in the matter of: the Resource Management Act 1991

and

in the matter of: a number of applications to take and use water from the Upper Waitaki catchment

Addendum to brief of evidence of **Donna Lee Sutherland** (on cumulative water quality effects)

Dated: 30 November 2009

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ADDENDUM TO BRIEF OF EVIDENCE OF DONNA LEE SUTHERLAND (ON CUMULATIVE WATER QUALITY EFFECTS)

INTRODUCTION

1 My full name is Donna Lee Sutherland.

2 My qualifications and experience are set out in the brief of evidence dated the 16 September 2009.

3 I have been engaged by Meridian Energy Limited (Meridian) to provide an addendum to my evidence dated the 16 September 2009 on the subject of the cumulative water quality assessment in response to caucusing that has occurred with experts engaged by Mackenzie Water Research Limited (MWRL) and Environment Canterbury (ECan) and in response to the supplementary evidence presented by MWRL.

4 I confirm that I have read the Environment Court's Code of Conduct for expert witnesses and this evidence has been prepared in accordance with that code. I agree to comply with the code's terms. In that regard, I confirm that the statements made in this evidence are within my area of expertise (unless I state otherwise) and I also confirm that I have not omitted to consider material facts which might alter the opinions stated in this evidence.

SCOPE OF ADDENDUM

5 In this addendum I outline:

5.1 The outcome of three caucusing meetings I have attended with experts representing MWRL to discuss issues arising from the cumulative water quality assessment.

5.2 Comments on the evidence provided by **Dr Gamage**, dated 6 November 2009.

5.3 Comments on the rebuttal evidence presented by **Dr Coffey**, dated 6 November 2009.

5.4 Comments on the addendum evidence presented by **Mr Turner**, dated 30 November 2009.

CAUCUSING

Caucusing meeting of 24 September 2009.

6 On 24 September 2009, I caucused with **Dr Coffey** and **Dr Ryder** representing MWRL, **Dr Meredith** from ECan and my colleague, **Dr Snelder**. At this meeting I outlined my concerns that are set out in my evidence in chief regarding the misuse of the TLI - for example

not using chlorophyll *a*, and using loads to determine TLI without consideration to in-lake processes. I also outlined my concerns with discrepancies between MWRL and NIWA data with respect to water quality and nutrient load data. **Drs Ryder** and **Coffey** could not respond to this as they had insufficient involvement in the lake work.

7 A copy of the agreed minutes from this caucusing meeting are attached as **Annexure A** to this evidence.

Caucusing meeting of 15 October 2009.

8 On 15 October 2009, I attended a caucusing meeting with **Dr Gamage**, **Dr Mzila**, **Mr Male**, **Dr Bright** and **Dr Robson**, representing MWRL, and my colleague **Dr Snelder**. At this meeting I outlined by concerns as stated above to **Dr Coffey** and **Dr Ryder**. **Dr Gamage** was able to respond to some of my concerns and has subsequently further addressed these in his evidence dated 6 November 2009. No agreement was reached during caucusing and my concerns outlined in my evidence in chief remain unchanged.

Caucusing meeting of 11 November 2009.

9 On 11 November 2009 I attended another caucusing meeting with **Dr Gamage** and **Dr Mzila** on behalf of MWRL, **Dr Meredith** and **Mr Heller** on behalf of ECan and my colleague **Dr Snelder**. This meeting was primarily concerned with the groundwater modelling and there were no topics discussed that directly concerned my evidence.

