agriculture from the Waiau and Hurunui rivers will be confounded by the proposed nutrient caps in the plan. Using best practise, with full spray irrigation and no run-off to surface water, full development of irrigated agriculture on less than 7,000ha is predicted to exceed the cap in the Hurunui River. While no cap is presently proposed on the

Waiau River, I understand Environment Canterbury is considering such a cap in the future.

The Officer's Recommendations

6.9 In her officer's report Ms White suggests some significant changes to how the nutrient cap would work in the Proposed Plan. In particular, in the definitions section:

- "Change of land use" now refers to an "increase greater than 10% in the long term average release" of nutrients "from the date this plan is made operative". I note that is a similar definition to the one used in the Proposed Land and Water Plan, which NTPL and Te Rūnanga O Ngāi Tahu have opposed..

- The nitrogen and phosphorous load is now proposed to be calculated as the rolling average over the last six years.

6.10 Ms White also recommends the deletion of previous Policy 5.3, which allowed for a 20% increase in nutrient discharges until 2017. A new Policy 5.3 is recommended for management of water quality in the mainstem of the Hurunui River which requires that:

(a) Periphyton biomass below the Pahau River confluence does not exceed 120 mg/m^3 and 20% cover of filamentous algae in four out of five years.
(b) Nitrate nitrogen concentration does not exceed the chronic nitrate toxicity threshold for 99% level of protection (1mgN/litre).
(c) Average annual dissolved reactive phosphorous concentrations do not exceed the current annual average (0.0044mg/l).

6.11 I note here that the first of these clauses relating to periphyton is based largely on criteria in Objective WQL1 and Table WQL 5 in the NRRP. While more conservative than Ministry for the Environment's National Guidelines, I believe this periphyton standard is broadly suitable for the lower reaches of an alpine river in the Canterbury region.

6.12 For reasons that will be explained later, if the hearing committee decides there is a need for nutrient management in the Hurunui River, I support this new recommended policy, albeit with some changes to Clauses (a) and (b).

Confusion of Recommended Rules and Duplication

6.13 Changes are also recommended to some (but not all) matters of restriction in the restricted discretionary activity rules, to refer to "effects on water quality" but not to compliance with Schedule 1. This applies for instance to the use of surface water under Rule 2.3 and use of groundwater under Rule 7.1.

6.14 Other rules however are recommended to continue to refer to compliance with Schedule 1.

These include Rules 2.4 and 11.1. Rule 11.2 contains a recommended new provision relating to nitrate and phosphate loadings.

6.15 It seems to me that the officer's recommendations are confused. Policy 5.3(a) is now outcome focused, not input (i.e. annual nutrient loadings) focused. NTPL supports this change to a focus on outcomes, although it does not entirely support the wording of this new Policy. However, as noted above, some of the rules remain input focused, as they continue to refer to compliance with Schedule 1. As will be explained later in this evidence, it is doubtful that Schedule 1 is necessary to achieve the environmental outcomes now recommended to be sought in the lower Hurunui River.

6.16 As already noted NTPL is about to apply for resource consents to use up to 7,000ha of land in Balmoral Forest for irrigation under Rule 2.3 of the Proposed Plan. The use of surface water for irrigation requires that effects on water quality be assessed. NTPL has already carried out that assessment for the full Balmoral property (see paragraphs 24-27 above),. With a total investment cost of over $300 million for the full development of irrigated agriculture on Balmoral, NTPL requires certainty that it can proceed and that it has resource consent to use all this land for irrigation.

6.17 Provided resource consent is granted under Rule 2.3, the way the recommended changes to the Plan are now drafted means that after 2017, NTPL would then require an <u>additional</u> land use consent under Rule 11.1 for effectively the same activity that it already holds consent for under Rule 2.3. In my view this is absurd, and very probably an unintended consequence of the changes recommended to the Proposed Plan.

6.18 The simplest remedy for this would be to add a new Rule in the Section 10 and 11 rules, which would make "any use of land for irrigation authorised under Rule 2.3" a permitted activity.

