IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of the hearing of submission on Proposed Plan Change 1 (and Variation 1 to the Waikato Regional Plan)

TOPIC 2

BY **FEDERATED FARMERS OF NEW ZEALAND INC, FEDERATED FARMERS OF NEW ZEALAND (WAIKATO REGION) 1999 INCORPORATED, FEDERATED FARMERS OF NEW ZEALAND – ROTORUA TAUPO PROVINCE INCORPORATED, FEDERATED FARMERS OF NEW ZEALAND (AUCKLAND PROVINCE) INCORPORATED**

("FEDERATED FARMERS")

Submitter with ID: 74191

To **WAIKATO REGIONAL COUNCIL**

("WRC")

STATEMENT OF REBUTTAL EVIDENCE OF IAN FRANCIS MILLNER FOR FEDERATED FARMERS ON HEARING TOPIC 2

10 May 2019

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STATEMENT OF REBUTTAL EVIDENCE OF IAN FRANCIS MILLNER

1. INTRODUCTION

1.1. My full name is Ian Francis Millner. My qualifications and experience are set out in my primary evidence dated 3 May 2019.

1.2. In the context of this rebuttal evidence, I consider what is particularly relevant is that I was involved in the Tukituki Plan Change 6 (where a nitrogen allocation approach based on Land Use Capability (LUC) was adopted) and Rotorua Plan Change 10 (where a nitrogen allocation based on LUC was proposed by one of the Environment Court appeals).

1.3. In relation to this rebuttal evidence, I confirm my compliance with the Code of Conduct for Expert Witnesses as set out in my primary evidence.

1.4. Due to the volume of evidence that has been filed, and the available time for preparing rebuttal evidence, it has not been possible to review and respond to all of the evidence. Accordingly, I have focused my rebuttal evidence on several matters that were not addressed in my primary evidence but are raised by other submitters and would result in fundamental and/or radical changes to PC1.

2. Land Use Capability (LUC)

2.1. Beef + Lamb have filed four statements of evidence, and I understand that there are a further three that are due to be filed on 10 May 2019. While it is difficult to understand the exact nature of the proposal, I understand from the evidence that has been filed that Beef + Lamb is proposing a nitrogen allocation approach based on Land Use Capability (**LUC**).

2.2. It is not clear whether the LUC proposal will apply to all land uses, or whether it will only be applied to low intensity drystock properties to allow them to potentially intensify (with greater reductions in turn expected from dairy or higher intensity farms). It is also not clear whether or how a catchment or FMU nitrogen load will be calculated, how that will be apportioned among the LUC classes or what the N allocation at a property level will be. No examples are provided as to how it would be applied to an individual farmer, the current

match between farming activities and LUC classes in the Waikato and what types of numbers farms might be allocated.

2.3. Without these details about the proposal, it is very difficult to comment on the evidence filed by Beef + Lamb to date. Accordingly, I have responded to the evidence of Dr Dewes, Dr Mackay, Mr Parkes and Mr Stokes where it is possible, but it is clear that there is some fundamental information missing that will impact on my views about what they are proposing. I may be able to provide a fuller response once the further evidence is filed and I have an understanding of the complete details of their proposal.

Purpose and development of LUC

2.4. At paragraphs 16 to 52 of his evidence, Mr Stokes sets out the history of LUC and describes how it comprises a resource inventory (that compiles the physical factors of land) and an LUC classification (where land is categorised into classes based on its capability to sustain one or more productive use). A lot of what Mr Stokes says is factual and based on the LUC Handbook. However, there are several parts of Mr Stokes' account that I do not agree with.

2.5. Mr Stokes' evidence paints a picture of LUC having a long and established history for reliably mapping and classifying land. I do not consider that to be the case.

2.6. Mapping of the initial LUC units across New Zealand was conducted primarily during the 1960s to 1970s. Often land was mapped as a desktop exercise using stereoscopes and aerial photography (this process produces 3 dimensional images). This resulted in low spatial resolution maps of around 1:50,000. Often units were mapped without a person actually walking the land.

2.7. This has resulted in a mapping system that is useful for regional scale analysis but is generally regarded as having limited utility at sub-catchment or farm scale. As an example, a sub-catchment program I developed in 2009 in Southern Hawkes Bay involved remapping the catchment LUC at farm scale. This involved remapping key characteristics of the Land Resource

Inventory ("**LRI**")[1] for the catchment. The net result was approximately 15% more units of a higher class i.e. all of the small areas of easy class 3 and 4 land that had previously been included with class 6 was able to be identified and mapped. In my opinion, the degree of change from regional mapping will vary from sub-catchment to sub-catchment.

2.8. It is not clear whether the Beef + Lamb proposal would involve remapping at a finer scale (and this may be clarified in the planning evidence that is still to be filed). At paragraph 16 of his evidence, Mr Parkes states that a specific FEP scale LUC map (1:10,000) should be undertaken. At paragraph 37(a) of Mr Parkes' evidence, there is the further suggestion that it is at a 1:5,000 to 1:10,000 scale.

2.9. If the Beef + Lamb proposal is that such LUC scale mapping ought to be undertaken as part of every FEP and/or as part of N allocation, I have some significant concerns about the potential time and cost involved in such a requirement. I am also concerned that any mapping exercise is a subjective assessment. This may impact on the consistency and certainty in the application of any rule framework for farmers. However, it is very difficult to comment on this aspect without seeing further details of the proposal.

2.10. In terms of the time and cost, LUC mapping to a farm scale or property level would take considerable time depending on the size of the farm and variability in land classifications and sub-classifications. To give the Hearing Panel an idea, I estimate that for a typical farm it could take at least 50 hours (but this is a very rough estimate).

2.11. A further issue with re-mapping is the impact on catchment loads. Without further details about the Beef + Lamb proposal, I am not able to comment about whether a re-mapping exercise at a property level would impact on the catchment load. It is conceivable that it could if it resulted in significant changes to the LUC classifications. However, it will depend on factors such as how the catchment load is intended to be apportioned among the LUC classes (as well as factors such as attenuation that are not reflected in LUC)

[1] The Land Resource Inventory is the assessment of physical factors considered to be critical for long term land use and management that was compiled when the LUC handbook was originally published in 1971.

and without these details I am not able to form a view on this issue at this stage.

