

BEFORE THE

Canterbury Regional Council

IN THE MATTER OF

the Environment Canterbury
(Temporary Commissioners
and Improved Water
Management) Act 2010

AND

IN THE MATTER OF

Submission and Further
Submission on Proposed
Variation 2 to the Proposed
Canterbury Land and Water
Regional Plan

**STATEMENT OF EVIDENCE OF LIONEL JOHN HUME ON BEHALF OF THE COMBINED
CANTERBURY PROVINCES, FEDERATED FARMERS OF NEW ZEALAND**

Dated 15 May 2015

Introduction

Qualifications and experience

1. My name is Lionel John Hume. I hold B.Ag.Sc and M.Sc. (First Class Hons) degrees from Massey University and a Ph.D. (Plant Science) from Lincoln University. I am currently employed as a Senior Policy Advisor, by Federated Farmers, based in Ashburton. I am also a board member of Irrigation New Zealand.
2. I previously worked as a scientist for the Department of Scientific and Industrial Research (New Zealand Soil Bureau/DSIR Land Resources) in the areas of plant nutrition and soil fertility. Specific areas of scientific research experience include:
 - a. nutrient uptake and use by plants – particular emphasis on nitrogen and phosphorus;
 - b. nutrient availability from soils;
 - c. effects of soil acidity (particularly aluminium toxicity) on nutrient uptake and symbiotic nitrogen fixation;
 - d. nutrient, water and management factors affecting the growth and competitiveness of major weed species;
 - e. effects of soil physical properties on plant growth; and
 - f. experimental design and data analysis.
3. I am a member of the NZ Institute of Agricultural and Horticultural Science, the NZ Society of Soil Science and the Agronomy Society of NZ.
4. Currently I am a member of Federated Farmers' Regional Policy team and have ten years experience of working with regional water planning processes, including: the Natural Resources Regional Plan process (from submission through to resolution of High Court appeals); development of the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 and membership of the implementation taskforce for those regulations; the development of catchment-based flow and allocation plans for several Canterbury catchments; the development of the Canterbury Water Management Strategy; and, recently, the Regional Policy Statement and Land and Water Regional Plan processes, including several catchment based limit-setting processes.

Code of Conduct

5. Notwithstanding that this is a Regional Council hearing, I have read the Environment Court Code of Conduct for expert witnesses and agree to comply with it. I confirm that I have not omitted to consider materials or facts known to me that might alter or detract from the opinions I have expressed.

Scope of evidence

6. My evidence covers the following matters:
 - a. Potential environmental impacts of farming;
 - b. Soil water and water availability to plants;
 - c. Reliability of water supply and its importance to efficient water use;
 - d. Fluctuation of N discharge from soils in response to climatic variation and the cyclical nature of routine farming operations;
 - e. Canterbury soils - the predominance of stony soils vulnerable to drainage and nutrient loss;
 - f. N discharge allowance – the need to take soil type into account;
 - g. Flexibility threshold – to enable low N dischargers the flexibility to carry on normal farming operations and make reasonable land use changes; and
 - h. Matrix of Good Management.

Potential environmental impacts of farming

7. Potential environmental impacts of farming on water quality include loss of nutrients (particularly N and P), sediment and harmful bacteria (indicated by *E. coli*) from soils.
8. N in nitrate form is highly soluble, will move anywhere that water goes and is vulnerable to loss via drainage. Therefore, the most effective methods of minimizing N loss are to match N supply with plant demand (to minimize the pool of N vulnerable to leaching) and to minimize drainage.
9. P is less soluble and tends to move with sediment. The risk of sediment loss is identified in the Upper Hinds/Hekeao Plains area and this is addressed by “requiring all farm activities to operate at GMP to maintain current P losses”. Methods to minimize sediment and P loss are to minimize surface flow of water containing suspended sediment, P and *E. coli* (where present) by avoiding over-irrigation, by maintaining

vigorous vegetation cover and via riparian management aimed at intercepting sediment and phosphorus (and *E. Coli* where present) before they enter waterways.

10. Soils vary in their ability to filter *E. coli*. In strongly structured soils *E. coli* may move through the soil by bypass flow, through larger pores and structural cracks. In soils without strong structure, matrix flow predominates, with more effective filtration and retention of *E. coli*.

