In the Environment Court
at Wellington

under: the Resource Management Act 1991

in the matter of: appeals under clause 14 of the First Schedule to the Resource Management Act 1991 concerning proposed One Plan for the Manawatu-Wanganui Region

between: **Federated Farmers of New Zealand**
(ENV-2010-WLG-000148)

and: **Minister of Conservation**
(ENV-2010-WLG-000150)

and: **Horticulture New Zealand**
(ENV-2010-WLG-000155)

and: **Wellington Fish and Game Council**
(ENV-2010-WLG-000157)

and: **Andrew Day**
(ENV-2010-WLG-000158)

Appellants

and: **Manawatu-Wanganui Regional Council**
Respondent

and: **Fonterra Co-operative Group Limited**
Section 274 party

Statement of evidence in reply of **Stewart Francis Ledgard** for Fonterra Co-operative Group Limited

Dated: 18 April 2012

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STATEMENT OF EVIDENCE IN REPLY OF STEWART FRANCIS LEDGARD FOR FONTERRA CO-OPERATIVE GROUP LIMITED

INTRODUCTION

1 My full name is Stewart Francis Ledgard and I have the qualifications and experience described in my Evidence in Chief (*EIC*). I repeat the confirmation given in that statement that I have read and agree to comply with the Code of Conduct for Expert Witnesses.

2 In this statement of evidence I respond to the evidence of Lucy Waldron and Alison Dewes who appear for the Wellington Fish & Game Council (*Fish & Game).* I also comment on the evidence of Dr Daniel Marsh for Fish & Game to the extent that his comments are relevant to my expertise.

3 The fact this statement in reply does not respond to every matter raised in the statements of other parties within my area of expertise, or every witness raising those matters, should not be taken as acceptance of the matters raised. Rather, I rely on my EIC and this reply statement to set out my opinion on what I consider to be the key issues concerning agricultural science matters in relation to the Manawatu-Wanganui Regional Council's (*Council*) Proposed One Plan (*POP*).

4 I have also replied to the statement of the technical conferencing held on 23 March 2012, which I could not attend.

SCOPE OF EVIDENCE

5 My evidence will consider the following matters

5.1 Issues raised at the technical witness conferencing regarding Land Use Capability (*LUC*) and "best practice" farm management.

5.2 Potential dairy farm land use scenario options for use in model evaluation of implications for nitrogen (*N)* loadings to waterways. These scenarios align with the planning regime recommended by Mr Willis for Fonterra in his evidence in chief.

5.3 Issues raised in Dr Waldron's evidence relating to:

(a) use of supplementary feeding to balance a cow's diet as a management option to reduce N leaching;

(b) additives to feed for reducing N leaching; and

(c) cow efficiency effects.

5.4 Issues raised in Alison Dewes' evidence relating to:

(a) The proportion of existing dairy farms considered by her to be already within the 20 year N-leaching limits set out in Ms Helen Marr's evidence for Fish & Game and achievability of these limits (Table 13.2, page 108).

(b) Use of N mitigations and possible N-leaching reduction scenarios, and effects of these mitigations for on farm profitability.

(c) Benchmarking, the use of LUC-based N leaching limits and grand-parenting.

(d) Full farm system modelling to ascertain costs of compliance, level of benefits, and to assist farmers to put mitigation in place.

(e) The use of low-protein feeds and other mitigations.

4.5 The issue raised in Dr Marsh's evidence relating to the cost of management practices to reduce N leaching.

ISSUES RAISED IN TECHNICAL CONFERENCING

5 Technical witness conferencing occurred on 23 March 2012 in relation to LUC and best practice farm management. Due to prior commitments I was unable to attend this conferencing.

6 Following the conferencing I have been provided with and have reviewed a copy of the Joint Statement dated 23 March 2012. I have also discussed the matters raised in conferencing with Dr Antony Roberts. In response to the matters addressed in the technical conferencing statement, I have set out my comments in the table provided at **Appendix A**.

SCENARIO ANALYSES

7 I have considered a number of potential scenarios for dairy farming in the Manawatu-Wanganui Region *(the Region)* which would arise under the planning regime recommended by Mr Willis for Fonterra in his evidence in chief. These are presented in **Appendix B**. These scenarios will be used by Dr Scarsbrook in his rebuttal evidence where they will be extrapolated out to catchment losses and related to targets as defined in evidence by Roygard and Clark.

8 My scenarios predict that the planning regime recommended by Mr Willis will lead to overall N-leaching improvements from the dairy sector (including existing and predicted new conversions). In my view, scenario 2 shows the most likely average N-leaching scenario (supported by the opinions of Dr Parminter on farming behavioural patterns). Under this scenario, existing dairy farms would reduce N leaching from the current average of 22.8 to 20.6 kg N/ha/year over a 10 year period. When a predicted conversion rate for that period of 5.5% is included, the N-leaching from existing and new dairy farms (factored onto the existing dairying area) will reduce from the current average of 22.8 to 21.3 kg N/ha/year. I have shown two other possible scenarios for balance, but note that in both of those, overall N-leaching from existing and new dairy farms still leads to net reductions.