2.12. In respect of my concerns about the subjectivity of the mapping exercise, it is common to find LUC maps at farm scale, produced by different individuals that have different units (or even completely new units) and therefore different stocking rates. Accordingly, updating LUC maps will likely create uncertainty and inconsistency, between farmers, across sub-catchments and across the catchment, due to this potential subjectivity.

Current uses of LUC

2.13. At paragraphs 49 to 52 of his evidence, Mr Stokes uses an example of a Land and Environment Plan (**LEP**) using LUC as a decision support tool to inform management decisions on two farms (at paragraph 54 of his evidence, Mr Parkes confirms that it is an LEP 3, the "gold plated" plan, that uses LUC). Mr Stokes also refers to the introduction of new tools such as lidar, geo-magnetic surveying, catchment modelling etc to inform FEP options. I agree that the LUC Handbook can be a useful decision support tool and can, along with the use of other tools such as those Mr Stokes refers to, inform FEPs. However, this is very different from using it in a regulatory sense to allocate nitrogen.

2.14. I also wish to record my view that LUC mapping as part of FEPs should not be compulsory. While it may be a useful tool, I consider that in many cases the significant cost in farm scale mapping outweigh the benefits (particularly in light of limitations with the stock carrying capacities (discussed below) that are typically sought to be applied to the LUC classes). I also consider that the LUC assessment is too subjective (and therefore uncertain) to be a mandatory requirement for FEPs.

2.15. LUC is widely used for high level analysis of landscape features. This includes soil types (where more recent soil surveys have not been completed), erosion types and severity, and slope. For example, when developing criteria for stock exclusion in the Tukituki Resource Management Plan (**PC6**) Hawkes Bay Regional Council based the requirements for stock exclusion around a slope class (<15 degrees). This was done because the LRI provided an easily accessible and region wide map of different slope classes. It was recognised when developing that policy that the LRI slope

map would not be completely accurate and that the ability for slope to be assessed at farm scale would need to be provided for.

2.16. At paragraphs 66 to 68 of his evidence, Dr Mackay refers to the use of LUC in the Horizons One Plan and Tukituki PC6 to allocate nitrogen. I do not agree that these frameworks are robust or provide support for adopting a LUC allocation framework in the Waikato.

2.17. The One Plan and PC6 use LUC to identify N leaching limits or thresholds on a proportional basis relative to an assessment of potential carrying capacity in the late 1970s to early 1980s. In the Horizons and Tukituki cases the potential stocking rates are developed into an area weighted average and converted into an amount of dry matter then incorporated into an Overseer file to establish an N loss for a particular class of land.

2.18. I note that this assessment requires numerous assumptions to be made about the farm system and in many cases they do not reflect the actual farm system. In my view, this is a fundamental flaw of the approach in Horizons and Tukituki.

2.19. From what I have read, Beef + Lamb's proposal will also rely on the LUC system to differentially apportion N loss across various classes of land. However, unlike Horizons and Tukituki, it appears that Beef + Lamb will not use Overseer to determine N leaching limits for each LUC class. A further potential difference may be that Horizons only applied the LUC allocation to high intensity farming, and I understand that Beef + Lamb may propose to only apply it to low intensity farming. However, this is not clear from the evidence filed to date so I am not able to comment on this.

2.20. My understanding from paragraph 69 of Dr Mackay's evidence is that instead of relying on Overseer, Beef + Lamb will rely on Top Farmer livestock numbers for each LUC class to rank relative productive potential of land and then apportion N to each Top Farmer stocking rate based on Dr Dewes' experience (an approach that I critique below). The use of the Top Farmer numbers is a further difference from the Horizons and Tukituki approach which were based on the Carrying Capacity Potential (**CCPO**) numbers in the LRI.

2.21. The “Top Farmer” stocking rates are the number of stock units per hectare that the farmer with the highest level of stocking rate, with at least average stock performance, was carrying on a particular LUC unit at the time they were assessed (during the 1970s and 1980s). They should not be confused with the “best farmer” in terms of water quality or nitrogen leaching. It is simply the “highest intensity farmer” in terms of stocking rate. There is no relationship with N leaching or the capacity of classes of land to leach a certain level of N or the assimilative capacity of land and water.

2.22. I explain my concerns below with how the Top Farmer stocking rates were calculated in the LRI. At this point I wish to raise a concern about the application of the “Top Farmer” stocking rate to average or below average farms, particularly where there is an indication that this may be the level to which they can increase.

2.23. While it is difficult to comment without understanding the whole proposal and while only some of the evidence has been filed, if the intention is that all farmers that are subject to the LUC allocation regime can come up to the N allocated to the Top Farmer stocking rates, the risk is that the approach over allocates N and creates a windfall gain for average and below average farmers.

2.24. At paragraphs 179 to 181, Dr Dewes states that she considers that grandparenting would enable dairy to “game” the system. By this she means that they could slightly change their practices (e.g. apply fertiliser during winter instead of summer) to increase their Nitrogen Reference Point and allow them to farm up to a higher number. I consider such an outcome highly unlikely and I consider the risk identified with the Top Farmer approach (i.e. average farmers farming up to that number) a more realistic risk.

2.25. There are many constraints on farm systems. Options for dairy farmers to intensify are limited by resource constraints (e.g. water allocation) and cost constraints (e.g. extra stock will mean extra feed, extra cows to milk etc). The costs of increasing up to the types of increases in N numbers that Dr Dewes is talking about (would could be 1-2kgN/ha) would significantly outweigh any increase in income, especially when considering that these types of actions would be designed to avoid regulatory risk. A far more likely

outcome is that farmers will be seeking to avoid being implicated in any 75th %ile obligation.