6.19 The alternative remedy, which would be to remove the requirement to seek consent for the use of surface water for irrigation under Rule 2.3, would be clumsy in my view. It would mean for instance that the use of water for hydro generation would require consent, while use of water for irrigation would not require such consent. Given that irrigation and hydro could develop in conjunction, this would be a perverse requirement as the effects of using water for irrigation are potentially greater than using water for hydro.

7. NUTRIENT MANAGEMENT

Nutrient Caps

7.1 The concept of capping nutrient discharges has been around in New Zealand for about 15 years. One of its primary triggers was research carried out late in the 1990's that found that water clarity in Lake Taupo would decrease from an average of about 14m to about 9m over the next 20 years unless nutrient discharges to the lake were limited.

7.2 Lakes act as nutrient sinks. Nutrients in the water column are taken up by microscopic phytoplankton which die and fall to the bed of the lake. The nutrients are then released and recycled again. This can occur because in most lakes water stays there for a long time. For instance in Lake Taupo the estimated turnover time, which is the average residence time of water in the lake, is about 11 years.

7.3 Because of this long turnover time, once a lake becomes enriched with nutrients it is very difficult to return the lake to a less enriched state. Nutrients are recycled time and again within the water column. This is not necessarily always a bad thing – provided the water does not become too nutrient enriched, lakes can support large fish and bird populations. However, particularly in very shallow windswept lakes like Te Waihora, it would take a very long time to reduce their enriched status even with reductions in nutrients from land uses because of the large volume of nutrients already in the lake sediments from past land uses, which are recycled from the lake bed, the water column and its biota.

7.4 So in lakes unless preventative action is taken to prevent further enrichment (as is the case in the catchments of Lake Taupo or many of the Rotorua lakes), remedial action is very difficult.

7.5 But in rivers, particularly gravel and cobble bedded rivers like the Hurunui and Waiau, both of which are characterised by highly variable flow regimes, there is little if any nutrient recycling. The residence time of water in a river is near instant – the water simply flows downstream rather than staying in situ for years or decades as occurs in a lake. While nutrients may be recycled as they move downstream, ultimately they will flow out to sea rather than being "captured" as they are in a lake. There is a simple remedy to almost entirely remove periphyton accumulations – the passage of freshes and floods down the river.

Water Quality in the Hurunui River

7.6 Water quality in the Hurunui River has been monitored regularly since 1988. This sampling was undertaken by NIWA as part of the National Water Quality Environment Network

Monitoring programme (NWQERN). This is most comprehensive dataset on water quality in the river.

7.7 The results of this sampling at Mandamus and the SH1 bridge were summarised by Quinn (2010). This information is presented as annual averages, which masks seasonal variation and variation within individual years. This is shown in Figure 1, attached to my evidence.

7.8 The two main sites monitored have been at Mandamus and at the SH1 bridge. Some data is also available at the SH7 bridge. Upstream of Mandamus only 1% of the catchment is developed for agriculture, so water quality is little influenced by farming practices. At SH1 26% of the upstream catchment is presently used for agriculture with water quality strongly influenced by run-off from tributaries. Indeed measurements undertaken by Environment Canterbury show that between 2005 and 2008 three watercourses draining the Amuri Basin – Dry Stream, St Leonard Stream and the Pahau River - contributed 55% of the total annual phosphate load, and 80% of the total nitrogen load at SH1 (Kelly 2010).

7.9 Data on nutrient levels and algal proliferations are influenced by a drought in 2001. This results in a number of outliers, e.g. high nutrient levels and significant algal proliferations at SH1. If this year is not taken account of, the following general trends can be seen in Figure 1:

- Dissolved Organic Nitrogen (DIN) is consistently very low at Mandamus (<0.05 g/m^3). However at SH1 it has increased since 1989 from a mean of about 0.2 g/m^3 to about 0.3 g/m^3. This increase is not statistically significant.
- Dissolved Reactive Phosphate (DRP) is consistently low at Mandamus (<0.03 g/m^3), whereas there has been a statistically significant decrease in DRP at SH1 since 2001, with current concentrations generally between about 0.02 - 0.04 g/m^3.
- There is no clear trend in periphyton abundance.