9 I have also included 20 year modelling results for comparison with the modelling work of Dr Roygard and Dr Ausseil, but note that Mr Willis views the 10 year period as likely to provide a more accurate representation of actual N-leaching outcomes.

EVIDENCE OF LUCY WALDRON FOR FISH & GAME

Supplementary feeding to balance the cow's diet

10 In paragraph 10 of Dr Waldron's evidence, she states that the use of supplementary feeding to balance a cow's diet is not considered by others as a management option to reduce N losses. I disagree and believe that this is covered in Table 3 of my EIC for tier 1 mitigation options under brought-in feed, where low-protein feeds (i.e. low N feeds) are identified as an alternative to brought-in pasture silage or as an alternative to N-fertiliser-boosted pasture (which has a high N concentration).

11 I acknowledge that this practice has potential to increase N use efficiency by cows and to decrease N excretion by cows per kg of milk produced. This benefit is greatest where it replaces pasture with high N content as shown in paragraphs 30 and 31 of Dr Waldron's evidence. However, my understanding is that New Zealand farmers generally do not want to intentionally decrease use of their farm-grown pasture and replace it with brought-in feed because of effects on reduced efficiency and lower profitability. Instead, low-N feeds would generally be used as a supplement to pasture. This would lead to an increase in milk production and can increase N use efficiency[1] but may not decrease N leaching per hectare.

[1] N use efficiency = sum of N output in products (milk+meat) as a proportion of total N inputs (from external input sources of fertiliser, feeds, effluent and the atmosphere).

12 In my EIC (paragraph 81), I described results from the DairyNZ Resource Efficient Dairying trial which showed that supplementation with maize silage (a low N feed) increased milk production per hectare by about 30% and resulted in no significant increase in N leaching per hectare on the dairy farm. This was associated with the increased N efficiency described by Dr Waldron. However, I also noted the need to account for the N leaching from the land used to grow the maize silage. In the DairyNZ trial, N leaching under the maize production area was high and this more than offset the benefit from the increased N efficiency on-farm so that on a whole-system basis (dairy farm plus maize production area) there was little or no benefit from maize silage use in N leaching per hectare. Nevertheless, with recent new practices for maize silage production to reduce N leaching (e.g. limited/nil cultivation; soil testing to optimise N fertiliser use) there is potential for reduced N leaching on a whole-system basis (Williams et al., 2007).

Additives to feed

13 At paragraphs 20 to 24, Dr Waldron discussed several compounds that can be added to feed, that can potentially increase N use efficiency from feed. I acknowledge that the potential of some of these compounds has been shown in some overseas studies. However, the compounds have had little or no testing in New Zealand's pasture-based dairy farm systems. Ionophores were described by Dr Waldron and have been identified for their potential to increase feed conversion efficiency and reduce methane emissions. But when tested in New Zealand pasture systems, they did not show any medium to longer term benefits compared to benefits identified in grain based systems (Waghorn 2011). The lack of proof of effectiveness in New Zealand pasture systems is a reason why such additives are not included as mitigation in the OVERSEER® nutrient budget model (hereafter called OVERSEER).

Cow efficiency

14 In paragraph 35, Dr Waldron identified that cull cows need to be "*disposed of, adding potentially to pollution from decomposition on burial*". However, most cull cows are processed off-site for use in the human or pet food chains and therefore this would not contribute to farm N pollution.

15 Dr Waldron's paragraph 35 discussed other aspects of cow efficiency including cow replacement rate. New Zealand has a relatively low replacement rate (i.e. cows live longer). The rate is about 22% compared to that in many overseas countries that use high feeding systems to achieve high milk production per cow. For example, the corresponding cow replacement rate for Sweden is 40% (Flysjo et al., 2011). Nevertheless, I acknowledge that there is potential to increase the cow efficiency through practices that increase milk

production per cow and reduce replacement rate and that these measures can give small-medium potential reduction in N leaching per kg milk production.

EVIDENCE OF ALISON DEWES FOR FISH & GAME

Existing dairy farms already within the 20 year N-leaching and achievability of these limits

16 Alison Dewes noted in paragraph 2.10 that "*many intensive farms are already well within the year one and year 20 limits*". She states later in paragraph 9.29 that "*Table 13.2 LUC based nitrogen leaching limits are achievable in most cases"*. I disagree with these statements for the reasons set out below.

17 Analysis of the data in Table 8 presented in the s42A evidence by Roygard (p 292 TEB) indicates that, according to the proportion of farms in different LUC classes, the weighted average N leaching loss across farms to meet the year one limit is 23 kg N/ha/year. That limit for year 20 is 17 kg N/ha/year.