EVIDENCE OF DR NIMAL GAMAGE

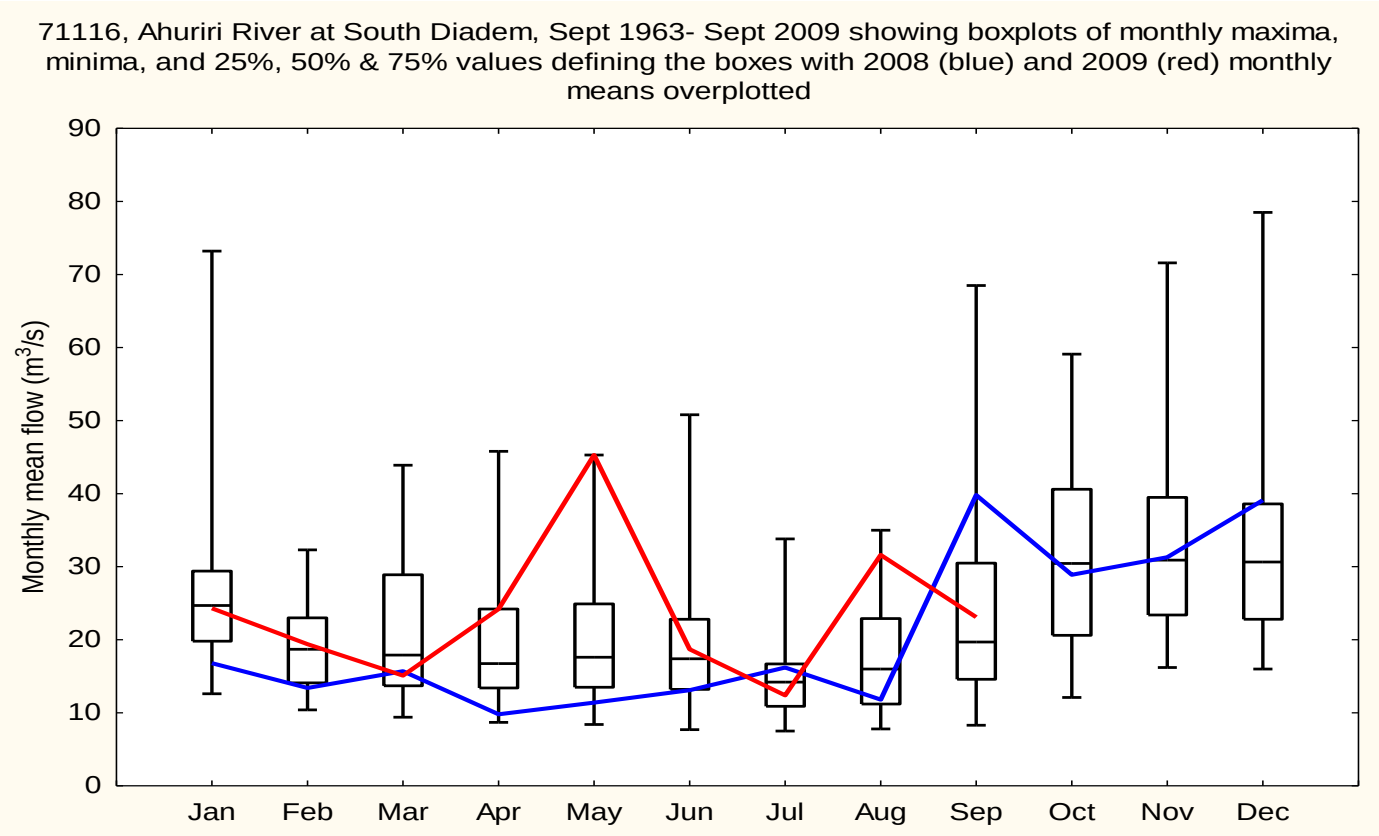
10 The evidence of **Dr Gamage** has concentrated on the NIWA water quality measurements from December 2008 – April 2009. **Dr Gamage** has identified what he believes are outliers in the NIWA data and he has removed these values to then compare our lower values with MWRL's measurements.

11 In the report Norton *et al* (2009), these measurements were discussed in the context of error measures of the modelled output. These measurements were described as relatively extreme events within the context of our sampling period but were not identified as outliers or removed from the dataset. The rationale behind this decision is that these measurements are real and reflect inflow spikes, and subsequently nutrient spikes, into Lake Benmore.

12 Mean monthly flow in the Ahuriri River is shown in Figure 1. Boxplots of monthly maxima, minima, 25%, 50% and 75% values from 1963 – 2009, as well as monthly means overplotted for 2008 – 2009 are represented by this figure. The graph shows that there is

large flow variability between months and between years. Further spikes in inflows exist within the monthly mean values.

Figure 1.



13 Given the high variability of inflow, particularly for the Ahuriri River, it is plausible to suggest that our limited sampling data has in fact underrepresented the occurrence, and therefore importance of these nutrient spikes in the Arm. Without long term comprehensive datasets to compare against there is no basis for discrediting these measurements as outliers and removing them from any subsequent analyses.