2.26. The converse is not necessarily true for drystock farmers farming up to a Top Farmer number. It will depend on their farm system, farm type and the N allocation but it is conceivable that the system could completely change (along with its contaminant risk profile). A currently run down drystock farm with 4.7 stock units per hectare could conceivably intensify to dairy grazing, bull finishing or some other intensive drystock activity at an average stocking rate of 16 or 17 (as is proposed by Dr Dewes in her Table 4 for those with class 4 land).

2.27. Getting back to Dr Mackay's comparison of Beef + Lamb's proposal against Horizons and Tukituki, without seeing Dr Cox's evidence about N loads and Ms Jordan's evidence about the planning framework, and any other evidence Beef + Lamb may file to explain their proposal, it is not possible for me to comment further about how they compare.

2.28. At paragraphs 196 to 204 of her evidence, Dr Dewes sets out her concerns with using Overseer to predict catchment loads. I consider that it is premature to be estimating a catchment load for the Waikato (or the FMUs). It is also very difficult to comment on Overseer without understanding Beef + Lamb's approach. An issue that is not raised is that I assume that compliance with any LUC allocation at a property would need to be assessed using Overseer, and I have not seen any discussion about this in the evidence filed to date. I have concerns that using Overseer in this way is contrary to the Overseer guidelines 2016 and 2018. Alternatively, if the proposal was to base it on a stocking rate, I set out my concerns about this at the end of my evidence.

Relationship between LUC and N

2.29. At paragraph 41 of his evidence, Dr Mackay states that there is currently no direct measure for natural capital. At paragraph 42, he effectively says that LUC is a proxy for natural capital (based on his opinion that it reflects the underlying capability of soil to retain and supply nutrients and water, and the capacity of soil to provide an environment to sustain legume and pasture growth). I agree that there are no direct measures for natural capital but I do

not agree that LUC is a reasonable or appropriate proxy or indirect measure. There are several reasons for this.

2.30. First, in my opinion, a natural capital approach is a much more holistic approach than just looking at nitrogen. Natural capital refers to the entire farm operation and environment. I consider that a natural capital approach would look at all aspects of the farm system and property, and all environmental effects, including all four contaminants that this plan change focuses on, biodiversity, whole of sub-catchment and edge of field mitigations, for example. Farming land in accordance with a nitrogen allocation is not the same as farming it to its natural capital. I consider that the most sound and robust approach available at present is a tailored FEP approach that considers critical source areas and develops mitigations to address them.

2.31. Second, the Top Farmer stocking rates (which are used to apportion N across the LUC classes) are not based on science. As I explain in the next section of my evidence, they are contained in the LUC (extended legend) and are based on a subjective assessment in the 1970s and 1980s of a specific farm system. This was before significant changes to land and farm system management such as fertiliser use, supplementary feeds and off farm grazing. In my opinion, they do not provide a realistic reflection of the natural carrying capacity of land (contrary to Dr Dewes' assertion in her Table 4).

2.32. Third, there is no relationship between the Top Farmer weighted average stock units (Table 1 in Dr Mackay's evidence) and nitrogen leaching. From paragraphs 59 to 65 of Dr Mackay's evidence, it appears that his assessment of the weighted average stock units for Top Farmers and Average Farmers (Table 1 of Dr Mackay's evidence) have come from a 1980 assessment of livestock carrying capacity for each LUC unit in the Waikato. He says that Dr Dewes has then estimated the N leaching based on a case study of 200 files.

2.33. Dr Dewes states at paragraph 131 and 132 of her evidence that she looked at 400 Overseer files (across New Zealand) and also based her assessment of N leach on her experience as a sharemilker and veterinarian for 20 years. In my view, Dr Dewes has not provided sufficient information regarding her assessment nor has she established a relationship between the Top Farmer

stocking rates and N leaching. It may be addressed in the evidence still to be filed, but I have also not seen a relationship between property level N allocation and in stream N concentrations or short term targets.

2.34. The process to derive the stocking rates within the LRI is non scientific and subjective. It is a simple estimation of management capability and standards at the time. The use of Overseer to validate these numbers is also subjective and uncertain and ultimately can only be another estimation of management capability bound by the limitations of the process used to derive them. They are not an objective estimation of a top farmers stocking rate for discreet units of land and are not an estimation of natural capital or nitrogen leaching.

2.35. The authors of the report that describes the process to obtain the stock carrying capacities and fertilizer data for the North island[2] were very clear that ‘’no north island correlations of present average or top farmer stock levels will be carried out as these figures are very dependent on local situations and need not be dependent on the inherent physical potential of the land”. In my opinion the top farmer stocking rates are closely aligned with management capability and infrastructure at the time they were assessed and against the farm system they were assessed.

2.36. Fourth, there are significant mapping issues with LUC whereby land has not been correctly classified. While this may be able to overcome by remapping LUC to a farm scale, this is a subjective and expensive exercise and in my view would likely create implementation issues for Council.

2.37. Fifth, Dr Mackay’s evidence in the Horizons One Plan and Tukituki processes was that the potential carrying capacities contained within the extended legend of the LRI were a good proxy for natural capital. In this process he is now saying that a different set of numbers (the top farmer) are a good proxy for natural capital. While my opinion is that neither are a proxy for natural capital (or nitrogen leaching), it is not clear why he has changed his position or whether this means that he now considers that the potential attainable stocking rate dataset used in the other two plan changes were an appropriate proxy.

[2] Ministry of Works and Development. “Stock carrying capacities and fertilizer data for the North Island”. Land Resources Group, Internal Report, no.22.

2.38. Likewise, the Horizons and Tukituki plans rely on Overseer to derive N numbers for each LUC class based on the potential attainable stocking rate. However, Dr Mackay is now saying that Dr Dewes' estimates of N leaching for each top farmer stocking rate is more appropriate. My opinion remains that neither approach is a reasonable basis upon which to allocate N.

2.39. In my opinion this highlights the uncertainty created by attempting to adapt datasets created for different purposes to underpin a regulatory outcome. The relevance of a proxy needs to be underpinned by science and objectivity. The process to derive the stocking rates in the LRI is, by its own definition non scientific and subjective. The same applies the process to link the top farmer stocking rates to N loss by Dr Dewes.