18 Data for actual N leaching losses for the average farm was 22-23 kg N/ha/year as specified in the supplementary evidence of Roygard and my EIC. Therefore, on average, less than one-quarter of dairy farms would currently fall below the year 20 limits (with uncertainty around this due to lack of knowledge of actual losses from farms in each LUC class).

19 I also note that, based on the above figures, the year 20 limit would require an industry wide average reduction of around 23-26% of current N leaching. Alison Dewes accepts the earlier evidence of Mr Smeaton (her paragraph 7.18) that industry wide average reductions in leaching of 10-15% can be achieved without significant impact on profitability and I also generally agree with that figure based on estimates of 4-12% for farms in the Rotorua catchment (paragraph 81 of my EIC). My view therefore is that reaching the year 20 limit is likely to have a significant impact on farm profitability.

Mitigations and profitability

20 Alison Dewes agrees (section 6 of her evidence) with most other expert witnesses about the existence of a range of N mitigation options that can potentially decrease N leaching from farms. She also acknowledges that their use needs to be evaluated on a farm-specific basis and that a farm system approach is required to determine their relevance.

21 *Infrastructure*: At paragraphs 7.6 to 7.13, Alison Dewes describes issues relating to infrastructure and in particular on the use of stand-off areas for cows during winter. She questions analyses by Neild and Rhodes that indicated significant costs from the use of

stand-off infrastructure (which included effluent capture and use). Alison Dewes refers to the need for full economic analyses and states that when these were undertaken by her and a colleague (Dewes, Appendix 1), the analyses indicated that their use was profitable. While I agree with the need for full economic analyses to determine costs versus benefits, I believe that additional supporting information is needed on the key assumptions that make their analyses show profitability. The two key assumptions are the nutrient value in stored effluent, and the beneficial effects on pasture production.

22 In my view, this analyses assumed significant nutrient benefits but did not consider well recognised Northern Hemisphere research showing that large N losses occur into the atmosphere from effluent during collection, storage and application from housed systems (e.g. over 50% of the total N; Rotz 2004). Similarly, research in New Zealand showed losses from stored effluent of up to 70% (Longhurst et al., 2006). This suggests that N loss may be higher when stand-off infrastructure is used compared to full grazing systems, and therefore less N is available to contribute to pasture production, i.e. less nutrient benefit.

23 The analyses also assumed a large benefit (e.g. +30% increase in production from nearly 20% of the farm) from use of a stand-off system in reducing loss in pasture production. However, recent research by Massey University in Manawatu, which compared grazed versus stand-off systems on poorly-drained soils prone to soil damage, showed less pasture production on the stand-off system which was attributed mainly to reduced nutrient return (Christensen et al., 2012).

24 If that data had been used, then the economic analyses of using stand-off infrastructure would likely have indicated a reduction in farm profitability (e.g. in Alison Dewes' example in Appendix 1, this would change from a $10,940 profit to a loss of over $40,000). The Massey study did, however, show a relatively large (43-65%) reduction in N leaching from the stand-off system.

25 *Low N cereal feeds*: Paragraph 7.14 of Alison Dewes' evidence, notes that effective use of cereal feeds is dependent on a number of critical management factors. Data is presented on a range of farm system analyses that indicated increased profitability from the use of cereal crops that would have included the key assumption relating to their effective use. However, this may not happen in various situations where such feeds are used. For example, in the summary of a large number of commercial dairy farms in New Zealand, Hedley and Bird (2006, Figure 1) showed that there was no increase in farm profitability with increasing amount of brought-in supplementary feed. They also noted that there would be a

reduction in the return on assets compared to farms relying predominantly on pasture.

26 A recent summary by DairyNZ (Economics Group 2009/2010; Matthew Newman, personal communication) also showed little difference in operating profit between low, medium and high input farmers in the Waikato region. Overall results indicated that during the last few years the differential between milk price and cost of imported feed has been such that some farmers have been able to achieve higher profits with imported feed than similar farms where feed wasn't imported. However, it also showed that there is a wide range in profitability even when the underlying fundamentals of milk price:imported feed cost ratios are favourable, i.e. good management ability is still required to turn potential into real profit. Thus, assumptions of effective utilisation of supplementary feed (while avoiding substitution for pasture utilisation) that are applied in farm system modelling are not always achieved in practice.

27 In paragraph 9.21, practices on "Braeburn farms" are discussed, which I assume refers to Byreburn farms (from the FARMS strategy), and it comments on this as a local example of reducing N leaching while maintaining profitability. No information was given on previous farm practices to know what N leaching was reduced from or how profitability had changed.