14 **Dr Gamage** has also expressed concerns regarding mean monthly rainfall and the timing of our sampling in the Haldon Arm. **Dr Gamage** equates a high December 2008 rainfall to a high measurement of TN and TP in the Haldon Arm on 8 December 2008. I consider that **Dr Gamage's** assessment of our data should be treated with caution.

Firstly, local rainfall is not necessarily a direct measure of inflow into Lake Benmore. Rainfall in the mountains, which feed the river inflows, may vary greatly from local rainfall recordings. Local

rainfall in the Upper Waitaki is skewed due to the highly variable interannual rainfall for any given month. Figure 2 shows the variability in rainfall for any given month from 1984 – 2008 (Rainfall recorded from Tara Hills). **Figure 2**. Tara Hills monthly rainfall records from 1984 – 2008 showing interannual variability for monthly rainfall.

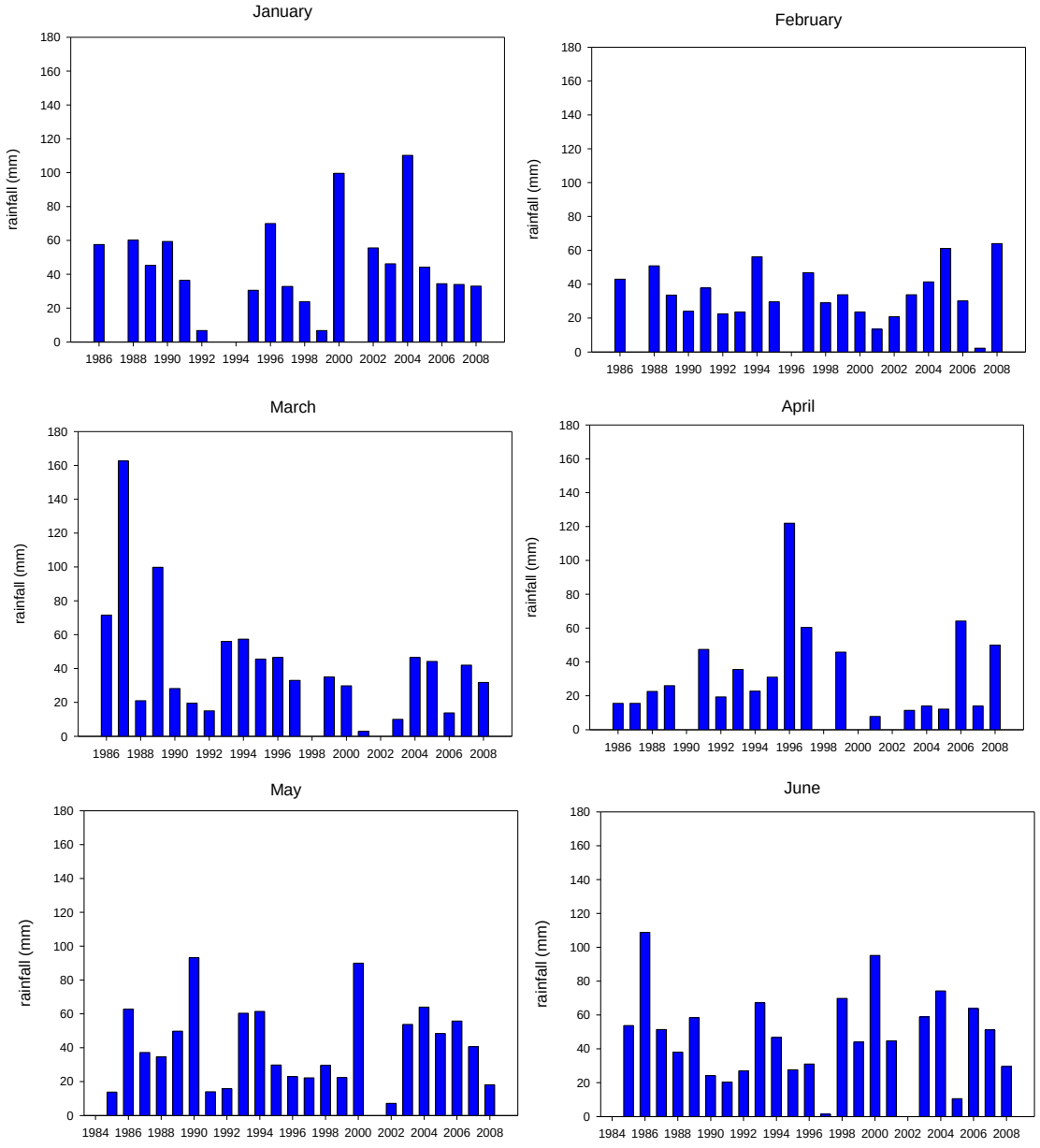
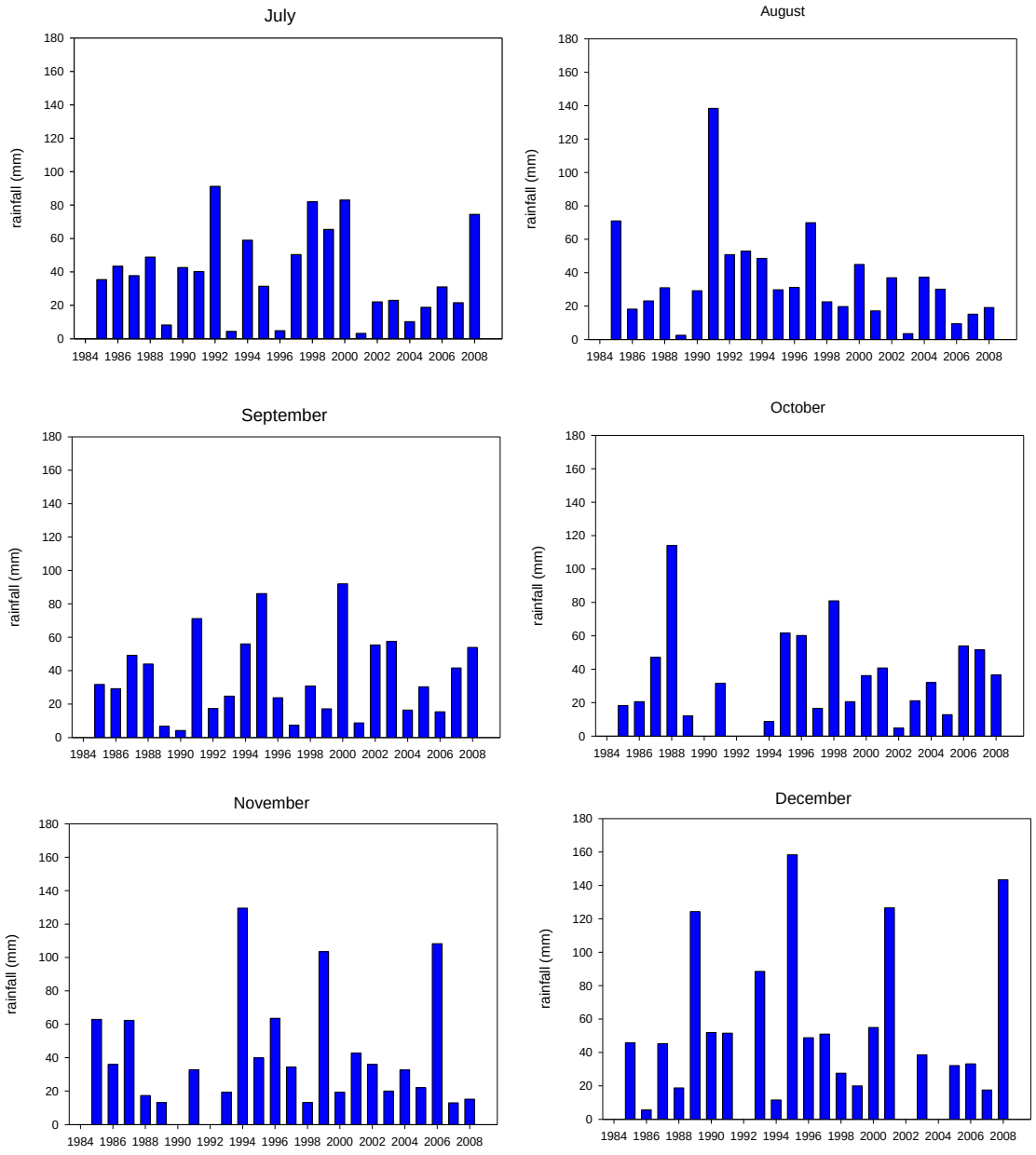


Figure 2 cont.