Soil water and water availability to plants

11. Water is crucial for plant growth and to sustain agricultural production. An understanding of how water is stored in soils and its availability to plants is essential in order to be able to manage it effectively, to optimize plant growth, and minimize drainage and consequent dissolved nutrient loss.
12. Field capacity has been defined as the amount of water that a well drained soil holds against gravitational forces, when downward drainage is markedly decreased. However, it is recognized that field capacity is an imprecise term and that true equilibrium is never reached. Although it varies with both soil type and conditions such as temperature, field capacity is often estimated to be the water held at a soil water potential (or suction) of -33 kPa. This is a measure of the energy that has to be used to extract water from the pores in a soil.
13. As soils dry out, the energy required to extract water increases to a point where plants wilt and do not recover overnight. This is known as permanent wilting point and generally occurs at about -1500 kPa. The water held in a soil between field capacity and permanent wilting point is known as plant-available water. However, water is not equally available over this entire range and extraction becomes increasingly difficult as permanent wilting point is approached. Once about the first half of plant-available water is used, the increasing energy required to extract further water results in decreased plant growth and decreased crop yield. In order to optimize plant growth, irrigation needs to be scheduled to keep plant available water above the 50% mark. Obviously there is less margin for error in this regard on soils with less plant available water.
14. The quantity of plant-available water is dependent on soil type, including factors such as:

- Soil texture – fine textured soils tend to retain more water than coarse textured soils.
 - Soil structure – the degree of aggregation of primary soil particles into structural units. Organic matter assists with the development and maintenance of good soil structure and increased plant available water.
 - Stones – stony soils retain less water than soils without stones (because of lesser soil volume). This is an important issue for Canterbury soils where some horizons may contain more than 50% stones.
 - Soil depth – deep soils retain more water than shallow soils (because of greater soil volume).
 - Impermeable or slowly-permeable layers – may prevent or reduce water movement through the soil profile and therefore drainage from it.
15. Soils which have the capacity to store less plant available water are more vulnerable to loss of water (and dissolved nutrients) via drainage compared with soils which have greater plant available water. The reason for this is that there is less ‘buffering capacity’ in soils with less water storage and therefore less capacity to store incoming rainfall without drainage losses. On soils which are irrigated, there is less capacity to deficit irrigate (leaving capacity to store incoming rainfall by not watering up to field capacity) where there is less water storage (especially given that only half of the stored water is easily available).
16. Therefore, irrigating little-and-often, using soil moisture monitoring, is likely to result in more efficient use of irrigation water for plant uptake and less potential for soils to exceed field capacity and leach nutrients, compared with less frequent application of greater quantities.

Reliability of water supply

17. Access to a reliable water supply is crucial for efficient water use, especially on the moderate to very light stony soils in Canterbury which tend to have low water storage and moderate to rapid permeability. A constantly available, reliable water supply encourages investment in modern irrigation technology and enables little-and-often approaches to the application of irrigation water (providing the benefits outlined in the previous paragraph). It also removes the need for use-it-or-lose-it approaches to irrigation which are encouraged by intermittent and unreliable supply. If it is known that water will be available when it is needed, the appropriate amount can be applied when it

is needed ('just in time' rather than 'just in case'). Reliability of supply also encourages the use of deficit irrigation, e.g. to leave storage capacity for expected rainfall, by providing the assurance that further water will be available if the expected rainfall does not eventuate.

18. Reliable water supply enables communities to maximise the benefits from irrigation. For example, it enables the development of high value arable and horticultural production systems where crop loss (decrease in yield or quality) or failure could occur if water is not available in the right quantity at the right time.
19. When irrigators have less reliability they tend to use greater quantities of water when it is available, hoping that will provide sufficient soil moisture and plant growth to minimize the impacts of possible future shortage (such as restrictions on takes related to minimum flows).
20. Limiting the calculation of reasonable use to method 1 in Schedule 10 (records of past use moderated to ensure that the annual volume is sufficient to meet demand in 9 years out of 10) will potentially reduce reliability of supply. Demonstrated use is likely to reflect short term rainfall conditions rather than long term requirements. Depending on the period over which records have been kept, demonstrated use reasonable use may under-estimate need and therefore reduce reliability, or it may encourage inefficient water use as consent holders seek to increase their allocation based on reasonable use as determined by method 1. In my opinion, the exclusive use of method 1 potentially discourages the efficient use of irrigation water that is crucial in a catchment which is deemed to be over-allocated for both water quantity and water quality.

Fluctuation of N discharge

21. N discharge will fluctuate from year to year under constant land use (farming activity). Fluctuations result from:
 - Climatic variation, especially rainfall¹:
 - Variation in drainage and consequent N loss (e.g. resulting from heavy rainfall events). This will be more pronounced on soils with relatively less plant available water.