28 Assuming the example refers to Byreburn farms, it can be noted that the N leaching on the Byreburn dairy farm was 37 kg N/ha/year (Dr Shepherd s42A evidence, paragraph 54) for production of 1740 kg milksolids/ha/year. The farm system had a support block of a similar size associated with it. When that block was included in the analyses, it resulted in the equivalent of 860 kg milksolids/ha/year and N leaching of 28 kg N/ha/year (Dr Shepherd, paragraphs 36 and 54). This production is similar to that for the average Manawatu farm (LIC 2011) but N leaching is somewhat higher than the Region average of 23 kg N/ha/year (e.g. Roygard and Clark supplementary statement, paragraph 127), although these cannot be compared directly because of differences in site factors and systems.

29 Similarly, in paragraph 6.4, Alison Dewes noted that there are examples of farms that have significantly increased production and are "leaching less than average". Such large increases in production will have been associated with relatively large amounts of brought-in feed. I have identified issues associated with use of brought-in feed earlier in this statement (see paragraph [12]).

30 In paragraph 7.16, Dr Scarsbrook of DairyNZ is quoted in relation to research that has shown the potential for an average Waikato dairy farm to reduce urinary N by up to 40% and increase profit by $700/ha (25%). This was based on theoretical modelling work on

the maximum increase achievable (Dave Clark, DairyNZ, personal communication) and cannot be assumed to be achievable on the average farm. Paragraph 7.18 also states that *"I would add that the degree of the implementation of change is dependent on the farmer's capability, the support that he/she is provided with, and the necessity to make change."*

Benchmarking, the use of LUC-based N leaching limits and grandparenting

31 In paragraphs 8.16 and 8.17, the benefits of a benchmarking approach is noted, however Alison Dewes stated that "*it does not engage the poor performers*" and "*hence will be ineffective in gaining change from what may be the highest risk group*". I disagree in that the process of benchmarking means that all farmers are engaged in understanding the extent of their emissions and environmental efficiency relative to their peers.

32 Additionally, a "high risk" farmer who has high N leaching, relative to others, is identified in the benchmarking process and therefore can be targeted by consultants/advisors to assist them in understanding and implementing options to reduce N leaching. My EIC referred to a benchmarking process and recommended that the top 25% of N leaching farms be targeted for N-leaching reduction. The recommendations are supported by Mr Willis in his recommended planning regime. This recommendation also addresses Alison Dewes' concerns at paragraph 8.14 regarding grandparenting rewarding polluters for being less efficient.

33 The usefulness of benchmarking is accepted in paragraph 8.19, but Alison Dewes then adds that "*a flat cap can result in some inequities on those farms that have higher inherent biophysical risks*". I disagree, in that farms with "higher biophysical risks" are treated the same as those with lower risks as they have the same N targets, albeit that it may be more difficult for them to achieve such targets than those on farms with lower biophysical risks. A LUC-based N leaching limit is potentially more inequitable in that it imposes a greater limitation on the farms with "higher biophysical risks" (i.e. a lower N leaching limit) making it more difficult for them to comply.

Full farm system modelling

34 Alison Dewes refers variously to the benefits of full farm system modelling in allowing costs of compliance to be assessed against the benefits, as well as to assist farmers to put in place mitigations. For example, paragraphs 11.4-11.6 describe the importance of whole farm system modelling using a number of tools for production, profitability and environmental analyses. I concur with this but acknowledge that it adds complexity to the process. Then in paragraphs 13.2-13.3, Alison Dewes notes that the capability of experienced OVERSEER users is increasing. However, I would contend that there is a limited pool of consultants that have

experience in farm system, economics and environmental modelling. Indeed, Dr Monaghan (paragraph 35, s42A evidence) noted "*this will require the development of much greater capability than currently exists in NZ*".

Use of low protein feeds and other mitigations

35 In paragraph 9.16 and Figure 1, Alison Dewes presents similar information to that of Dr Waldron illustrating her view of the large reduction potential from integrating low protein feed such as maize silage. Again, this is for the same dry matter intake and therefore assumes that the supplement replaces pasture, rather than adds to pasture intake which is what occurs in practice. As discussed above, in paragraph 11, when low-N supplements are used they can increase milk production and decrease N leaching per kg milksolids produced but are unlikely to decrease N leaching per hectare unless other mitigation methods are also used. This also does not account for the N leaching losses associated with the land used to produce the low-N feed as discussed earlier in paragraph 12.

36 In paragraphs 9.15-9.26, Alison Dewes gives a number of modelled examples of farm system changes for achieving reduced N leaching and gives a summary of mitigation reductions modelled in Table 2. While I would generally agree with the modelled magnitude of reduction in N leaching from research, some are also relatively untested in research studies. For example, the use of a summer forage crop, and its link with effluent use, has had little research. The OVERSEER model includes a caveat on uncertainty in calculating N leaching from forage crops and this aspect has been upgraded in the new version of OVERSEER. This new version may lead to higher calculated N leaching from forage crops (dependent somewhat on timing of their use; D Wheeler, personal communication).