15 Secondly, it should be noted that the NIWA in-lake sampling location for the Haldon Arm was positioned over the deepest part of the Haldon Arm. Given the size of the basin, the residence time of water from the inflow to the NIWA lake sampling site is approximately 35 days. This means that it takes 35 days for a molecule of water to travel from its inflow site to the sampling site. . Samples collected from the inflows of the Haldon Arm are not comparable to the samples collected from the in-lake site of the Haldon Arm on the same day. Nor is the December rainfall data

applicable to the 8 December in-lake sampling, given that the sampled water arrived in the lake some 35 days prior.

16 The spikes in the Norton et al (2009) sampling data demonstrate that there is not enough information presently available to describe the level of variability within the existing system. By excluding variability from a model it is unclear how you could model for natural variability of the system. In my opinion, this is fundamental for understanding the current system for which changes are being proposed, modelled and monitored for.

17 In his evidence, **Dr Gamage** also discusses why he considers it appropriate not to include chlorophyll *a* in his TLI calculations. In my opinion, I do not consider his argument justification for the exclusion of the only measure of biological response to increased nutrient concentrations. Biological response is one of the most fundamental concerns to lake users and managers. To my knowledge, no lake where the TLI is being monitored by regional councils excludes the chlorophyll *a* from TLI assessments. Chlorophyll *a* is specifically monitored and modelled for, in the cases of lakes where modelling has been undertaken, in Lake Taupo and the Rotorua lakes.

EVIDENCE OF DR BRIAN COFFEY

18 In **Dr Coffey's** supplementary evidence he states that *Lagarosiphon major* (lagarosiphon) does not thrive in mesotrophic conditions and is displaced by alternative taxa such as *Egeria densa* (egeria) or *Ceratophyllum demersum* (hornwort) when they are also present in mesotrophic conditions.

19 I agree with **Dr Coffey** that lagarosiphon is displaced by egeria and hornwort but for the purpose of assessing the effects of land-use intensification on Lake Benmore I had to base it on the plant community type currently residing in the lake. While increased nutrients would favour egeria and hornwort growth, the risk of transfer of these weeds to the lake is not increased under land-use intensification. Egeria and hornwort are two of New Zealand's more aggressively growing weeds and the consequences of these species becoming established in the Waitaki lakes are far worse than lagarosiphon and changes in nutrient concentrations would have a much greater impact than that predicted for lagarosiphon.

20 However, I disagree with **Dr Coffey** that lagarosiphon does not thrive in mesotrophic waters. Lagarosiphon is present in a number of North Island mesotrophic lakes, including Lakes Okareka and Rerewhakaaitu where I have been undertaking FRST funded research on lagarosiphon and epiphyte loadings in response to increased nutrient concentrations. Both these lakes have egeria but lagarosiphon continues to thrive in embayments where egeria has

not reached yet. In these lakes, lagarosiphon invests more biomass in the upper third of the water column that in the neighbouring oligotrophic lakes, such as Lakes Rotoma and Tikitapu. This has implications for recreational activities, such as those described by **Mr Greenway** in his evidence.

21 **Dr Coffey** also questions my concerns regarding dense macrophyte beds and benthic respiration and anoxia at paragraph 47 in my evidence in chief. While deoxygenation can, and does occur in dense weed beds in oligotrophic lakes, as a result of the restriction of water flow through the beds, my paragraph 47 concerns the implications of increased nutrients to macrophyte beds, without the assumption that nutrient loads remained at ideal levels.

22 Nutrient gradients occur along the lake from the source of the in-flow until the water becomes fully mixed into the pelagic zone, or main body of the lake. For the Ahuriri Arm, the most dense beds of lagarosiphon occur on the delta near the mouth of the Ahuriri River. These beds are likely to intercept higher nutrient concentrations from the inflows than they would have if they occurred closer to the main body of the lake. Furthermore, a lack of clarity around where the groundwater finally re-charges into the lake makes it difficult to assume that the interstitial waters will remain at low nutrient concentrations, thus not affecting the growth of lagarosiphon, periphyton or epiphyton.