Stock carrying capacity for LUC classes

2.40. At paragraphs 46 to 49 of his evidence, Dr Mackay sets out the reasons that he considers that productive capacity of land and stocking rates have not changed since the 1970s and 1980s. I do not agree.

2.41. The process that was carried out to determine productivity and potential stock carrying capacities is set out on page 114 of the LUC Handbook. This is reproduced below:

4.6 Productivity indices

Regional productivity indices were created for LUC Units as part of the NZLRI mapping project. Indices include three levels of stock carrying capacity for pastoral use, and a *Pinus radiata* site index for forestry.

4.6.1 Stock carrying capacity indices

Stock carrying capacities have been estimated for each LUC unit recorded in the 1st Edition NZLRI. Carrying capacities are based on sheep stock units (su) where one stock unit is equivalent to a 55 kg ewe rearing one lamb. Representative LUC Units were evaluated by Ministry of Agriculture and Fisheries (MAF) Advisory Officers together with NZLRI survey staff. Three types of carrying capacity were assigned to each LUC Unit:

1. Present Average – The number of stock units per hectare (su/ha) which the 'average farmer' was typically carrying on a particular LUC Unit.
2. Top Farmer – The number of stock units per hectare that the farmer with the highest level of stocking rate, with at least average stock performance, was carrying on a particular LUC Unit.
3. Attainable Physical Potential - the number of stock units per hectare capable of being carried on a particular LUC Unit, assessed within the limits of present technology and given favourable socio-economic conditions (Table 23).

NZLRI stock carrying capacities only apply to 'typical sheep and beef farming systems'. They do not apply to dairying or cropping systems (LRG, 1981).

Table 23: Potential stock carrying capacity rankings (significant regional variations occur).

Stock carrying capacity ranking	Potential stock units per ha[1]
Very high	>25
High	21-25
Moderately high	16-20
Moderate	11-15
Low	6-10
Very low	1-5
Sparse	<1

[1] *One stock unit is equivalent to a breeding ewe (55 kg at mating) rearing one lamb.*

Figure 1: Extracts from page 114 of LUC Handbook.

2.42. The process is further descripted in a Ministry of Works and Development report as "subjective and having no scientific basis."[3] In my opinion the stocking rate numbers that were developed through that process are no

[3] Ministry of Works and Development. "Stock carrying capacities and fertilizer data for the North Island". Land Resources Group, Internal Report, no.22.

longer relevant as they were developed within the context of 1978. Farming systems, technology and science has developed significantly since then.

2.43. Over the past 40 years animal performance has improved significantly. The following graph provides one example of this by illustrating the improvement in lambing percentage in the Rotorua area from sub-100% during the 1970s to the late 130% mark of today. This has been achieved via multiple methods including management and improved animal genetics.

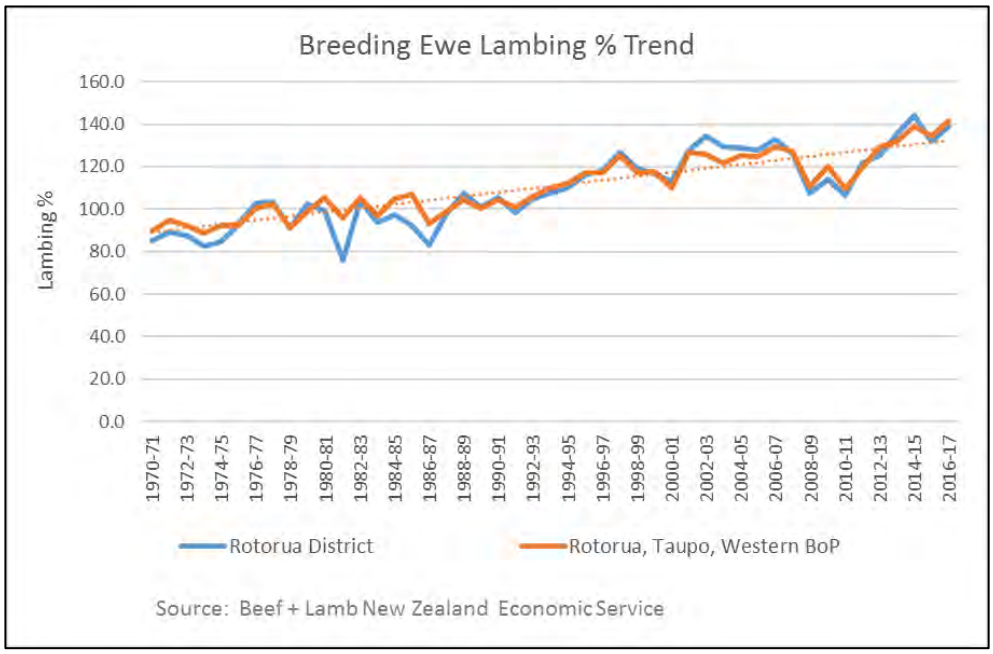


Figure 2: Change in lambing %age 1970 - 2017, Rotorua district. Source: Beef + Lamb New Zealand Economic Service Sheep and Beef Farm Survey.

2.44. Underpinning the improvement in animal genetics has been a significant improvement in plant genetics that has resulted in a 0.76% per annum increase in ryegrass yield since the late 1970s. This is set out in the figure below.

	Annual genetic gain				Correlation with total yield
	Pre-1990		Post-1990		
	kg DM/ha/year	%	kg DM/ha/year	%	R^2
Total yield	2 ± 9^{NS}	-	$105 \pm 11^{**}$	0.76	-
Winter	1 ± 3^{NS}	-	$14 \pm 2^{**}$	1.01	0.59^{**}
Early Spring	-3 ± 3^{NS}	-	$23 \pm 4^{**}$	0.81	0.02^{NS}
Late Spring	4 ± 6^{NS}	-	$20 \pm 3^{**}$	0.50	0.53^{**}
Summer	3 ± 6^{NS}	-	$35 \pm 5^{**}$	1.13	0.81^{**}
Autumn	5 ± 3^{NS}	-	$34 \pm 4^{**}$	1.28	0.86^{**}

NS=not significant, **=P<0.01.

