In the matter of:	Clauses 6 and 8 of Schedule 1 – Resource Management Act 1991 – Submissions on publicly notified plan change and variation – Proposed Plan Change 1 and Variation 1 to Waikato Regional Plan – Waikato and Waipa River Catchments
And:	**Wairakei Pastoral Ltd**
	Submitter
And:	**Waikato Regional Council**
	Local Authority

REBUTTAL EVIDENCE OF RICHARD GEORGE CRESSWELL

Block 1 Hearing Topics

Dated: 26 February 2019

REBUTTAL EVIDENCE OF RICHARD GEORGE CRESSWELL

Block 1 Hearing Topics

SUMMARY

1 Relevant to my expertise, I wish to rebut the evidence of the following expert witnesses:

Name	Submitter
Dr Jane Marie Chrystal Dr Timothy Jason Cox	**Beef + Lamb New Zealand Ltd ID 73369**
Dr Paul Frederick le Miere	**Federated Farmers of New Zealand ID 74191**
Ms Jude Addenbrooke	**Miraka Ltd ID 73492**
Dr Bryce Cooper	**Waikato Regional Council (WRC) ID 72890**

2 I support Dr Chrystal's statement at paragraph 44 that, "Losses of nitrogen differ temporally and spatially..." and at paragraph 55 that, "there is no 'one-size-fits-all' approach to farm mitigation strategies."

3 I support Dr Chrystal's comment at paragraph 57 that, "Reducing N leaching on already low input farms, may not result in any meaningful reduction of in stream N concentration or benefit to aquatic ecosystem health, and can have the unintended consequence of rendering the farm financially unsustainable."

4 I support Dr Chrystal's estimation of N leaching from sheep and beef enterprises as about 60% greater than modelled for PC1.

5 I do not support the extrapolation of the beef and sheep findings to the dairy industry and in my Block 2 evidence I will show that the most recent estimates from OVERSEER® for N leaching under dairy enterprises is appropriate.

6 I support the comment by Dr Cox at paragraph 50 that, "[Model] refinement should be guided by site-specific measured data and a modelling platform capable of incorporating time-of-travel lags and dynamic exports."

7 I support Dr Cox' recommendation at paragraph 141 "that work be done to better quantify attenuation rates and export coefficients throughout the basin" and that this "will be critical to future basin decision-making, including Farm Environment Plans and the prioritisation of sub-catchments."

8 I support Dr le Miere's comment at paragraph 6 (and paragraph 78) that, "The best data currently to hand indicates that the nitrogen load to come is discernible only in the decimal points, that it is unlikely to materially impact chlorophyll levels."

9 I support Dr le Miere's comment at paragraph 69 that, "PC1 overestimates the importance of the Nitrogen load to come."

10 I support Ms Addenbrooke's comment at paragraph 4.15 that, "The scale of this single Freshwater Management/Sub-catchment Unit approach needs further consideration. The scale of the current FMUs is too coarse."

11 I do not support Dr Cooper's comment at paragraph 15 that, "there is no 'headroom' for increasing contaminant losses created through the scenario setting process."

12 I do not support Dr Cooper's comment at paragraph 28 that, "the simulation modelled the effect of the (sic) groundwater lags (the N load-to-come)" as I believe the premise behind this simulation is fundamentally flawed.

13 I do not support Dr Cooper's comment at paragraph 31 that, "nitrogen legacies evident in groundwater in the upper catchment make it difficult to maintain or improve all water-quality outcomes at a number of monitoring sites in this location."

REBUTTAL

1 My name is **Richard George Cresswell**. I have the qualifications and experience recorded in my statement of evidence filed in relation to the Block 1 Hearing Topics.

2 My rebuttal evidence has been prepared in accordance with the Code of Conduct for expert witnesses as set out in Section 7 of the Environment Court of New Zealand Practice Note 2014.