In **Dr Coffey's** main supplementary evidence he responds to my concerns over the often isolated area of the Haldon Arm at the Tekapo / Pukaki inflow. In my evidence in chief Plate 2 shows the three distinct zones of water for the three distinct inflows at the top of the Haldon Arm. This photo was taken during a spill event to demonstrate that even during higher inflows from the Tekapo / Pukaki River these areas do not mix. At paragraph 7.11 of his supplementary evidence, **Dr Coffey** has assumed that the turbid waters seen during spill are typical of inflows from the Tekapo / Pukaki River and that this would limit growth. However, for periods outside of spill events, water in the Tekapo / Pukaki inflows is considerably clear as shown in horizontal black disc measurements (Figure 3) and in Plate 1.

Figure 3. Horizontal black disc measurements for the Tekapo / Pukaki inflow (top graph) and the Ohau C inflow (bottom graph) into the Haldon Arm from December 2008 – April 2009. The greater the black disc distance the greater the clarity of the inflow water.

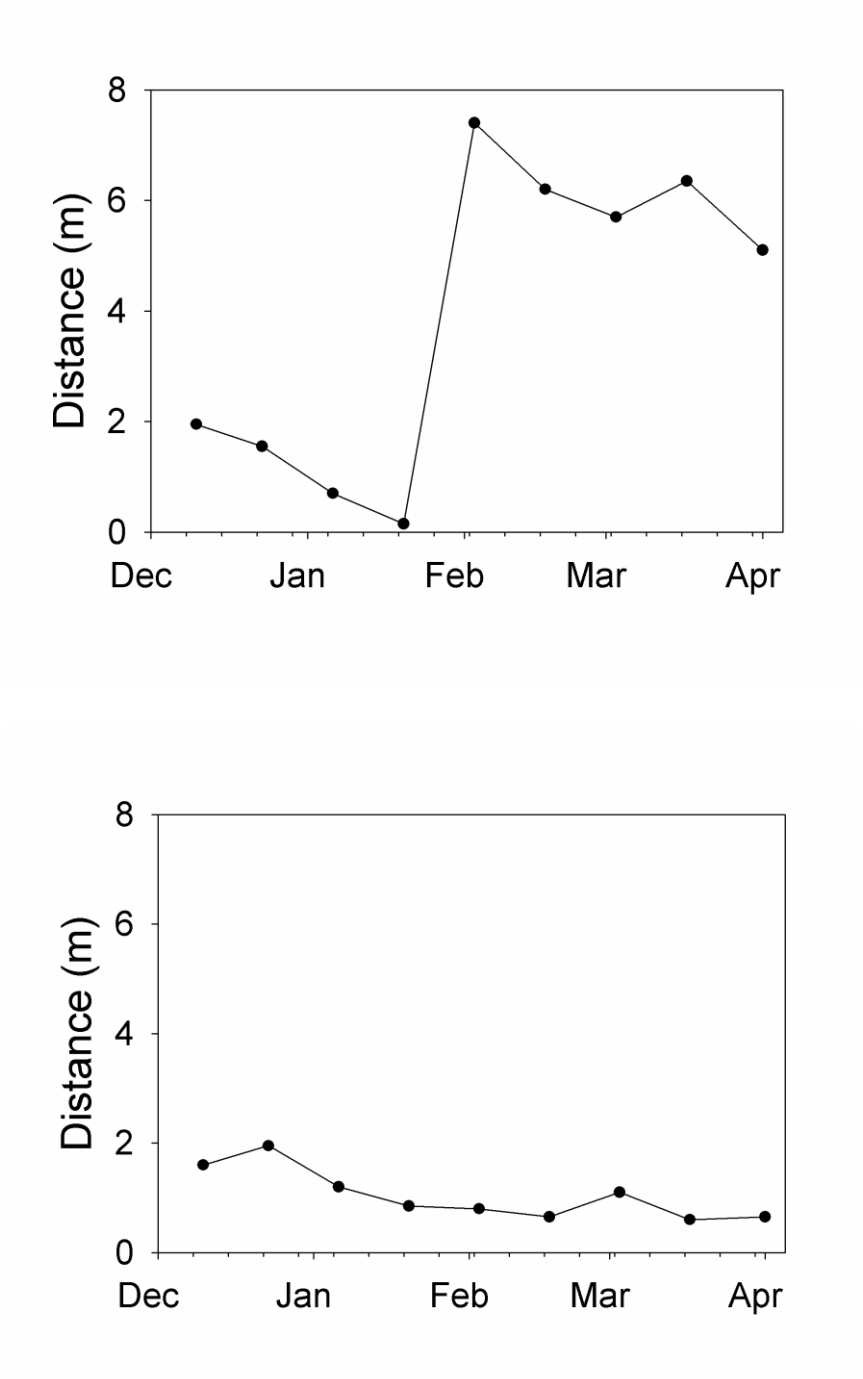


Plate 1. Distinct zonation of inflow waters from the Ohau C Canal, lower Ohau River and Tekapo / Pukaki River. The low mixing zone of the Tekapo / Pukaki River extends past the right of the photo.

23 The area of concern in the upper Haldon Arm is very shallow (< 2.5m) so light is not a limiting factor for growth of algae. Given that it is so shallow there is unlikely to be underflows of waters of different temperatures and densities mixing into this area.

24 In my evidence in chief I did refer to algal blooms but did not specify phytoplankton alone. In my opinion, periphyton will be the