EVIDENCE OF DANIEL MARSH FOR FISH & GAME

Costing of changes in management practices

37 In paragraph 32, Dr Marsh states that it is preferable to look at changes in profitability and not only in costs when evaluating mitigation options. He then gives an example of stand-off pads and accounting for increases in productivity from their use. I agree that short-term pasture production benefits may occur if their use reduces pugging of soil due to poor management. However, this can be less than the negative effects on production from their use due to reduced nutrient recycling. This was discussed earlier in paragraph 23 based on the Manawatu research of Christensen et al. (2012) and would make them less cost-effective.

38 In paragraph 48, Dr Marsh considers that N leaching can be reduced at moderate cost based on the work of Doole and Pannell (2011) in the Waikato region. I believe that the work of Doole and Pannell (2011) probably underestimated the costs of reducing N leaching,

particularly for moderate-to-high levels of reduction. This is because they examined the use of different mitigations by adding their effects to achieve a defined level of N leaching reduction. In practice, mitigations target different parts of the N cycle and it is not possible to sum the N reduction value for mitigations that act on the same N leaching mechanism. For example, reducing losses from excreta returned in winter can be achieved by reducing N inputs in winter, grazing off-farm, stand-off pads or nitrification inhibitors, but their effects are non-additive. Additionally, the cost-effectiveness of nitrification inhibitors would have been overestimated based on a recent comprehensive study covering Waikato and Manawatu (Gillingham et al., 2012) that showed only a small pasture production benefit.

39 Consequently, the abatement cost of $25-62/ha for a 20-30% reduction in N leaching from Doole and Pannell (2011) is likely to be underestimated. Similarly, the extrapolated cost to the Manawatu region of $1.8-4.4 million/year (Marsh, paragraph 124) is also likely to be underestimated.

40 A single example of this is evident by considering the nitrification inhibitor eco-N as an effective option for reducing N leaching. In the analyses in Appendix B, I assumed that it was used on all farms in the upper quartile of N-leaching farms. The current cost of eco-N is approximately $200/ha and a realistic net cost is about $100/ha. The latter is based on the latest research (Gillingham et al., 2012) showing an average pasture increase of 3%/year and assuming that it would be captured via increased milk production and equate to approximately half the application costs. Extrapolation of that net cost to the upper quartile of farmers (based on a total area of 71,168 ha from Marsh) would be $1.78 million/year. On its own, this cost is at the lower end of the range of the total extrapolated costs of $1.8-4.4 million/year (Marsh, paragraph 124).

41 The analyses in Appendix B included farmers in the upper quartile of N leaching and in order to achieve the average reduction in N leaching of 23% the use of a nitrification inhibitor was required. This was because other tier 1 mitigations are either already being used or resulted in insufficient decrease in N leaching on a system basis, accounting for the additive effects of various mitigations.

42 One of the other mitigations with greatest effectiveness was the replacement of pasture growth from one-half of the fertiliser-N with a low-N supplementary feed, which depending on the cost of supplementary feed could represent an additional $30-80/ha. Thus, potentially that mitigation could also add about $0.5-1.4 million/year to costs on upper quartile farms. Apart from this, Appendix B included other mitigations with associated costs such as ceasing use of winter forage crops, accounting for low rate/storage effluent systems on poor-draining soils, and switching brought-in

feeds to low-N sources. The analyses described in these paragraphs only refer to the upper quartile of farmers and do not include costs of implementation of mitigations for farms on the lower 0-75% N leaching category. This limited summary associated with N loss reduction in Appendix B highlights the net costs in achieving significant reductions in N leaching in a real farm system context.

CONCLUSIONS

43 There are a range of N mitigations available to farmers, including use of low-N supplementary feed. This can be a valuable option for intensification and increasing milk production with little increase in N leaching per hectare. However, the relatively high N leaching per hectare from land used to grow the supplementary feed needs to be accounted for, especially if grown within the catchment.

44 Efficient use of low-N supplementary feed may increase farm profitability, but this cannot be assured due to risk of substitution for pasture consumption, the need for farmer skills in its effective use and feed prices. For example, a large farmer survey (Hedley and Bird 2006, and recent DairyNZ analyses by Newman) showed no increase in farm profitability with increased use of supplementary feed.

45 Use of infrastructure, such as stand-off pads and animal shelters, may provide some economic benefits that may partly counter their establishment costs. However, such benefits are often overestimated. Captured nutrients from effluent in these structures can provide savings on fertiliser if applied onto land, but this happens anyway with grazed systems and N losses can be high from manure after capture, storage and application. A recent dairy system study by Massey University compared a stand-off system with a well-managed grazing system and showed 45-63% lower N leaching but production was lower and profitability would have been lower. Thus, it is important to recognise the significant net costs that may occur from some N mitigation options.

46 The effects of mitigation practices on reducing N leaching may not be additive since some mitigations target the same N leaching mechanism e.g. use of several mitigations to reduce leaching of urine-N in winter may be no more effective than a single one. Consequently, I believe that some evaluations of the costs of implementing moderate-to-large reductions in N leaching that required assumptions on the use of multiple mitigations will have been underestimated.