Periphyton in the Hurunui River

7.10 Periphyton is a collective term for the algae and associated organisms that live on the substrate in the beds of rivers. It is made up of three groups: filamentous green algae which grows as unsightly strands in rivers; green algae which grow on rocks and microscopic diatoms, which along with green algae give rocks their characteristic green tinge and slightly "slimy" feel. This stone surface organic layer forms a critical part of the food chain, as it is the primary food source for most macroinvertebrates present in braided rivers, such as the ubiquitous mayfly *Deleatidium spp*. Filamentous green algae can form nuisance growths during periods of sustained low flow; they reduce aesthetic values, make the bed of a river slippery to walk on, and can foul fishing tackle.

7.11 The invasive exotic diatom *Didymosphenia geminata* is present in the North Branch of the Hurunui River, where it was first recorded in 2007 (Duncan, 2007). To my knowledge "didymo" has not been recorded further down the catchment, but it must be present as at least microscopic growths.

7.12 The periphyton biomass observed in a river reflects the balance between biomass accrual and loss. Factors such as light, temperature and nutrients affect accrual rates. Biomass loss is caused by factors such as grazing by invertebrates, but more particularly, by the scouring that occurs when freshes and floods disturb the bed. Filamentous green algae are particularly susceptible to scouring by freshes. This is because their preferred habitat is slow flowing channel margins and minor braids, and higher flows remove filamentous green algae from these habitats as the water becomes more fast flowing.

7.13 The time that periphyton takes to accumulate to nuisance levels after a substantial fresh or flood is known as the accrual period. In the Hurunui River the accrual period for periphyton has not been measured. It has been estimated by Norton and Kelly (2010) to be about 7 weeks at the SH7 bridge, and this is generally consistent with other reported findings in New Zealand (e.g. Scimengour and Winterbourn 1989). The accrual period may be less at the SH1 bridge because nutrient levels are generally higher there.

7.14 Although "didymo" is present in the catchment it has not established as nuisance growths downstream of the confluence of the North and South branches. This will be because it is easily scoured from the river by freshes and floods. Growths of "didymo" only become prolific where river flows are stable, such as below lake outlets (e.g. the North Branch of the Hurunui and the Upper Buller River) and downstream of hydro dams (e.g. the lower Waitaki River).

7.15 In braided rivers with cobble beds and without strong bed armouring, freshes of about 1.5 – 3 times the median flow (FRE 1.5 - FRE3) cause movement of fine sediment and cobbles, and so reduce periphyton abundance. The larger the fresh, the more effective it is in removing periphyton accumulations. This is explicitly recognised in Objective 3c of the proposed plan, a provision that the officer recommends be reinforced in line with NTPL's submission.

7.16 The long term median flow in the Hurunui River at Mandamus is 43.8 m^3/s, so the FRE1.5 – FRE3 range is approximately 66-132 m^3/s. Under the natural flow regime in the river, mean daily flows over 130 m^3/s occur on 25 days per annum on average, whereas flows between 70 and 130 m^3/s occur on 65 days per annum. If the existing A block allocation of 6.2 m^3/s is taken into account these frequencies reduce slightly to 23 and 60 days per annum respectively. Or to put it another way, for over a quarter of the time flows in the river will

ensure the abundance of filamentous green algae is minimised. This is particularly the case in spring when monthly median flows are highest

7.17 This analysis is a little simplistic because it does not take account of seasonal factors. Periphyton accrual will be most rapid in summer, when photoperiod is longest and water temperatures highest. This is also the time when flows are lowest – the median flows are 48, 39, 29, 28 and 33 m^3/s in December through April respectively with the natural flow regime. The equivalent monthly median flows with the existing "A" block allocation are 44, 35, 26, 25 and 32 m^3/s respectively.

7.18 Again however, provided freshes of over about 70 m^3/s are retained in the river for a period of about 24h, filamentous green algae will not accrue to nuisance levels unless no natural freshes occur.