3 Relevant to my expertise, I wish to rebut the evidence of the following expert witnesses:

Name	**Submitter**
Dr Jane Marie Chrystal Dr Timothy Jason Cox	**Beef + Lamb New Zealand Ltd ID 73369**
Dr Paul Frederick le Miere	**Federated Farmers of New Zealand ID 74191**
Ms Jude Addenbrooke	**Miraka Ltd ID 73492**
Dr Bryce Cooper	**Waikato Regional Council (WRC) ID 72890**

Dr Chrystal for Beef + Lamb New Zealand Ltd ID 73369

4 I am in general agreement with the evidence presented by Dr Chrystal. Dr Chrystal presents some theory and modelling relating to nutrient transport, specifically as it relates to the beef and lamb industry.

5 Dr Chrystal outlines similar deficiencies and limitations of the OVERSEER® Nutrient Budgets model to those outlined in the Parliamentary Commissioner for the Environment's recent review of "*Overseer and regulatory oversight: Models, uncertainty and cleaning up our waterways*" (PCE, 2018, p. 47). I will address the limitations of OVERSEER® in more detail in my later evidence for Topics C1 in Block 2 of these Hearings.

6 Dr Chrystal further explores the changes that have occurred under different versions of the HRWO model and highlights (Table 7 and paragraph 178) the under-estimates of N leaching used in the NIWA modelling for sheep and beef for the HRWO. Dr Chrystal's estimates "from B+LNZ's Sheep and Beef Farm Survey farms" (paragraph 174) suggests that significantly more (an increase of nearly 60% - paragraph 175) N is leached from these enterprises

than has been modelled in PC1 and this has ramifications on attenuation rates between these enterprises and the receiving water body and "… conclusions around 'attenuation' which is used to link land use to water quality" (paragraph 30).

7 I will present evidence to the Block 2 Hearings that supports Dr Chrystal's estimation of N leaching from sheep and beef enterprises.

8 I will, however, also present modelling that does not support the extrapolation of the beef and sheep findings to the dairy industry (paragraph 178) and I will show that the most recent estimates from OVERSEER® for N leaching under dairy enterprises is appropriate, not supporting Dr Chrystal's suggestion that dairy leaching should also increase by about 60% (Table 7).

9 I support the statement at paragraph 44 that, "Losses of nitrogen differ temporally and spatially..." and at paragraph 55 that, "there is no 'one-size-fits-all' approach to farm mitigation strategies."

10 I support the comment at paragraph 57 that, "Reducing N leaching on already low input farms, may not result in any meaningful reduction of in stream N concentration or benefit to aquatic ecosystem health, and can have the unintended consequence of rendering the farm financially unsustainable."

Dr Cox for Beef + Lamb New Zealand Ltd ID 73369

11 I am in general agreement with the evidence presented by Dr Cox. Dr Cox presents some theory and modelling relating to nutrient transport at the catchment scale, specifically as it relates to modelling transparency, calibration, uncertainty and application. Dr Cox has developed a new model to simulate water quality in the basin (paragraph 23).

12 Paragraph 43 considers the ambiguous use of different nitrogen attenuation factors in the HRWO models used to support the HRWO planning process and I support the comment that, "This limitation of the model does raise concerns about model over-simplification and uncertainties associated with basin attenuation".

13 I support the comment at paragraph 50 that, "[Model] refinement should be guided by site-specific measured data and a modelling platform capable of incorporating time-of-travel lags and dynamic exports".

14 Dr Cox describes the development of his own model (CASM – Contaminant Allocation Simulation Model) in paragraphs 55 to 62 and in his Appendix A.

