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:	**Various submitters as set out in Annexure 1 to the Joint Statement of Rebuttal** *Submitter*

Joint statement from Nic Conland, Michelle Sands, Phillip Jordan and Richard Cresswell in response to minute on modelling scenarios, issued by hearing Commissioners on 12 September 2014

Dated: 18 September 2014

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JOINT STATEMENT FROM NIC CONLAND, MICHELLE SANDS, PHILLIP JORDAN AND RICHARD CRESSWELL IN RESPONSE TO MINUTE ON MODELLING SCENARIOS, ISSUED BY HEARING COMMISSIONERS ON 12 SEPTEMBER 2014

INTRODUCTION

1 This joint statement is made by Nic Conland, Michelle Sands, Phillip Jordan and Richard Cresswell in response to the Minute on Modelling Scenarios issued by the Hearing Commissioners on 12 September 2014.

2 The full qualifications and experience of those making this statement are set out in the joint evidence in chief (*EIC*). We also again confirm that we have read the Environment Court practice note and that we have complied with it in preparing this evidence.

3 As with our EIC and rebuttal evidence (*RE*) this joint statement is made on behalf of all the submitters named in Annexure 1 to our RE.

RESPONSE ON MODELLED SCENARIOS

4 We refer to the minute on modelling scenarios issued by the Hearing Commissioners, dated 12 September 2014.

5 We can confirm that the scenarios detailed in Table 14 of our EIC are indeed the same five scenarios (with the same labels) that are discussed in our RE dated 8 September 2014. For clarity, the five scenarios that we refer to in both our EIC and RE are included and are summarised in **Table 1** of this supplementary evidence.

6 The five scenarios that we modelled are different to those that were modelled by Environment Canterbury (ECan), as referred to in the report by Robson (2014).

7 Nevertheless, there are three scenarios that are comparable between our modelling and the modelling undertaken by ECan (Robson, 2014). These three scenarios are as listed in paragraph 8 below.

Discussion of comparable Scenarios

8 In terms of further context (for the models that are comparable) it is noted that:

Scenario 1

8.1 Our Scenario 1 is comparable to the ECan Scenario 1 although there are some differences.

8.2 We ran the Source model for all scenarios for the climatic period between 1 January 1972 and 14 May 2014. As with all our scenarios we ran the Source model with a landuse map that did not vary temporally through the scenario run. However, when we analysed the output from all of our scenarios, we found that there was a model warm up period of between 5 and 8, years at the start of the run, when in-stream flows, soil moisture, drainage to groundwater, groundwater storage state and nutrient concentrations in the groundwater and stream are dependent on the initial model conditions and cannot be relied upon to be accurate.

8.3 Our analysis of outputs for all scenarios has therefore been restricted to the climatic period from 1 July 1980 to 14 May 2014, with the first 8½ years of the model run ignored to allow for transient effects to be excluded.

8.4 The use of this timeframe means the outputs from our Scenario 1 (as referred to in our EIC and RE) are comparable to the ECan modelling Scenario 1 outputs referred to in the Robson 2014 report.

8.5 Having completed our Scenario 1 modelling run, we compared flows and nutrient concentrations predicted from our Scenario 1 against ECan's observed data for the purposes of model calibration and did not have a separate calibration scenario. Our view is that since the transient effects of changes in landuse in the catchment are observed in the model outputs within about five to ten years and the majority of water quality monitoring and flow gauging is restricted to the period since about the year 2000, it was reasonable to compare outputs from our Scenario 1 against observed data for the purposes of demonstrating model calibration to observed data.

8.6 It should however be emphasised that the landuse map modelled in our Scenario 1 is not the same as that adopted in the ECan Scenario 1 for their modelling as, given the desire to improve the accuracy of the model inputs, we have adopted a spatial distribution of current landuse (that was informed through more vigorous existing landuse assessments and consultation with the primary production sector).

8.7 Overall, there are some potential appreciable differences that could influence the modelling outcomes for our Scenario 1 as opposed to the ECan Scenario 1, namely that:

(a) The ECan landuse map included no landuse category for Dairy Support, whereas our Scenario 1 model included 21,053 ha of dairy support.