7.19 The importance of freshes and floods versus nutrient levels in controlling periphyton abundance is shown clearly by analysing the findings of Quinn (2010), who summarised information NIWA has collected on periphyton abundance at Mandamus and SH1 since 1989. Their findings are that about 3% of the time, or about 11 days a year on average, there is greater than 15% filamentous algal cover at SH1. Critically however at Mandamus, this same threshold was exceeded about 2% of the time, or 7 days a year on average, despite nitrogen concentrations at Mandamus being on average nearly an order of magnitude less, and phosphorous concentrations considerably lower at Mandamus (see Figure 1). In other words, nutrient concentrations play little role in accentuating algal accrual rates in the Hurunui River.

7.20 I note here that the officer now recommends that a periphyton biomass target be set for the mainstem of the Hurunui River, and that this be that it does "not exceed 120 mg/m^2 or 20% cover of filamentous algae[2] in four years out of five."

7.21 While I consider such a target to be along the right lines, I do not support the specific target recommended. This is because if no flows over about 65 m^3/s occur naturally for 6-7 weeks or more, particularly in summer, the target will be exceeded largely irrespective of nutrient concentrations in the river. So in my view the recommended policy needs to be qualified with the words along the lines of "unless natural flows in the river do not exceed 65 m^3/s at the Mandamus recording site for more than 45 consecutive days".

7.22 I also question whether Schedule 1 remains necessary, particularly in relation to nitrogen. As noted earlier Schedule 1 focuses on inputs (of nutrients) rather than the environmental

[2] Note that the NIWA data discussed above related to 15% bed cover by algae.

outcomes being sought. The outcome for periphyton now recommended by the officer as Policy 5.3(a) (see Paragraph 35 above) can be achieved primarily by providing for the passage of floods and freshes along the river, supplemented by management of nutrient discharges. Long term monitoring suggests that phosphorous, rather than nitrogen, is the key nutrient for managing periphyton accrual in the lower Hurunui River. Accordingly I question the need for any nitrogen discharge cap, because although average nitrogen levels have increased in the river at SH1, periphyton abundance has not shown any parallel increase (see Figure 1).

The Questions

7.23 In my opinion there are three questions, each of which must be unequivocally answered yes, before there is any justification for nutrient caps to be imposed in a cobble bed river like the Hurunui.

7.24 The first question is "is there a problem?" Based on over 20 years of sampling NIWA have reported that on average nuisance growths of periphyton are observed on average about 11 days a year at SH1 (or to put it another way they don't occur on average for over 350 days per year). Such growths reduce aesthetic values, foul fishing tackle and make rocks slippery for wading or swimming.

7.25 It is often claimed that periphyton accumulations reduce invertebrate habitat quality. Taxa such as chironomid larvae, small beetles and purse caddis will become more dominant in the invertebrate community if substantial accumulations of periphyton are present. This lowers QMCI (a measure of invertebrate habitat quality), but the change is not permanent. Once periphyton is scoured from a braided section of river, species such as the mayfly *Deleatidium* will recolonise the river quickly and soon dominate the fauna, and QMCI will increase again.

7.26 So in my opinion the answer to the first question is "maybe" and certainly not an unequivocal yes.

7.27 The second question is "if there is a problem are annual nutrient caps on nitrogen and phosphorous an appropriate tool to help solve it?" In my opinion the answer to this is no for the following reasons:

(i) According to long term NIWA datasets, nuisance periphyton growths occur only about 4 days per year more at SH1 than they do at Mandamus, despite nutrient concentrations being much higher at SH1. Put another way, if there was a direct link between nitrogen levels and nuisance periphyton, you would expect there would be about another 20 - 40 days more nuisance infestations at SH1 versus Mandamus.

Although mean dissolved inorganic nitrogen concentrations have increased by about 50% over the last 20 years at SH1, there has been no accompanying increase in mean periphyton abundance (see Figure 1). The one year where some link may be possible was 2001, but this was a drought year, so the high levels of periphyton and nutrient concentrations observed are most likely due to an absence of freshes and floods.

(ii) Mean dissolved reactive phosphorous concentrations have decreased significantly since 2000, and this has been associated with a slight trend for mean algal biomass to also decrease. In conjunction with increasing mean nitrogen concentrations, this at least suggests that phosphorous is the main limiting nutrient in the river.

(iii) During times of the year, particularly spring, flows are sufficiently high that the risk of any significant periphyton accrual is minimal.