Figure 3: Genetic gain in cultivar yield up to and including 1990 and those commercialised after 1990.[4]

2.45. The difference between required metabolizable energy required between a ewe producing one lamb and a ewe producing 1.5 lambs (as a flock average) is approximately 30%.[5]

2.46. The research that Dr Mackay relies on at paragraphs 46 and 47 of his evidence is based on data collected in the late 1990s. The data reflected in the figure below is based on the genetic potential from "almost every cultivar commercialised in Australia and New Zealand over the past 45 years." As further illustrated in Figure 4, while not all cultivars exhibit genetic gain, most of the genetic gain has been made since the mid-1990s and it is significant (compare with a similar graph on page 14 of Dr Mackay's evidence, which ends at the mid-1990s):

[4] Harmer M, Stewart A V and Woodfield D R. "Genetic gain in perennial ryegrass forage yield in Australia and New Zealand". NZ Grasslands Association, 2016. https://www.grassland.org.nz/publications/nzgrassland_publication_2825.pdf

[5] Trafford G and Trafford S. "Farm Technical Manual". Lincoln University, 2011.

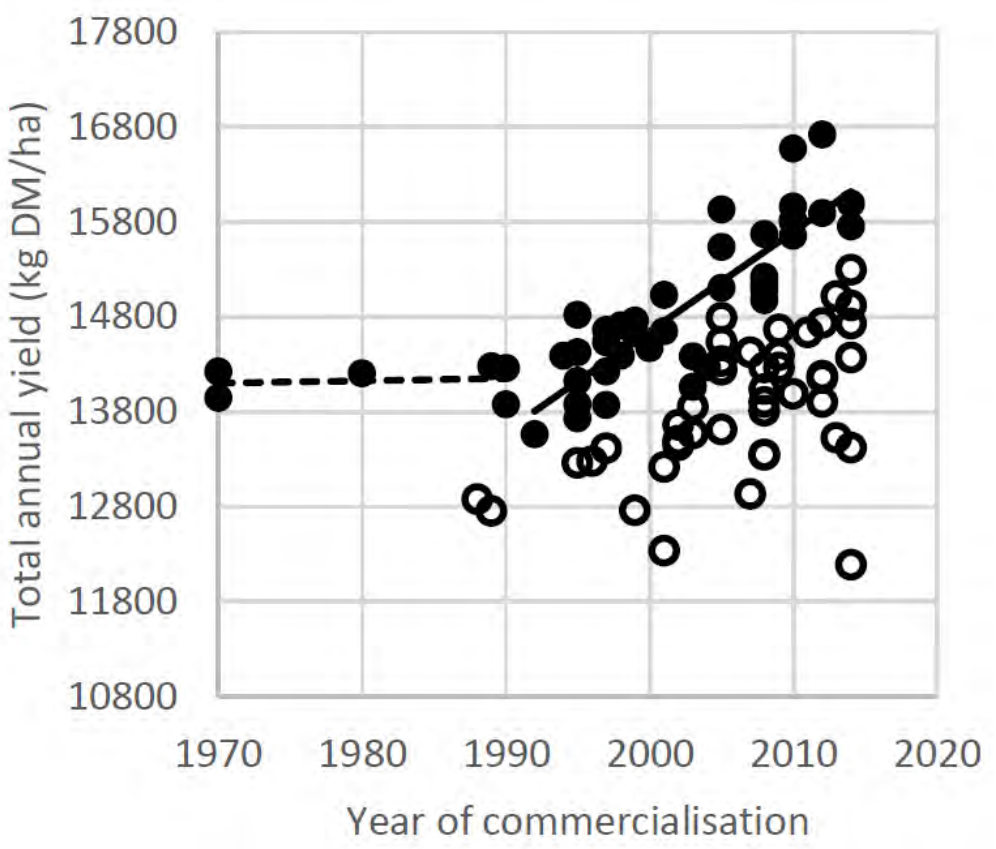


Figure 4: Genetic gain – total annual yield.[6] Closed circles are cultivars at the frontier of genetic gain; open circles are the cultivars not at the frontier of genetic gain; the dashed line is the rate of gain up to and including 1990 and the solid line the genetic gain after 1990.

2.47. There is little doubt in my opinion that our ability to grow more grass has developed significantly since 1978. In addition to the improvements in absolute growth the relative growth has also changed. This is driven by the simple effect of those parts of the landscape we can reliably and profitably cultivate are the parts of the landscape where we will realise the expected gains in dry matter growth potential. This means steeper ground is unlikely to experience the same gains. Should new cultivars be established on steeper (and shallower) soils they are unlikely to persist as long due to the higher frequency of soil moisture deficits and grazing events (due to larger paddocks).

[6] Harmer M, Stewart A V and Woodfield D R. "Genetic gain in perennial ryegrass forage yield in Australia and New Zealand". NZ Grasslands Association, 2016. https://www.grassland.org.nz/publications/nzgrassland_publication_2825.pdf

2.48. The farm system relied upon in 1978 is a further limitation. The potential carrying capacities were based on a typical sheep and beef farming system, not dairy, cropping or any other system.[7] The potential stocking rates (including the Top Farmer rates) were assessed according to the following criteria:

a. Land was assumed to be managed exclusively for livestock grazing in a typical sheep and beef grazing system of the time.

b. On-farm feed cropping only (no supplements).

c. It is the base carrying capacity and not seasonal extremes..

d. It was assumed that each LUC unit was managed as a discrete entity.

2.49. Further limitations were that the attainable physical potential was defined as "the number of stock units per hectare capable of being carried over the winter on a particular land use capability unit, assessed within the limits of present technology and given favourable socio-economic conditions." As dairying and cropping production systems are heavily weighted toward spring to autumn production, a definition that measures stocking rates based on winter carrying capacity will not adequately reflect the relative stock carrying capacities of those systems. This is a fundamental flaw in the use of the attainable stocking rates as a proxy for natural capital.

