

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 Plan
Change 3 to the Proposed
Canterbury Land and Water
Regional Plan

**STATEMENT OF EVIDENCE OF DR LIONEL JOHN HUME ON BEHALF OF THE SOUTH
CANTERBURY PROVINCE OF FEDERATED FARMERS OF NEW ZEALAND**

Dated 25 September 2015

South Canterbury Federated Farmers Inc
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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 Canterbury 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 culminating in plan changes.

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 – wide range of vulnerability 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 minimising N loss are to match N supply with plant demand (to minimise the pool of N vulnerable to leaching) and to minimise drainage.
9. P is less soluble and tends to move with sediment. The risk of sediment and phosphorus loss is identified in Proposed Plan Change 3. These risks are addressed via the use of Farm Environment Plans prepared in accordance with Schedule 7, which includes a requirement to manage soils in order to minimise the movement of sediment, phosphorus and other contaminants to waterways. Methods to minimise sediment and P loss are to minimise 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*.
11. Farm Environment Plans (FEP's) are a powerful tool for addressing the loss of nutrients (mostly N and P), sediment and harmful bacteria (indicated by *E. coli*) from soils because they are able to address these issues in the context of particular land uses in particular farming environments. However, FEP's come with a cost and capacity to produce them is limited (because of a limited number of suitably qualified personnel). Therefore, their use as a regulatory tool is best focused on properties where significant nutrient, sediment or *E. Coli* discharge issues are likely to arise.

Soil water and water availability to plants

12. 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 optimise plant growth, and minimise drainage and consequent dissolved nutrient loss.
13. 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 recognised 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.
14. 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 optimise 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.

15. 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.
16. 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.
17. 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

18. 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 (referred to previously). 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.

19. 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.
20. 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 minimise the impacts of possible future shortage (such as restrictions on takes related to minimum flows).
21. 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) as in Clause 2 (ii) of Rule 15.5.27 or Clause 4 (ii) of Rule 15.5.30 (for consent applications lodged on or after 20 December 2021) 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 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. This is crucial in any catchment which is deemed to be fully or over-allocated for either water quantity or water quality. There appears to be no valid reason why all Schedule 10 methodologies should be available to determine reasonable use before 20 December 2021 and only method 1 from that date.

Fluctuation of N discharge

22. 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.
 - 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.

23. In order to be workable, any regulatory regime to manage N loss, such as the nutrient management rules in proposed Plan Change 3, must recognise 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 as defined in Section 2.9 of the Canterbury Land and Water Regional Plan). 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 potentially have the greatest long-term impact on water quality.

¹ Long term records show that annual rainfall on the Canterbury Plains can vary by up to 100% year to year. See for example:

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

Canterbury soils

24. Soil type is a key factor influencing drainage and the loss of soluble nutrients (especially N) in Canterbury². 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)³. 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.
25. The numbers quoted in the previous paragraph refer to the whole of Canterbury. The percentage of stony soils in South Coastal Canterbury will be substantially less than for central or Mid Canterbury, but there is a wide diversity of soils in terms of their potential to leach nutrients, ranging from extremely light through to fine-textured and deep soils, with substantial areas of poorly drained soils.
26. 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^{4&5}.
27. Therefore, it is crucial that soil type is taken into account when establishing N discharge limits or thresholds in a planning context.

² Lilburne, L.; Webb, T.; Ford, R. & Bidwell, V. 2010: Estimating nitrate-nitrogen leaching rates under rural land uses in Canterbury. Environment Canterbury Report No. R10/127.

³ 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.

⁴ 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.

⁵ 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.

N discharge allowance

28. The desired outcomes stated in the South Coastal Canterbury ZIP Addendum (September 2014) are that “Wainono Lagoon is a healthy ecosystem”, that “coastal streams have high water quality” and that there is a “vibrant economy and sustainable growth”. Under the third heading, it is stated that there should be a “growing local economy”, “highly reliable and secure irrigation” and “a diversity of farming systems”. To achieve this, a large proportion of the productive potential of South Coastal Canterbury 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, I support the approach taken in Proposed Plan Change 3 to base the Nitrogen Maximum Cap Limits (Table 15(n)) on soil type, with a greater discharge limit for light soils with greater propensity for drainage. If we wish to maintain the productive potential of soils in South Coastal Canterbury, it is important for the Plan to allow for greater rates of N discharge from those soils with a greater vulnerability to drainage (i.e. the soils classified very light through to moderate). These soils have the potential to be highly productive and make up a significant proportion of the area of the land with potential for intensive land use.