7.28 The appropriate tool to solve the "problem", to the extent it exists, is to retain floods and freshes for sufficient time to scour most periphyton from the river. Changes recommended to the Proposed Plan by the officer recognise, at least in part, the key importance of retaining such events.

7.29 The third question is "if there is a problem and nutrient caps on nitrogen and phosphorous are the best way to solve it, do the costs of taking action outweigh the benefits of taking action?"

7.30 In my opinion the answer to that question is confused in the Proposed Plan. The Zone Committee has expressed a desire to see up to 100,000 ha irrigated using water from the Waiau and Hurunui Rivers. Agricultural development of about 7,000ha in Balmoral – largely for irrigated dairy platforms – will take up the entire nitrogen cap proposed for the Hurunui River, despite a commitment by NTPL to best environmental practice. An average of four days more nuisance algal growth per year, with no accompanying significant environmental effects, at SH1 could potentially prevent the development of many thousands of hectares throughout the Hurunui catchment. In my view, this is a high cost to pay for so little benefit.

7.31 It is important to link causes with effects in managing natural resources. There is strong evidence that retention of freshes and floods will control periphyton biomass in gravel bed rivers such as the Hurunui. There is little evidence that capping annual nitrogen levels will have any similar benefit However, capping phosphorous discharges potentially does have benefits, and accordingly I support the officer's recommended amendment in Policy 5.3(c).

Nitrate Toxicity

7.32 I also wish to comment on the officer's recommended new Policy 5.3(b), which says that:

"Nitrate nitrogen concentration does not exceed the chronic nitrate toxicity threshold for 99% level of protection (1mgN/litre)"

7.33 I understand that this is based on a report prepared by NIWA for Environment Canterbury on nitrate toxicity by Hickey and Martin (2009).

7.34 There are some important points that need to be understood about the way this information was derived by Hickey and Martin, and how Environment Canterbury has used that information.

7.35 Information for the NIWA report was based on information derived from work undertaken in Canada and the USA. Only one fish species found in the Hurunui River downstream of Mandamus (Chinook Salmon) were used in any of these studies. The only related invertebrate species used was a snail, although caddisflies were also included. So the information used is not based on any work on native or indigenous fish or invertebrate species. The information is also assessed in a very conservative fashion.

7.36 Importantly the report makes recommendations about appropriate levels of protection for different environments. The 99th percentile threshold of 1mgN/l is recommended to be applied to *"high conservation/ecological value systems – effectively unmodified or other high valued ecosystems typically occurring in national parks, conservation reserves or in remote and/or inaccessible locations"*.

7.37 The 95th percentile threshold of protection of 1.7mgN/l is recommended to be applied to *"slightly to moderately disturbed systems – ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small by measureable degree by human activity. The biological communities remain in a healthy condition and ecosystem integrity is largely retained".*

7.38 Given the conservative nature of the recommendations in Hickey and Martin, the officer's recommendation that the 99th percentile be used to set water quality targets is flawed. One could not describe the middle and lower reaches of the Hurunui River as a high conservation/ecological value system. Rather it fits neatly with the definition of a slightly to moderately disturbed system. The threshold should accordingly be set at the 95th percentile of 1.7mgN/l. The 99th percentile threshold could however be applied to the headwaters of the Hurunui River, upstream for instance of Surveyor's Stream or the confluence of the North and South Branches.

8. 8 CONSENT DURATION

8.1 NTPL opposed Policies 9.1 and 9.3 in the Proposed Plan. NTPL also asked that Policy 9.2 be clarified by removing the words “Notwithstanding Policy 9.1”.

8.2 The total cost of converting Balmoral Forest to agriculture will be in the order of $310,000,000. Of this total some $132,000,000 will be spent developing infrastructure to take water from the Waiau and (perhaps) Hurunui Rivers, store up to about 8-10 million cubic metres of that water in excavated storage reservoirs within the forest, and to pump water sourced from the Waiau River up about 60-70 vertical metres to upgradient storage reservoirs.