Stewart Francis Ledgard
18 April 2012

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APPENDIX A – TABLE RESPONDING TO MATTERS ADDRESSED IN THE TECHNICAL CONFERENCING STATEMENT DATED 23 MARCH 2012

Topics addressed by experts

Topic	Statement of agreed position	Statement of disagreed position	Comments from Stewart Ledgard
1. Is there a water quality issue to be addressed?	All parties agree that there is a water quality issue to be addressed.		Agree; based on technical evidence of water quality scientists
2. If there is a water quality issue, what are the contaminants/externalities that are of concern?	All parties agree that their discussions will focus on nitrogen leaching but recognise that other factors including phosphorus, sediment and pathogens are externalities of concern.		Agree in general with the Statement of agreed position.
3. Is there a need for water quality limits?	All parties agree that there is a need for water quality limits. Applying the N-loss limits set out in Table 13.2 of DV		Outside my area of expertise

	POP across all farms in the catchment will not protect and enhance water quality across the entire Region.		
4. Should the water quality issues be managed at a catchment level?	All parties agree that water quality issues should be managed at a catchment level.		Agree in general with the Statement of agreed position.
5. Who should set them, and on what basis?	All parties acknowledge that effective management of limits will be enhanced by the active participation of farmers and all other stakeholders in the community in the determination of the limits.		This is a planning issue, but Agree in general with the Statement of agreed position.
6. What are the sources of the in-river / lake N loadings?	Diffuse sources of N are the dominant source of N to the river, based on current evidence. We need to do our best to address them.		Agree in general with the Statement of agreed position; based on evidence presented.

7. Identify which land use activities are contributing to the water quality issue.	All parties agree that all land use activities contribute to the water quality issue. There is evidence that sheep and beef farming, and dairy farming (including all cropping activities), are significant contributors to the N loadings in rivers and lakes in the Horizons Region. In some specific catchments there may be other significant sources of N. All parties recognise that all uses contribute, they also recognise that dairy farming results in high N loss per hectare relative to other pastoral land use activities and represents the greatest opportunity for making reductions to N loading.		Agree in general with the Statement of agreed position. Wording relating to "significant contributors" reflects the fact that these land uses occupy a "significant" proportion of the total area. Agree in general with the Statement of agreed position. Nevertheless, there is a wide variation in N leaching per hectare between individual farms within any one farming type.

	In some catchments, other land uses may present significant opportunities to make improvements to water quality. For example, commercial vegetable production, cropping Sheep and beef farms have a low N loss per hectare relative to other farming activity but make up a large proportion of most catchments, and therefore contribute a significant amount of the non-point source N load. Due to the large land area of sheep and beef, a relatively small increase in N loss per hectare could cause a significant increase in diffuse N loss (Aussiel Table 18 & 19).		Agree in general with the Statement of agreed position. Agree in general with the Statement of agreed position. Agree in general with the Statement of agreed position (although the magnitude and implications of the word “significant” would need to be agreed on).

	Any intensification of land use on those units could result in a significant increase in N load.		
	All parties agree there are fewer opportunities on sheep and beef farms to reduce N loss through mitigation.		Agree in general with the Statement of agreed position.
	All parties agree that the contribution of sheep and beef farming, including cropping activities, to the in-river N loading should not be ignored by the One Plan.		Agree in general with the Statement of agreed position.
	All parties agree there is a three- to six-fold increase in N leaching losses from extensive sheep farming to dairy farming on a per hectare basis (Clothier et al., 2007)		I agree that on average N leaching is higher under dairy than sheep farming (which can be up to several-fold). However, there is a wide variation in N leaching per hectare between individual farms within any one farming type.

	All parties agree that all land users in the catchment should contribute to solving the problems of water quality / in-river N levels. This is because there is a significant risk that the regulated land users will shift their load to unregulated land users.		Agree in general with the Statement of agreed position.
8. What mechanism should be put in place to ensure that farmers make a contribution to the water quality goals? • Calculate their N loss?	All parties agree that there will be a need to set a N load goal per catchment. Once this has been established, all farmers must know the targets they are required to achieve.	There is disagreement among the parties as to how this will be achieved.	Agree in general with the Statement of agreed position.
9. How do you allocate the in-river limit to the landscapes that contribute to water quality outcomes?	All parties agree that **if** an allocation mechanism is instigated, it should be directed to all land uses in	Some parties (JR, PT, AM, LG, AD, TR, BC & ADM) agree that there should be a mechanism, where	This is a Planning question and is best dealt in detail by experts in this area. However, I agree in general with the

	the catchment.	each farm should have a limit. Other parties (AR, DE, RT, LF) agree that there should be a catchment limit, and each farm should be required to take all reasonably practicable steps to reduce their contribution in order to achieve that limit. LW agrees that each farm should have a limit, however how that limit is defined remains in question.	Statement of agreed position. I also believe that the first requirement is around all parties agreeing on catchment limits. As noted in my evidence, I support the focus on an approach based on "reasonably practicable steps" and working with farmers in the upper quartile of N leaching to achieve N leaching reduction where it is agreed that such reduction is required.
10. How can a farmer demonstrate what their farm N loss is / will be?	All parties agree that each farm should submit to MWRC a N loss estimate using OVERSEER, and prepared in association with a suitably qualified professional and signed by the farmer, at intervals to be determined by MWRC.		Agree in general with the Statement of agreed position.