most predominant and problematic algal growth in this area, particularly didymo and filamentous greens. However, during calm periods and low flows there will most likely be long enough residence time to allow phytoplankton communities to bloom as well.

25 In response to my concerns that the hydrodynamic mixing between the two Arms are not adequately addressed in GHD's water quality assessment, **Dr Gamage** states that he believes that the lower nutrient concentration waters from the Haldon Arm would produce positive water quality effects for the Ahuriri Arm. However, my concern was and remains the fact that at present the lower nutrient waters of the Haldon Arm provided a level of protection to the Ahuriri Arm. As the nutrients increase in the Haldon Arm, under land-use intensification, the level of protection that the Haldon Arm water exchange offers the Ahuriri Arm will be diminished. This could result in poorer than expected water quality in the Ahuriri Arm as the buffering capacity of the Haldon Arm waters to the Ahuriri Arm is diminished.

ADDENDUM EVIDENCE OF MR RICHARD TURNER

26 In his addendum evidence, **Mr Turner** has raised concerns regarding the movement of groundwater into the Upper Waitaki hydro-canals through non-return valves in the floor of the canal bed. Increased ground water intrusion into the canals, as a result of water tables rising in response to increased irrigation, would bring higher concentrations of nutrients into the canals on a more frequent basis. As discussed in my evidence in chief, increased nutrient concentrations in the hydro-canals has negative implications for the growth of filamentous green algae and didymo.