2.50. In calculating the rates, there was also reliance on fertiliser application to maintain pastures at attainable stocking rates. As an example, the recommendation for unit 6e11 is a capital application of 1,250kg/ha of superphosphate and maintenance applications of 400kg/ha superphosphate, 250 kg/ha potash and 20 kg/ha calcined magnesite.[8] It is clear from this assumption that the use of the attainable stocking rates as a proxy for natural capital is reliant on capital (fertiliser) that is not "natural."

2.51. This farm system, practices and definitions relied on reflect the mixture and range of capitals employed in on specific farm system in 1978. Science and technology has evolved significantly since then. In my view, it is illogical to

[7] "Stock Carrying Capacities and Fertilizer Data for the North Island," Land Resources Group, Aokautere Science Centre, Ministry of Works and Development (April 1981).
[8] "Stock Carrying Capacities and Fertilizer Data for the North Island," Land Resources Group, Aokautere Science Centre, Ministry of Works and Development (April 1981).

try to develop a metric based on the subjective interpretation of several interrelated parameters and then claim that the metric developed is only representative of one of the interpreted parameters. This does not allow for or recognise the advancements in technology and management capability over the last 40 years. "Potential" by definition cannot be static.

2.52. The potential carrying capacity process (including identifying the Top Farmer stocking rate) does not and did not measure natural capital (N leaching or the assimilative capacity) and has simply estimated our ability to extract provisions from natural capital at a point in time. The natural capital in the Waikato catchment has not changed over the last 100 years but our ability to use it has.

2.53. In order to attempt to build an N allocation framework based on natural capital it would be necessary to understand the inherent properties of the landscape in question to assimilate N and alter N loss pathways to freshwater (regulating services). Contrary to Dr Mackay's comments at paragraph 42 of his evidence, LUC does not consider regulating services. An example of why this is important can be illustrated in a known effect of the allocation system in both Horizons and Tukituki whereby soils with distinctly different characteristics (e.g. free draining vs slow draining) may exist within the same LUC class. This will result in the two soils receiving the same allocation yet they will have vastly different N leaching and effects on the receiving environment.

2.54. I note that I am only considering nitrogen leaching. This is just one part of the environment or natural capital. To develop a system that is truly based around natural capital and environmental footprint would require an understanding of all contaminants (including phosphorous, sediment and E coli), all aspects of the environment (including biodiversity) and all of the "capitals" involved in farming (including farm system management). This would ideally weight and balance these factors. While I am aware that nationally there is work going on about land use suitability, I am not aware of any work in this field that is sufficiently developed to inform this process.

2.55. The papers that Dr Mackay quotes at paragraphs 46 and 47 of his evidence are based on data collected in the late 1990s.

Attenuation

2.56. At paragraphs 177, 197 and 198 of her evidence, Dr Dewes acknowledge that a limitation of a N allocation approach is that attenuation is not understood or provided for. However, her view is that the lack of knowledge of attenuation is not a reason to delay. I agree that attenuation is poorly understood and is not taken into account in an LUC allocation approach but, unlike Dr Dewes, I consider that this is a reason not to allocate nitrogen.

2.57. At paragraph 63 of his evidence, Dr Mackay suggests that an attenuation factor is applied in the "nitrogen accounting" framework behind the proposed LUC allocation. However, no further detail is provided around how this has been calculated and applied. I set out my general views below about attenuation and will provide more specific comments if further information is provided in the evidence to be filed on 10 May 2019.

2.58. While attenuation is not well understood, it is generally accepted that at least some of the nitrogen discharges from a farming activity are attenuated by the time they reach the receiving water body. The level of attenuation will vary depending upon soil and ground conditions in any particular sub-catchment.

2.59. I consider that attenuation is a fatal flaw for any proposal to allocate N in the Waikato based on LUC. This is on the basis of recent research regarding attenuation within the Horizons One Plan area, and on the basis of analysis I have undertaken in relation to the sensitivity of water quality outcomes under Tukituki PC6 to attenuation assumptions and to the unknown implications changes in land use patterns would have on water quality if land use was to align with LUC classification.

2.60. Within the Horizons catchment Dr Ranvir Singh (Massey University) has been researching attenuation potentials across the various catchments. The initial results of this work show that attenuation of diffuse N loss varies significantly. Many areas that were required to reduce to a certain amount of N under the One Plan (based on LUC as a proxy for natural capital) are actually contributing much less N to the receiving environment. Attenuation was assumed to be 50% under the One Plan framework.

2.61. Dr Singh summarises the potential of this research as follows:[9]

> A series of models were evaluated for their ability to predict SIN loads to the Rangitikei river. The best predictions of SIN loads in the river were made when the spatial effects of both soil types and underlying geologies on nitrogen attenuation in the subsurface environment were incorporated in the model.
>
> This clearly suggests that the effects of catchment characteristics such as soil type, underlying geology, and subsurface geochemistry should be considered in prediction and accounting of nitrogen flows and its potential attenuation from farms to receiving surface water bodies in agricultural catchments. Further research is needed to better understand and model effects of catchment characteristics on spatial variations of nitrogen attenuation capacity in subsurface environment in agricultural catchments. Maps of this variable nitrogen attenuation capacity will also be the basis of the tools and the planning required to spatially aligning intensive land use practices with high nitrogen attenuation pathways, i.e. 'matching land use with land suitability', in order to minimise the impacts of agricultural production on receiving water quality.'

2.62. I agree with Dr Singh's conclusion that ultimately a land use suitability approach is likely to be a more effective management framework upon which to base significant resource management decisions as it will likely incorporate far greater landscape and farm system specific information upon which to make an informed decision. In circumstances where no such system is currently available (and unlikely to be available for some time) I consider that the general PC1 framework (with those above the 75th percentile reducing, farmers obtaining FEPs and most farmers remaining at their NRP, but with the ability to increases where appropriate in their sub-catchment) is more appropriate.

2.63. Dr Singh's work aligns with analysis I have completed to try to understand the likely effects of PC6 on water quality outcomes in the Tukituki River. That work was based around developing a sensitivity of diffuse N loss to various attenuation assumptions. The key finding from this work was that without specific spatial understanding of attenuation potentials any allocation system is unlikely to be accurate.