15 The CASM model incorporates a 'Reservoir attenuation coefficient' (described at paragraph 149). This coefficient is a linear function of time and the model calibration process is used to determine the best estimate for each specified monitoring point. This may be a valid approach for a purely analytical model, but it:

15.1 Highlights the need for good spatial verification data as unrealistic outcomes can be generated when extrapolating to explore mitigation strategies (paragraph 84);

15.2 Denitrification is more generally understood to be non-linear with respect to time (e.g. Tesoriero and Puckett, 2011) and is more accurately modelled using a kinetic rate law (Jin and Bethke, 2005) as the primary driver is the changing availability (i.e. reduction) of oxygen in groundwater, and

15.3 Does not recognise that generalisations about denitrification in sub-soils and aquifers is difficult (Hallberg and Keeney, 1993) due to the multiple pathways and contributing processes (Clague, et al., 2019).

16 I agree with Dr Cox when he states (in paragraph 140) that he finds "the discussion of apparent vs. ultimate attenuation rates unsettling".

17 I support Dr Cox' recommendation at paragraph 141 "that work be done to better quantify attenuation rates and export coefficients throughout the basin" and that this "will be critical to future basin decision-making, including Farm Environment Plans and the prioritisation of sub-catchments".

18 I support Dr Cox' recommendation at paragraph 145 regarding "incorporation of *seasonality* in future modelling efforts". I will demonstrate in my evidence in Block 2 that this has profound effects on the leaching rates expected under different climatic and management regimes.

Dr le Miere for Federated Farmers of New Zealand ID 74191

19 I support the comment by Dr le Miere at paragraph 6 (and paragraph 78) that, "The best data currently to hand indicates that the nitrogen load to come is discernible only in the decimal points, that it is unlikely to materially impact chlorophyll levels".

20 I support the comment at paragraph 69 that, "PC1 overestimates the importance of the Nitrogen load to come".

21 I support the comment at paragraph 70 that states that the Section 42A Report "neglects to acknowledge different groundwater conditions which may attenuate (reduce) nitrate concentrations in

groundwater. Work commissioned for PC1 in fact estimates that "nitrate rich groundwater is likely to encounter reducing conditions in about 50% of the catchment area." Despite the possible mis-correlation between "reduce" and "reducing" by Dr le Miere, the outcome is the same and supports consideration of nitrate attenuation between source and receptor of N.

22 I support the comment at paragraph 75 that points out that, "It is relevant to note that the TLG went on to recommend further work to "better evaluate the load to come and the time trajectory of response to interventions".

23 I support the comment at paragraph 82 that, "There are several problems with monitoring and the reporting which will constraint the development of PC1 and hamper informed decision making. Indeed, it is my understanding that the need to improve base data and our understanding of hydrological pathways and cause-effect relationships is central to positioning PC1 as the first step, pending more robust data to support efficient and effective interventions".

24 I agree with Dr le Miere's opinions that:

24.1 Groundwater data collection can often be correlated with known contamination assessments (paragraph 151) as these events or known sources generally require an increase in local monitoring.

24.2 There is spatial and temporal disjunct ("only 62 of the 74 sub-catchments have monitoring sites with PC1 targets" - (paragraph 80a), hence extrapolation is required to estimate conditions within the non-monitored sub-catchments.

24.3 "the trend period is not clear" (paragraph 145)) and "makes it difficult to reconcile" (paragraph 142) reported values in the monitoring reports to the Section 42A Report as different time periods are referred to with no consistent assessment across a single defined time period.

25 I support the comment at paragraph 152 that, "historic readings should not be presented in the Section 42A Report purporting to be a "*summary of groundwater chemistry in sub-catchments".* Dr le Miere has assessed the data set as used by the TLG and found that the primary source reported, "relatively few wells have suitable data for trend analysis; analysis of data has not been completed, e.g. [sic], well depth; and capture zones of wells have not been delineated" (paragraph 148).

26 I support the comment at paragraph 158 that, "If the CSG decision cannot be justified or there is a better way or solutions to give effect

to the RMA and Vision and Strategy then the CSG should not be followed".

Ms Addenbrooke for Miraka Ltd ID 73492

27 I am in substantive agreement with the evidence presented by Ms Addenbrooke. Ms Addenbrooke discusses the limitations of the proposed Freshwater Management Units (**FMU**) and offers alternative strategies for sub-catchment consideration.