8.3 Policy 9.1 as drafted in the Proposed Plan threatened to prevent such development, as consents to take water may be granted for only up to 10 years and that provides far too little certainty for major investment to occur. Run of river irrigation will be too unreliable once the B block allocation has to be relied on, so larger scale storage will need to be constructed to make water reliable for further irrigation development.

8.4 However the officer has recommended changes to Policy 9.2 that include reference to “large scale irrigation infrastructure with a capital cost of more than $10,000,000 and provide for a resource consent duration of up to 35 years”. As development of Balmoral would clearly pass this cost threshold, NTPL considers that this policy would now also apply for them.

8.5 NTPL also supports the officer’s recommendation to delete Policy 9.3.

9. 9 STORAGE AND ACCESS TO THE C BLOCK

9.1 As drafted the C blocks in each of the Waiau and Hurunui Rivers are available only if storage of greater than 20 million cubic metres is developed. This is a result of Policy 3.5 and its reference to Table 1.

9.2 It is ambiguous what the words “until storage with a capacity of more than 20 million cubic metres is developed” in the Proposed Plan mean. Does it apply to each of the Hurunui and Waiau catchments separately, or is it in combination? If it is separate, how is water taken from the Waiau River but stored and used in the Hurunui catchment to be counted? Could water stored in irrigation or HEP canals be counted as part of this volume? None of these questions are addressed by the policy as drafted.

9.3 The officer’s recommendations have responded positively to NTPL’s concern and

recommended a change to Table 1 to refer to "cumulative storage". NTPL supports this recommended change. More clarity is needed however as to how water taken from the Waiau catchment and stored in the Hurunui catchment is to be "counted" under this proposed change.

9.4 However the key issue that remains is why water from the C block is available only if large scale storage of at least 20 million cubic metres is provided. The environmental effects of taking water from the C block occur irrespective of whether water is stored or not. Indeed storage implies water is used consumptively and not returned to the river, with effects occurring from the point of take all the way down the length of the river. Run of the river HEP generation on the other hand returns water to the river, and so the effects of taking that water are restricted to a discrete section of a river. Somewhat perversely therefore, the C block is potentially only available if the effects of taking that water are potentially greatest. Also somewhat perversely if other storage is not developed, a hydro scheme would need to store 20 million cubic metres of water to gain access to the C block – irrespective of whether or not that storage is necessary for irrigation.

9.5 The increases in minimum flows in both the Waiau and Hurunui Rivers in the Proposed Plan should incentivise storage. Under the "C" block flow regime neither the A nor (particularly) B blocks, will be sufficiently reliable to provide run of the river irrigation for larger irrigation schemes. Storage will be developed in any case.

9.6 NTPL accepts that the Zone Committee was trying to promote wide scale irrigation by adopting this policy approach. Clearly however the means provided to do this is flawed. There is no good environmental reason to tie access to the C block with mandatory storage. If the C block water is taken for irrigation, storage will be essential in any case to provide reliable water. But if C block water is taken for hydro, there is no good case for storage to be mandatory. This is neither an efficient or effective way of meeting the Zone Committee's desire.

10. DIFFERENT MINIMA FOR DIFFERENT USES

10.1 The flow and allocation regime for the Hurunui River on pp28 of the proposed plan contains different minimum flows for the months of June to August inclusive depending on whether the water taken is used consumptively or not. If water is used consumptively the minimum flow is 12 m^3/s; if it not used consumptively it is 10 m^3/s (provided water is returned to the river within 250m)

10.2 NTPL notes that this is the reverse rationale for allowing access to the C block on the implicit basis that storage is provided (and so use is consumptive).

10.3 In this case also however the environmental values supported by the Hurunui River are not sensitive to whether water is used consumptively or not. If 10 m^3/s is sufficient to protect those values in winter months, then this should be the minimum flow regardless of how the water taken is used. In my opinion this flow should be adequate to protect instream values in those winter months.