11. How can MWRC demonstrate that progress is being made towards achieving water quality outcomes?	All parties agree that water quality monitoring by MWRC is one of the appropriate mechanisms.		Agree in general with the Statement of agreed position.
12. If an allocation mechanism is to be used for N loss limits for individual farms, how should it be allocated?	All parties agree that not withstanding the various methodologies being debated by the experts, water quality needs to be maintained and enhanced.	AD, AM, LW, TR, LG, ADM, PT, BC and JR agree that LUC is the best mechanism available at present. DE, AR, LF and RT agree that LUC is a flawed mechanism. AR and DE agree that **<u>if</u>** it is necessary to implement an allocation mechanism, that a single benchmark N loss number per hectare (option (c)) would be a viable alternative.	Agree in general with the Statement of agreed position, provided that such agreement on the desired water quality status has been agreed by all parties. As noted in my evidence, for N leaching I support the use of a single benchmark value for a catchment. However, the concept of LUC has some merit in relation to sediment and P loss.
13. Should new and existing intensive farming N loss be treated differently in the One Plan?	All parties agree no.		I do not understand the context of this question and so have no comment.
14. Are the agricultural land use intensification scenarios that have been modeled realistic?	All parties agree that the scenarios are plausible.		Agree in general with the Statement of agreed position.

15. What are the advantages and disadvantages of each regime being proposed Horizons – Year One LUC, etc. WF&G – Year 20 LUC with step downs, etc. Fonterra – 26 kg/N/ha/year nitrogen discharge allowance plus what for farms that do not comply? Federated Farmers – decisions version re "reasonably practicable farm management practices"? HortNZ – Exclude horticulture from the rules framework? having regard to the answer to question 13, in terms of effects on farmers and effects on water quality based on the modelling that has been undertaken		Some parties (TR, AD, LW, ADM, LG, BC, PT and JR) agree that of the regimes put forward, option (b) in respect of N loss limits is the most likely to result in improvements in water quality. Some parties (RT, DE, AR and LF) agree that option (d) is the most likely.	I understand that this question was not discussed in any detail at the conferencing. Additionally, I am uncertain of the qualification at the end of this question, especially since I did not understand the context of question 13 to which it refers. In practice this question requires a large amount of comment and context to adequately qualify it. I believe that my thinking regarding the various major issues regarding policy options were covered in my evidence.

regarding water quality?			
16. Should a catchment nitrogen cap be applied to achieve a water quality outcome?	See above.		This is a Planning issue and I feel it is inappropriate for me to speculate on it.
17. Are there farming management/mitigation practices that can reduce nitrogen leaching?	All parties agree that there are mitigation options available. PT tabled a handout, *Farming practices to mitigate nutrient and contaminant loss to water*, for information and feedback. This document is attached as Appendix A.		I agree that there are mitigation options available, many of which were covered in my evidence. The Appendix A (which I understand was not discussed at the Conferencing meeting) contains a range of mitigations. However, I feel that a number of caveats are required before it is acceptable (e.g. the 2nd practice requires a qualification that it is associated with an effective effluent management system).
18. To what extent can farming management/mitigation practices reduce nitrogen leaching?	Refer to Appendix A, and the extensive coverage given to this question in evidence.		This was widely covered by many, including in my evidence (Tables 1 and 3).
19. What are the costs of farming management/mitigation practices and what effect do they have on profitability?	All parties agree that the costs are hugely variable and farm specific, and depend on the magnitude		Agree in general with the Statement of agreed position.

	of reduction of N loss required.		
20. Are the farming management /mitigation practices "reasonably practicable farm management practices"? *Note - some of the evidence suggests that some farming management/mitigation practices are too expensive and, therefore, not reasonably practicable.*	See above.		I believe that the "practicality" of some mitigations is farm-specific and that some management/mitigation practices outlined in various evidence could be considered as too expensive to qualify as "reasonably practical" (see my evidence for detailed examples).
21. To what extent is it known whether farmers are implementing management/mitigation practices to reduce nitrogen leaching in the region?	All parties agree that individual farmers are implementing these practices but the extent of this is unknown.		Agree in general with the Statement of agreed position. However, while there are no comprehensive surveys of all management/mitigation practices, there is some data available on a number of the practices and mitigations (as used in Appendix B).
22. To what extent is it known whether farmers are implementing "reasonably practicable farm management practices" to reduce nitrogen leaching in the region?	See above.		Relatively unknown.