[9] Singh R, Elwan A, Horne D, Manderson A, Patterson M and Roygard, J. "Predicting land-based nitrogen loads and attenuation in the Rangitikei River catchment – the model development". Massey University, 2017.
http://flrc.massey.ac.nz/workshops/17/Manuscripts/Paper_Singh_2017.pdf

3. DAIRY AND DRYSTOCK SECTORS

3.1. In this section I set out my response to comments by parties from one sector about the responsibilities of other sectors.

Dairy intensification and increase in N loss

3.2. A key theme of Dr Dewes' evidence is that the dairy sector has intensified over recent years, the area of dairying has increased and the level of N discharge has increased, all the while the drystock sector has reduced in area and N discharge. For example, at paragraph 89 she refers to dairy farms increasing in total farm area by 88,000ha (26%) and at paragraph 95 she refers to dairy N load increasing to 72.2% and drystock N load reducing to 27%.

3.3. In my opinion, one sector pointing the finger at another sector is not a helpful basis upon which to consider water quality. Dairy could rightly point to the sources of E coli and phosphorous and the fact that the short term water quality targets are several times over the NOF bottom lines in some areas, while total nitrogen in other areas is in the A band. However, that does not help farmers in the Waikato to move forward and address water quality issues.

3.4. It does not recognise that both sectors rely and depend on each other. For example, the dairy sector relies on bulls supplied by the drystock sector. The drystock sector rears the calves from the dairy sector. The dairy sector pay levies to Beef + Lamb for cull cows and bobby calves. Each sector needs the other to prosper.

3.5. It also does not recognise that different land use activities have different N leaching characteristics. A key driver of nitrogen leaching of farm systems modelled through Overseer is that urine patches contribute a large amount of a typical farm's modelled N loss. This is because when cattle urinate patches of elevated N concentrations are created. While there is some ability to control N leaching (through changes in farm systems and practices), the fact remains that activities involving the farming of cattle, like dairy farming and some beef operations, and activities that rely on significant amounts of N like horticulture (particularly commercial vegetable growing), have higher nitrogen discharges than other activities.

3.6. Accordingly, around New Zealand, dairy farming and commercial vegetable growing have a disproportionate level of leaching relative to land area. I do not consider that there is anything unusual about the Waikato context, and while it is important to be aware of and manage N leaching, I do not consider that a disproportionate level of leaching from dairy compared with drystock or a disproportionate area of land is somehow bad.

Dairy ability to reduce N

3.7. At paragraphs 137 to 160, Dr Dewes sets out the reasons she considers that dairy can reduce N. I do not agree with her analysis.

3.8. I do not consider it helpful for the debate for one sector to focus on the reasons why another sector can make greater reductions. It does not take into account the other contaminants of risk and takes the focus off water quality and the real benefits, in my opinion, of tailored actions through FEPs (as opposed to catchment wide or sector wide reductions of one contaminant).

3.9. I have reviewed the evidence filed on behalf of Dairy NZ and consider that Mr Thorrold addresses the issue of what reductions can realistically be expected of the dairy sector and also Mr Newman in his evidence for Topic 1 provided a helpful analysis of the cost abatement curve for N and the increasing costs as N reductions increase.

3.10. I have also reviewed the evidence filed on behalf of Fonterra. In particular, Mr James Allen's evidence about drivers of N leaching and how things such as soils or climate affect the level of N reductions that are achievable. This is consistent with my own direct experience in Tukituki and with what I would expect (particularly for the Upper Waikato FMU where over 60% of soils are pumice soils and they have high rainfall).

3.11. I consider that Dr Dewes makes many generalisations and instead the focus ought to be on finding efficiencies through tailored FEPs and GFPs, from all contaminants, not just N.

4. STOCKING RATE

4.1. Stocking rate and stock units have been raised by several witnesses in several different contexts. I have seen at least three examples in the evidence, and there are likely to be further.

4.2. The first example is Beef + Lamb's use of stock units for its LUC allocation approach. Dr Mackay uses the Top Farmer stock units from the LRI to set stock units for each LUC class in Table 1 of his evidence. Dr Dewes also uses stock units for each LUC class in Table 4 of her evidence (but I note they differ from those contained in Dr Mackay's Table 1). It is not clear, but there could be a proposal to assess compliance on the basis of stock units (as opposed to using Overseer to assess compliance with a N number).

4.3. The second example, is the section 42A proposal to use it as a trigger point for the permitted activity rule. Mr Palmer (for WRC as proponent) describes his analysis of the relationship between stocking rate and Overseer v6 at paragraphs 39 to 44 of his evidence. He attaches a report to his evidence and the conclusions of that report are that for drystock farms that are not grazing dairy stock, farming to a stock unit per hectare is not likely to result in an increase in N leaching.

4.4. The third example is Federated Farmers' proposal for the stock exclusion standards in Schedule C to apply to properties below 18 stock units as opposed to those below a certain slope threshold (as proposed in the section 42A report).

4.5. I consider that it is important to understand what stocking rates are and their limitations. In my opinion, they may provide a helpful trigger point with different or additional standards or rules applying below or above a certain number of stock units. However, they do not provide a basis upon which to allocate contaminants or to assess compliance with a N allocation.

4.6. Stocking rate is an attempt to standardise relative feed demand between different farm operations based on an estimation of likely feed demand for a level of animal performance. Stocking rate is not a direct measure of environmental performance and, in my view, it is better described as a measure of potential risk. The assessment of risk in context is a key aspect of a FEP. Using a stocking rate as a proxy for allocation (and/or compliance

with a N allocation) does not consider the variability of N loss at farm scale different stocking rates will produce.

4.7. The allocation of N at farm scale is an attempt to control or limit the N losses from a farm (diffuse losses). In my experience, two farms with the same overall stocking rate do not automatically have the same N loss. This is because farms are a collection of different soil types, geologies, climates, topography, and infrastructure. It is the alignment (or not) of these factors with the different classes and performance of livestock on the farm that determine the risk of N loss. This means that any particular stocking rate will have a range of possible N loss effects.