Dr Brent Cowie
12 October 2012

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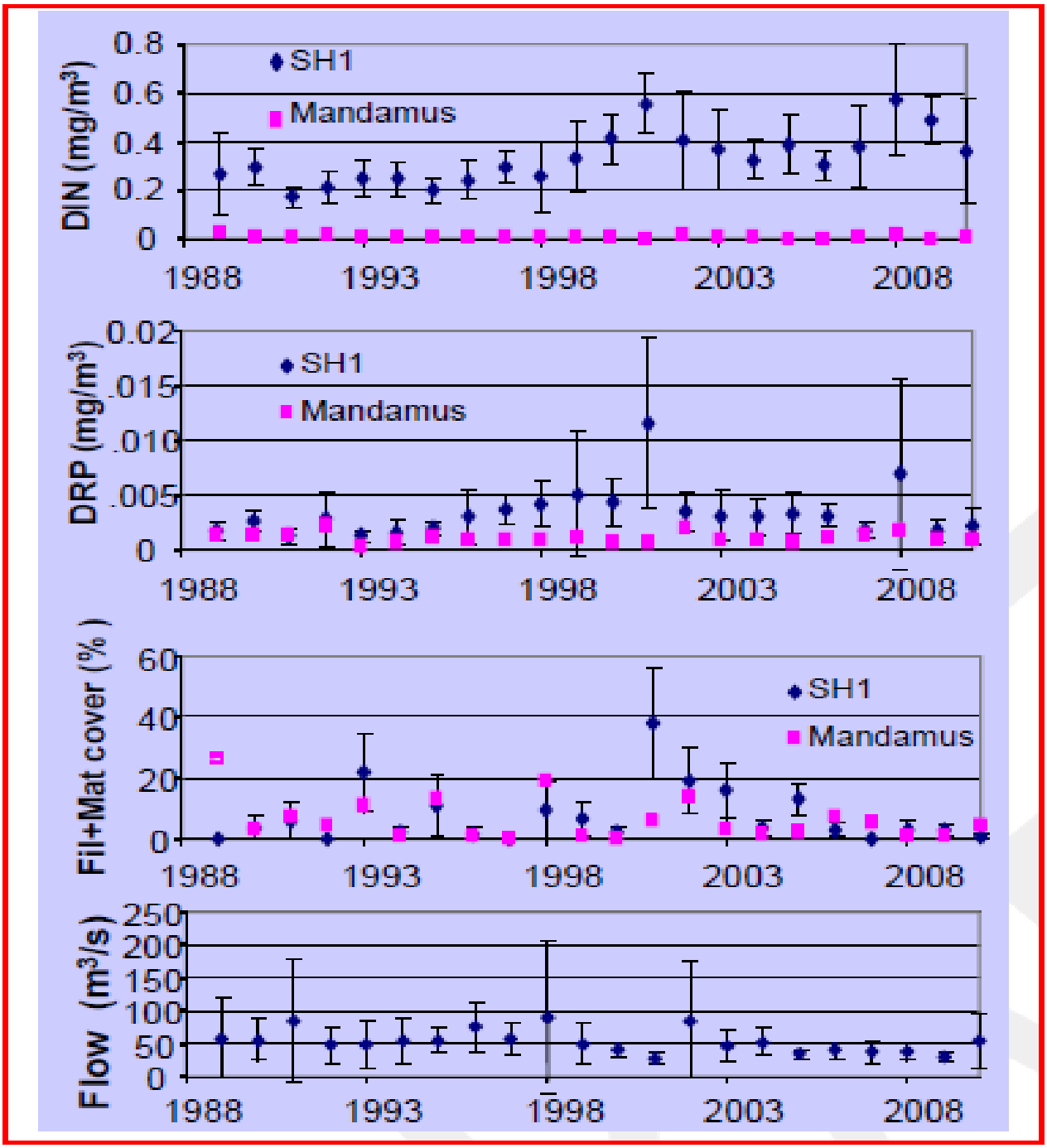
Figure 1


DIN (mg/m³)
0.8
0.6
0.4
0.2
0
SH1
Mandamus
1988
1993
1998
2003
2008
DRP (mg/m³)
0.02
.015
.010
.005
0
SH1
Mandamus
1988
1993
1998
2003
2008
Fil+Mat cover (%)
60
40
20
0
SH1
Mandamus
1988
1993
1998
2003
2008
Flow (m³/s)
250
200
150
100
50
0
1988
1993
1998
2003
2008