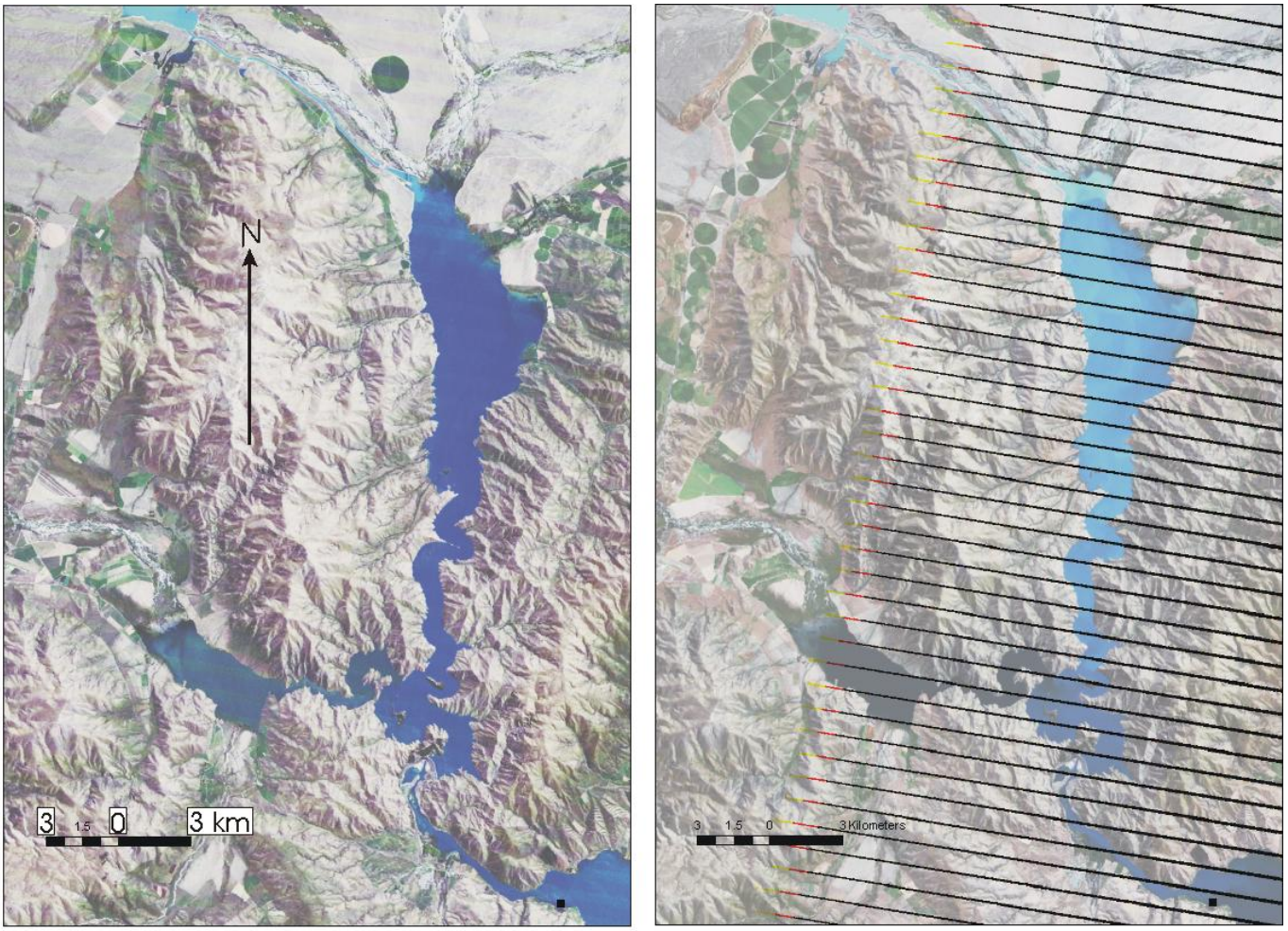
27 Didymo was first recorded in the Ohau C Canal in April 2007. Unlike the nearby Ahuriri River, where didymo reached full bloom status 4 months after initial detection (Larned et al 2006), growth of didymo in the Ohau C Canal was initially slow.

28 I have conducted 6-monthly benthic sampling of didymo in the Ohau C Canal since April 2007, with the latest survey conducted in November 2009. Over the two and half years of monitoring, didymo growth has slowly increased at the downstream end of the Ohau C Canal.

29 Relative abundance of didymo in the lower half of the Ohau C Canal in November 2009 averaged 95%, compared to only 5% in November 2008. In contrast, in the upper half of the canal didymo relative abundance has remained consistent between November 2006 and present, with an average relative abundance of 15%.

30 Given that light conditions and flows are uniform along the length of the Ohau C Canal, it is plausible to suggest that the observed differences in didymo growth between the upper and lower halves of the canal are a result of groundwater intrusion. Figure 4 shows a satellite image of land-use intensification that has occurred in the Wairepo groundwater catchment from 2005 to 2008.

Figure 4. Satellite image of Lake Benmore and surrounding catchment in January 2005 and February 2009. Intensification of land-use, as indicated by irrigation circles, can been seen in the Wairepo groundwater catchment.



CONCLUSION

31 While my concerns regarding the lakes and canals assessment were raised during caucusing, there was no resolution or agreement on any issue. **Dr Gamage** has now provided his interpretation of the NIWA data in response to my concerns but for reasons stated above I believe that these interpretations should be treated with caution.

32 My concerns and recommendations discussed in my evidence in chief remain unchanged.

Dated: 30 November 2009

Donna Lee Sutherland