(b) Our 2014 existing landuse layer also included an additional 12,558 ha classified as dairy, compared with ECan's 2011 Scenario 1 landuse map (58,150 ha from Tables 1, 2 and 3 of our RE compared with 45,592 ha from Table 62 in Appendix 9 of Robson, 2014).

(c) Scenario 1 modelled by ECan also included an additional 616 ha that were classified as lifestyle and golf (15,667 ha from Tables 1, 2 and 3 of our RE compared with 16,283 ha from Table 62 in Appendix 9 of Robson, 2014).

(d) The ECan modelling Scenario 1 included significant areas assigned as "Uncategorised" (17,532 ha from Table 62) and "Mask" (22,535 ha from Table 62).

8.8 We consider that the amended landuse areas that we have incorporated into the Source model provide a better and more accurate reflection of current actual landuse than those used in ECan's modelled Scenario 1.

Scenario 2b

8.9 Our Scenario 2b is comparable to ECan modelling Scenario 2 (Robson, 2014). The intention of our Scenario 2b and ECan Scenario 2 is to model the combined influences of an additional 30,000 ha in the catchment under irrigated agriculture, an associated switch from groundwater to surface water supply for the additional irrigated area and increasing leaching rates for agricultural landuse classes that are currently discharging less than 15 kg TN/ha/year to the 15 kg TN/ha/year limit.

8.10 Our understanding is that changes to landuse within the potential CPW command area (30,000 ha of new irrigation) have been implemented in a similar manner between our modelling and the ECan modelling.

8.11 In modelling Scenario 2b, we implemented groundwater restrictions on the total volume of irrigation water applied across the catchment to the limit imposed in Schedule 10 of proposed Variation 1 (estimated to have an annual reliability of 8.5 years out of 10), whereas ECan modelling apparently did not impose this limitation (refer to Robson, 2014, Appendix 2).

Scenario 3a

8.12 Our scenario 3a is comparable to ECan modelling for the Zone Committee Solutions package (Robson, 2014).

8.13 The intention of these scenarios were to model, the additional effects over Scenario 2b of reduction in allowable leaching rates by specified percentages, as specified in policy 11.4.14 of proposed Variation 1. These percentage reductions are the same to those specified in Table 59 of Robson (2014).

Further scenarios modelled

9 Our EIC and RE included two scenarios that were not modelled by ECan.

10 Scenario 0 represents "naturalised" flow conditions, with all currently irrigated landuses converted to dryland and all irrigation extractions (both surface and groundwater) removed. This scenario was run for the purposes of further calibration (being used for estimating minimum flows under natural conditions).

11 Scenario 2a represents existing landuse but with an allowance for increase in TN discharge to 15 kg TN/ha/year for those landuses below the limit and capping of irrigation extractions to the limit set out in Schedule 10 of proposed Variation 1. Scenario 2a also represents the predicted outcome that would occur under the plan if the additional 30,000 ha of irrigation (associated with CPW) were not to proceed.

12 The modelling by ECan includes three scenarios for which there is no comparable equivalent in the modelling that we have presented in our EIC and RE. These scenarios are Scenarios 2+, Scenario 3 and the Solutions Package 1 scenario.