4.8. For example, if a farm is assessed as having a stocking rate of 10 su /Ha in one year, and this stocking rate is then correlated with a N loss value, this does not necessarily mean that that will be the N loss for that farm while it has that stocking rate. The farmer may choose to change the management of the farm so that all cattle are grazed intensively on flat ground next to a river and graze all sheep on hills away from the river (as opposed to grazing them equally over the whole farm) and this will likely produce a different N loss profile and will require an assessment of risk.

4.9. In my view, this example also illustrates the benefits of a tailored FEP approach for the management of contaminants, as opposed to an allocation approach. By definition, farming is about flexibility and responding to changes in environmental and economic conditions. In my opinion, a tailored FEP (within an appropriate planning framework) enables farmers to identify and address critical source areas whilst maintaining flexibility to make changes to their farm system in response to things like drought, a downturn in the wool market etc. It encourages innovation and resilience. Contrast that with an approach where farmers are required to meet a nitrogen allocation and that effectively limits their options, creates perverse outcomes and increases costs for arguably worse environmental outcome (particularly if N is not the issue but constraints on N allocation deter mitigation of other contaminants).

4.10. Separate from using stocking rate as a means to allocate contaminants is the use of a stocking rate as a trigger point or threshold above or below which

different or additional standards and rules apply. In my view, it is possible to use stock units in this way, particularly when compared with alternatives.

4.11. For example, the use of 18 stock units as a threshold for stock exclusion is a clearer and more easily understood threshold than slope. It would not prevent a FEP from identifying, for example, that certain waterways ought to be fenced even if the stock units are below this. I also support the proposal to use stock units as the trigger point in the permitted activity rule. It is a pragmatic alternative to relying on the use of Overseer to measure compliance in an absolute sense with a N number. It also sets a trigger above which more detailed analysis is required.

4.12. As signalled in my primary evidence, I do have some concern with the focus on N, particularly in the context of low intensity farmers. In my view, there is merit in all farmers obtaining a FEP of some sort. For low intensity farmers, it would make sense for that to be a more simplified format that addressed the key issues for them. I am aware that the content of FEPs is to be discussed at the Topic 3 hearing and I will provide further evidence as part of that.

5. SETBACKS AND STOCK EXCLUSION

5.1. The statements of evidence that have been filed on behalf of the Department of Conservation (**DOC**), Auckland/Waikato & Eastern Region Fish and Game Councils (**Fish & Game**) and Wairakei Pastoral Ltd (**WPL**) raise the issue of minimum standards for setbacks in Schedule C (I set out my views on setbacks at paragraphs 6.7 to 6.21 of my primary evidence dated 3 May 2019).

5.2. As an example, Ms McArthur in her evidence on behalf of DOC at paragraphs 24 and 25, recommends a minimum riparian buffer width of 10m for cultivation and stock exclusion.

5.3. In my primary evidence I have explained why I consider that there needs to be flexibility in the setback distance. I also explain why I support Federated Farmers' proposal for a 1m setback in Schedule C and for tailored actions in FEPs to provide for greater setbacks where appropriate to address critical source areas. In my opinion, this is a more appropriate response than to

impose a more onerous standard, like requiring a 10m setback, as a catchment-wide standard in Schedule C.

5.4. DOC, Fish & Game and WPL have adopted the latter approach and required a more onerous standard for setbacks. After reviewing their evidence, my views about the appropriate approach to setbacks have not changed from what is set out in my primary evidence.

5.5. Much of the evidence for these parties focuses on their review of the literature. There are parts of this that I agree with, such as Ms McArthur's statement to the effect that there is no clear and consistent approach in the literature to slope and setbacks:[10]

> None of the slope and setback distances recommended by the s42A officers for PC1 appear to be supported by clear empirical evidence. In determining an appropriate setback width, the New Zealand literature is varied and equivocal as the width required for trapping of particulate nutrients in surface runoff through riparian buffers varies as a function of slope, soils, drainage/hydrology, vegetation and mode of contaminant transport (Collier et al. 1995; Parkyn 2004; Quinn and McKergow 2007; McKergow et al. 2016).

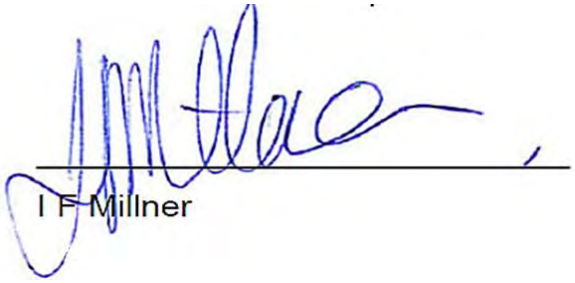
5.6. My own review the literature regarding setbacks is that multiple factors influence the effectiveness of riparian setbacks is a repeated theme. Another consistent theme is that the most efficient option is likely to be a varied, context-specific and tailored approach. This supports Federated Farmers' proposal of adopting a 1m setback distance as a catchment-wide standard then tailoring that in the FEP to the particular situation.

5.7. I also note that none of the submitters' evidence refers to the report and findings of the Whatawhata project[11] which was the longest and most comprehensive project of its type and based on research in the Waikato. As explained at paragraphs 6.37 to 6.42 of my primary evidence, the key findings were that there is no "one size fits all" solution when it comes to setbacks and riparian management. This is why it is so important to adopt a tailored and sub-catchment specific approach.

[10] Statement of Evidence of Kathryn Jane McArthur for DOC dated 3 May 2019 at [38].
[11] Hughes and Quinn, 2014, Before and after integrated catchment management in a headwater catchment – changes in water quality.

6. CONCLUSION

6.1. As explained above, it has not been possible to review or respond to much of the evidence that has been filed for Topic 2 due to the volume of that evidence and the time available. I have instead focused on several of the key issues that were not addressed in my primary evidence. It has been difficult to understand Beef + Lamb's proposal due to critical information being contained in evidence that has not yet been filed. However, I hope to be in a position to provide a fuller response following receipt of the further three statements of evidence for Beef + Lamb.



I F Millner