¹ http://resources.ccc.govt.nz/files/NaturalHazards_1758_AnnualRainfall-docs.pdf

- Surface flow events where incoming rainfall exceeds the infiltration capacity of the soil. This may result in loss of sediment and P, as well as dissolved N.
 - Variation in plant growth (crop yield), plant N uptake and urine deposition (in the case of livestock farming) as influenced by varying conditions for plant growth, availability of animal feed etc.
 - Cyclical variation in farming operations, including:
 - Crop rotations.
 - Livestock changes in response to market signals.
22. In order to be workable, any regulatory regime to manage N loss (such as the baseline provisions in Variation 2) should recognize the seasonal fluctuations which occur as part of biophysical systems and in response to market signals. Such fluctuations may occur over an extended period, longer than four years (being the duration of the 2009-2013 “nitrogen baseline” period and the 4 year rolling average “nitrogen loss calculation” period). These fluctuations in N loss are conceptually different from the sort of change which arises from a radical change of land use, from one with inherently low rates of N loss to another with substantially greater (perhaps several fold) rates of N loss (such as a change from dry-land sheep and beef farming to irrigated dairy farming). It is these gross changes in land use and associated N loss that will have the greatest long-term impact on water quality.

Canterbury stony soils

23. Soil type is a key factor influencing drainage and the loss of soluble nutrients (especially N) in Canterbury. Canterbury has 890,000 ha of stony soils (soil depth less than 45 cm to gravels), which are classified moderate, light or very light (in terms of their primary soil class)². These soils occupy 64% of the total land area in Canterbury that could potentially be used for intensive agriculture (less than 15 degree slope). They have moderate to rapid permeability, and a large proportion have low water storage (less than 60 mm or 60-90 mm for very light and light soils respectively). Therefore, these soils are vulnerable to drainage and consequent loss of soluble nutrients. In 2012, 143,000 ha of Canterbury’s stony soils were used for dairy farming and 196,000 ha were under irrigation. While the numbers quoted refer to the whole of Canterbury, in percentage

² Carrick, S.; Palmer, D.; Webb, T.; Scott, J.; Lilburne, L. 2013: Stony Soils are a Major Challenge for Nutrient Management Under Irrigation Development. In: Accurate and efficient use of nutrients on farms. (Eds L.D. Currie and C.L. Christensen). Occasional Report No. 26. Fertiliser and Lime Research Centre, Massey University, Palmerston North, New Zealand.

terms they are equally true for the Hinds catchment, where shallow stony soils occupy much of the land area west of State Highway 1.

24. The contrast between very light to moderate stony soils and heavier soils is stark. In a study of nitrate leaching from cow urine patches in Canterbury, leaching from a Lismore shallow and stony soil (at the better end of stony soils in terms of its water storage capacity) was double that from a stone-free Templeton soil^{3&4}.
25. Therefore, it is crucial that soil type is taken into account when establishing N discharge limits or thresholds in a planning context, to allow for greater drainage and nutrient leaching from light, stony soils compared with deep, fine textured soils. Allocation on the basis on Land Use Capability (LUC) classification, where better soils are allocated greater N discharge than poorer soils, as requested by one submitter to Variation 2 (Central South Island Fish and Game Council), is not logical, particularly on the Canterbury Plains which has 64% stony soils and 75% of soils in LUC classes 3 to 7⁵. Such an approach would greatly reduce production from Canterbury's stony soils.

N discharge allowance

26. If the commitment of the Ashburton Zone Committee to improve cultural and environmental outcomes in the Hinds Plains area "while maintaining farm viability and providing for further economic growth" is to be achieved, a large proportion of the productive potential of the Hinds catchment (and the wider Canterbury region) and its soils will need to be maintained. In order for the productive potential of soils to be expressed, it will need to be accepted that, even with a high standard of management, there will be greater drainage of water and soluble nutrients (especially N) from some soils than others. Therefore, if we wish to maintain the productive potential of soils in the Hinds catchment, it is important for Variation 2 to allow for greater rates of N discharge from those soils with a greater vulnerability to drainage i.e. the stony soils classified very light through to moderate, discussed previously. These soils have the potential to be highly productive and make up approximately 64% of the area of the land with potential for intensive land use in Canterbury. Again, while this percentage refers

³ Di, H.J. and Cameron, K.C. 2005: Reducing environmental impacts of agriculture by using a fine particle suspension nitrification inhibitor to decrease nitrate leaching from grazed pastures. *Agriculture, Ecosystems & Environment* 109, 202-212.