Dated: 18 September 2014

Nicholas Conland, Michelle Sands, Phillip Jordan and Richard Cresswell

Table 1. Scenario set up for the Selwyn Waihora Source Model

	Scenario.	Model Objective	Key Inputs			Summary of findings	Comparable ECan Modelled Scenario (Robson, 2014)	
			Landuse	Total Nitrogen drainage values	Abstractions and flow restrictions		Scenario Number	Differences in modelling inputs and assumptions
Calibration	**1** **Current Conditions**	Calibration of water movement to gauged flows and FEMWATER fluxes Calibration of nitrate concentrations and attenuation functions Estimate current nitrogen loads to lake	Current landuse as informed by informed by Primary Sector (Best Info 2014).	Lilburne et al. (2013) look up table (LUT) for TN drainage rates to groundwater per unit area	The water use for abstractors is calculated from the soil moisture water balance for irrigation demand in the Source model. Water applied to irrigated area as 100% reliability on all days of modelling period. The existing minimum flow restrictions (MFL) restrictions on consented takes are applied.	The model is calibrated and can be used to predict of surface water and groundwater quantity and quality in the catchment. The model has a sufficiently long run time that the lag time in the groundwater is accounted for and our assessments account for the predicated long term outcome of landuse scenarios. The Source model predicts that the current DIN load is around 973 (t/year) to the lake.	1	Differences in existing conditions landuse layer, as discussed in paragraph 8.6. Our Source modelling simulates soil moisture, surface water runoff generation, drainage to groundwater, groundwater flow and denitrification in an integrated package, whereas the ECan modelling separates surface water and groundwater flow pathways and applies a factor for the effect of denitrification and dilution to total DIN loads to Lake Ellesmere / Te Waihora.
	0	Estimate naturalised flows (No Irrigation)	Best info 2014 with irrigated land changed to dryland Arable	Modified LUT to convert irrigated leaching rates to dryland arable leaching rates	Remove all consents. No MFL or allocation limits	Scenario run used for estimating minimum flows under natural conditions.	No Comparable Scenario	
Water Allocation	**2a**	Variation 1 proposal without CPW. Effects on Groundwater and Surface water quality Change in nitrogen lake load Effects of MALF for lowland streams	Best info 2014	Modify LUT to increase leaching rates for particular landuse areas to 15kg/ha/yr as per Variation 1	MFL restrictions as per Variation 1. Allocation capped to Variation 1 Allocation volumes calculated internally by model based on method in Schedule 10.	The Source model predicts increases from current in lowland stream concentrations of up to 15% (as 95th percentile DIN concentration). The Source model predicts a slight deterioration in mean groundwater Nitrate concentration from current (8%). The Source model predicts that the 2a scenario DIN load is around 1103 (t/year) to the lake. The Source model predicts decreases in the MALF of the lowland streams to the lake. It also predicts no improvement to the mean daily flows.	No Comparable Scenario	
Water Allocation	**2b**	Variation 1 proposal including CPW Effects on Groundwater and Surface water quality Change in nitrogen lake load Effects of MALF for lowland streams	2014 landuse, modified to include CPW irrigation scheme area	Modify LUT to increase leaching rates for particular landuse areas to 15 kg TN/ha/yr as per Variation 1	Water Allocation and MFL as per 2a Addition of CPW irrigation scheme diversions from Rakaia and Waimakariri Rivers. Change of CPW users from GW to SW.	There is a small increase in the likely exceedance of the maximum allowable value for nitrates in drinking water. The Source model predicts increases from current in lowland stream concentrations of up to 17% (as 95th percentile DIN concentration). The Source model predicts a slight deterioration in mean groundwater Nitrate concentration from current (8%). The Source model predicts that the 2b scenario DIN load is around 1132 (t/year) to the lake. The Source model predicts increases both the mean daily flows and the MALF in the majority of the lowland streams to the lake.	2	Differences in landuse for areas outside of the additional 30,000 ha of irrigated land (as discussed for Scenario 1 in paragraph 8.6). Significant differences in modelling approach, as for Scenario 1 above. ECan modelling applied no limitations to extractions, whereas the SOURCE model included limitations on extractions.
Nitrogen Allocation	**3a**	Variation 1 proposal with CPW and proposed clawback. Effects on Groundwater and Surface water quality Change in nitrogen lake load	As for 2b	Modify leaching rates based on clawback identified in Policy 11.4.14 Leaching rates capped at 80kg/ha/yr upper limit 11.4.16	As for 2b	The Source model predicts reductions from current in lowland stream concentrations of up to 15% (as 95th percentile DIN concentration). However, the Selwyn and Halswell River will likely have a small increase 3-4% (as 95th percentile DIN concentration). The Source model predicts a slight improvement in mean groundwater Nitrate concentration from current (3%). The Source model predicts that the 3a Scenario DIN load is around 1033 (t/year) to the lake.	Zone Committee Solutions Package	Differences in landuse for areas outside of the additional 30,000 ha of irrigated land (as discussed for Scenario 1 in paragraph 8.6). Significant differences in modelling approach, as for Scenario 1 above.

REFERENCES

Lilburne, L., Webb, T., Ford, R., Bidwell, V. (2013) *Estimating nitrate-nitrogen leaching rates under rural land uses in Canterbury* (updated). R10/127, Environment Canterbury

Robson, M. (2014) *Technical report to support water quality and quantity limit setting in the Selwyn Waihora catchment, Predicting the consequences of future scenarios, Overview Report*, January 2014.