28 I support the comment at paragraph 4.9 that, "These [FMU] units are too large and heterogeneous in terms of bio-physical attributes and will fail to identify the priority contaminants upon which to focus, or the enterprises which have the most opportunity to improve their practices and thereby improve water quality. Also, the application of this scale for the calculation of the Nitrogen Reference Point (NRP) 75th percentiles is both ineffective and inequitable". Whilst this latter point may not be entirely accurate, I support the opinion that the scale of calculation of the NRP is critical in providing benchmarks against which to judge mitigation strategies at the enterprise level.

29 I support the comment at paragraph 4.15 that, "The scale of this single Freshwater Management/Sub-catchment Unit approach needs further consideration. The scale of the current FMUs is too coarse".

30 I do not support the comment at paragraph 5.7, however, concerning reconfiguration of the FMU boundaries, whereby "current Plan Change 1 sub-catchments can be aggregated to result in an effective scale …" which still fails to address the actual bio-physical integration of the landscape and linkages between sub-catchments and monitoring capabilities which are essential to establish and report on mitigation outcomes.

Dr Cooper for Waikato Regional Council (WRC) ID 72890

31 Dr Cooper's evidence is largely procedural. A number of comments, however, can be highlighted.

32 A highlighted principle of scenario modelling (stated at paragraph 15) is that, "there is no decline in water quality from the current state". What is not stated, but is implicit in the modelling process, is that comparison can only be made between current and a designated future state and not on the temporal change that may occur getting from one state to the next.

33 I will expand on this issue during my Block 2 evidence, where I will demonstrate that transitioning land use may generate greater temporary leaching until the new land use is established and leaching rates stabilise at a lower level. Hence, I do not support the

following comment at paragraph 15 that, “there is no ‘headroom’ for increasing contaminant losses created through the scenario setting process”.

34 I do not support the comment at paragraph 28 that, “the simulation modelled the effect that groundwater lags (the N load-to-come) will have in ‘frustrating’ attempts to reduce future surface water N concentrations below the current state”. I believe the premise behind this simulation is fundamentally flawed as presented in both my evidence (Appendix 2, paragraphs 6-12) and that of Mr Williamson (paragraphs 17-36 in Mr Williamson’s EIC).

35 I do not support the comment at paragraph 31 that, “nitrogen legacies evident in groundwater in the upper catchment make it difficult to maintain or improve all water-quality outcomes at a number of monitoring sites in this location”. This statement assumes there is substantial ‘N load-to-come’, a premise that does not withstand scrutiny, whilst also assuming that, regardless, water-quality outcomes cannot be improved even if there were increased load to the waterways (from whatever source). There are several potential processes that can reduce contaminant levels regardless of the initial inputs, including almost complete attenuation of nitrate in very short timeframes where strongly reducing conditions exist in groundwater or riparian zones.

Dr Richard George Cresswell

Principal Hydrogeologist, Eco Logical Australia

26 February 2019

Cited References

Clague, JC, Stenger, R and Morgenstern, U, 2019. The influence of unsaturated zone drainage status on denitrification and redox succession in shallow groundwater. Sci. Total Env. 660, 1232-1244

Hallberg, GR and Keeney, DR, 1993. Nitrate. Chapter 12 *in* Alley, WM (ed), Regional Ground-water Quality. Van Nostrand Reinhold. New York. ISBN 0-442-00937-2

Jin, Q and Bethke, CM, 2005. Predicting the rate of microbial respiration in geochemical environments. Geochimica Cosmochimica Acta, **69**, 1133-1143.

PCE, 2018. *Overseer and regulatory oversight: Models, uncertainty and cleaning up our waterways*. Parliamentary Commissioner for the Environment. Wellington. ISBN: 978-0-947517-12-0

Tesoriero, AJ and Puckett, LJ, 2011. O2 reduction and denitrification rates in shallow aquifers. Water Res. Research, **47**, W12522, doi:10.1029/2011WR010471