Flexibility caps

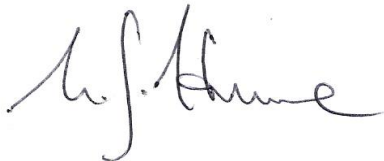
29. The purpose of a flexibility cap is to allow low N dischargers the flexibility to carry on with their normal farming operations, which are typically cyclical in nature, and to make reasonable changes in land use (without converting to a high N discharge land use) in response to market signals. For the reasons stated previously, the proposed single number thresholds across all soil types (Table 15(m)) give greater flexibility to those on deep, fine textured soils or poorly drained soils (which have less vulnerability to drainage) than to those on shallow, coarse textured soils (which have greater vulnerability to drainage).
30. Care must be taken to ensure that the flexibility cap gives all land users a reasonable degree of flexibility and enables them to farm normally, taking into account the factors which may result in fluctuation of N discharge, discussed above. To this end it would be advantageous to have a two (or more) tiered flexibility cap based on soil type specified in table 15(m) (in a similar way as has been provided for the maximum caps in Table 15(n)).

31. Recognising the linkage between soil type and potential N loss would enable the management of N loss in a way that is more equitable to land users. If the thresholds are set appropriately, this would enable reasonable flexibility of land use on all soil types, without allowing for conversion to high N loss activities without further scrutiny. In my opinion, a tiered approach based on soil types (e.g. 15 kg/ha/yr for heavy, poorly drained and medium soils and 20 kg/ha/yr for light and very light soils) would help to achieve that outcome. The actual numbers would depend on how the Overseer estimates match up with farm practice, in order to enable a reasonable degree of flexibility for those engaged in activities with relatively low rates of N discharge.
32. Care must also be taken to ensure that changes in Overseer version do not erode the effectiveness of the flexibility caps. This is problematic in a planning context because of the difficulty of changing numbers in a plan via the RMA plan change process. A way around this might be to have narrative thresholds, caps or limits in the plan which can be linked to a model-generated number outside the plan (MGM/Overseer). This concept was developed by the Matrix of Good Management (MGM) Working Group whose role was to develop options for implementing the MGM project.
33. Currently, there is concern about the impact of the new version of Overseer (Version 6.2) on the absolute numbers in Table 15(m), and whether or not the intended flexibility afforded by these caps has been eroded.

Matrix of Good Management

34. The Matrix of Good Management (MGM) project is currently being undertaken by Environment Canterbury in partnership with the primary sector. The main purpose of the project is 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 minimise nutrient discharge.
35. 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.

36. The MGM benchmarks should provide an ideal basis for planning rules which:
- Recognise 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, recognising 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 stated in the South Coastal Canterbury ZIP Addendum (September 2014).



Dr Lionel Hume
25 September 2015

References:

Aqualinc Research Ltd Memorandum, July 2014: Modelled irrigation demand changes – 90th percentile vs 85th percentile.

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.

Cornforth, I. S. 1998: Practical Soil Management. Lincoln University Press with Whitireia Publishing and Daphne Brasell Associates Ltd.

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.

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.

Lilburne, L.; Webb, T.; Ford, R. & Bidwell, V. 2010: Estimating nitrate-nitrogen leaching rates under rural land uses in Canterbury. *Environment Canterbury Report No. R10/127*.

McLaren, R.G. and Cameron, K.C. 1990: *Soil Science - An introduction to the properties and management of New Zealand soils*. Oxford University Press.

Kirkham, M. B. 2014: *Principles of Soil and Plant Water*. Academic Press.

Sutcliffe, J. 1968: *Plants and Water*. Edward Arnold (Publishers) Ltd.