⁴ Di, H.J. and Cameron, K.C. 2007: Nitrate leaching losses and pasture yields as affected by different rates of animal urine nitrogen returns and application of a nitrification inhibitor – a lysimeter study. *Nutrient Cycling in Agroecosystems* 79, 281-290.

⁵ Canterbury Natural Resources Regional Plan, Chapter 8: Soil Conservation. Operative 11 June 2011.

to the whole of Canterbury, it is at least equally true for the Hinds catchment where shallow stony soils occupy much of the land area west of State Highway 1.

27. If the very light, light and moderate soils are unable to be used to their reasonable potential, this would potentially have a major adverse social and economic impacts on the Hinds catchment and the wider region. This was illustrated by 'scenario 3' of the Selwyn Waihora limit-setting process where measures required to reduce the trophic level index of Te Waihora to 6.0 were explored. This extreme scenario featured very low intensity sheep and beef farming on the extensive areas of light to extremely light soils, with no irrigation and no N fertiliser application. Under this scenario, most income was generated from very intensive dairying, on good soils (with less vulnerability to drainage), using advanced mitigation. While, under this scenario, the regional contribution to GMP was greater than the 'current' situation, it was considerably less than 'scenario 2' where a lesser level of intensification, with less advanced mitigation, was assumed across the whole catchment. 'Scenario 3' involved considerable capital costs of transition and considerable social disruption, and was considered to be unacceptable.
28. In the Hinds catchment, required reductions of N discharge (from a baseline of good management practice) in the proposed plan would substantially reduce farm gross income (Federated Farmers submission under Section 32 Evaluation Report and evidence of Mr George Lumsden). Mr Lumsden estimates that the Variation 2 provisions, requiring reductions in N discharge from dairy farming, will reduce cash farm surplus for a modal farm by over 90% compared with what it would have been without having to comply with those provisions.

Flexibility cap

29. The purpose of a flexibility cap is to provide a degree of equity for low N dischargers by allowing them the flexibility (as a permitted activity) to carry on with their normal farming operations, which are typically cyclical in nature, and to make reasonable changes in land use (without converting to a high N discharge land use) in response to market signals. A flexibility cap of 15 kg/ha/year will give reasonable flexibility for those on deep, fine textured soils or poorly drained soils but less for those on shallow, coarse textured soils (which have greater vulnerability to drainage).
30. Any flexibility cap, along with other thresholds in the plan, will need to be adjusted in line with the changes in N discharge estimates generated by new versions of Overseer. As

well as overall changes, it should be noted that new versions of Overseer will result in differential changes in N discharge estimates between soil types.

Matrix of Good Management

31. The Matrix of Good Management (MGM) project is currently being undertaken by Environment Canterbury in partnership with the primary sector and Crown Research Institutes. The main purpose of the project is to define good management practices, and to quantify and benchmark nutrient (especially N) losses from farms across Canterbury's soils and climates. It will define what can reasonably be expected in terms of nutrient discharges from various combinations of land use, soil type, climate and topography, and identify a range of management practices designed to minimize nutrient discharge.
32. The MGM project should provide a great deal of useful information to assist with managing N loss, setting catchment limits and establishing N reduction regimes where these are required. It will provide key information about which combinations of land use and land use practices are likely to meet various N loss targets and, therefore, about the likely social and economic effects of different catchment limits and N reduction regimes.
33. The MGM benchmarks should provide an ideal basis for planning rules which:
 - Recognize the investment in existing land use.
 - Enable the productive potential of all land to be expressed – within the constraints of soil type, climate and topography, recognizing that water and nutrient deficiencies can, and mostly will, be overcome.
 - Allow for nutrient discharge only where it cannot be avoided without frustrating reasonable land use.
 - Assume an appropriate level of good management practice.
 - Facilitate flexibility of land use and enable regional economic wellbeing.
 - Assist with achieving the desired outcomes for the Hinds Plains area.

References:

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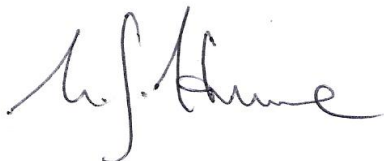
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A handwritten signature in black ink, appearing to read 'L. Hume', written in a cursive style.

Lionel Hume

15 May 2015