23. Is it possible that there will be disagreement between farmers and horizons' consent processing staff as to what "reasonably practicable farm management practices" are to reduce nitrogen leaching?	All parties agree that this is possible.		Agree in general with the Statement of agreed position.
24. Can overseer be used to estimate nitrogen leaching from dairy farming/ cropping/ intensive sheep and beef farming/ horticulture?	All parties agree yes, but DE, AR and RT qualify that the errors in output need to be recognised. LW notes that she abstains from this agreement as she has not used the program.	Horticulture NZ's position is that OVERSEER is the best available option at present, but are awaiting the release of Version 6 before evaluating whether it is fit for purpose for horticulture.	Agree in general with the Statement of agreed position.

APPENDIX B – SUMMARY OF A NUMBER OF POTENTIAL FUTURE DAIRY FARM SCENARIOS FOR USE IN CATCHMENT MODELLING

1 An outline of a number of potential future scenarios for Manawatu-Wanganui Region dairy farming in relation to the POP policy recommended by Mr Willis is given below. This is split into farms in the upper quartile of N leaching and the sum of the 0-75th percentiles, to align with Gerard Willis' recommended planning regime. Within the later category, three options relating to potential farm practices and intensity are described. Estimates of N leaching from these are then made based on the data for existing farms in the region in the evidence of Roygard and Clark (dated 24 February par. 127, p5223 TEB and Figure 3), i.e., assuming the average N leaching for the upper quartile of 33.8 kg N/ha/year and for the lower 75% category of 19.3 kg N/ha/year.

Existing dairy farm scenarios

2 The potential future farm option for existing farms in the upper 25% of N leaching losses and the basis for calculating the N leaching losses from it are:

OPTION 1: It was assumed that all tier 1 mitigations (see Table 3 in evidence in chief of Ledgard, February 2012) would be adopted (except for circumstances where adoption is limited by site characteristics or where they are already currently being used). The latter required assumptions on the current use of these practices (e.g. 5% applying N fertiliser in winter; 2% using pond FDE systems; 20% using winter crops; 2% using DCD and 65% wintering cows off-farm; M. Scarsbrook evidence in chief; and A. Metherell, personal communication from Ravensdown farm survey data).

Additionally it was assumed that about 20% of farms in this upper 25% category were in LUC IV or above with a rainfall above 1500 mm/year and that the potential for N leaching reduction on these farms was less (e.g. DCD effectiveness was assumed to be halved). From these assumptions and use of OVERSEER to estimate the possible reduction in N leaching (accounting for non-additivity of mitigations) it was calculated that a reduction in N leaching of 7.6 kg N/ha/yr was potentially achievable, thereby moving the average for this group from 33.8 kg N/ha/year to 26.2 kg N/ha/year.

3 Three potential future farm options for existing farms in the lower 75% of N leaching losses and the basis for calculating the N leaching losses from them are:

OPTION 2: It was assumed that one-quarter of farms would adopt all tier 1 mitigations (except for circumstances where adoption is limited by site characteristics and where they are already currently being used). The later required assumptions on the current use of these practices (e.g. 2% applying N fertiliser in winter; 2% using pond FDE systems; 20% using winter crops; 2% using DCD and 65% wintering cows off; M. Scarsbrook evidence in chief; and A. Metherell, personal communication from Ravensdown farm survey data).

Additionally it was assumed that about 20% of farms in this lower 75% category were in LUC IV or above with a rainfall above 1500 mm/year and that the potential for N leaching reduction was lower as in Option 1. It was further assumed that there would be no change in N leaching losses from the other three-quarters of farms in this category. This allowed for some intensification (i.e. increased milk production per on-farm hectare) happening on farms in the latter category but recognised that they would also adopt some of the tier 1 mitigations and newly-developed mitigations due to increased awareness and extension activities (such as the benchmarking process comparing N use efficiency and N leaching for individual farms with district averages), as well as recognising benefits from adoption of other practices such as stream-fencing required in the Plan, with a net effect of no change in N leaching. From this it was estimated that a reduction in N leaching of 1.1 kg N/ha/yr was potentially achievable (i.e. 4.3 kg N/ha/year from one-quarter of farms), thereby moving the average for this group from 19.3 kg N/ha/year to 18.2 kg N/ha/year.

OPTION 3: It was assumed that one-quarter of farms would adopt N mitigations as outlined in option 2, while one-half would be unchanged and one-quarter would intensify resulting in a 10% increase in N leaching. The result is a reduction in N leaching from the average for this group from 19.3 kg N/ha/year to 18.7 kg N/ha/year.

OPTION 4: It was assumed that one-quarter of farms would adopt N mitigations as outlined in option 3, one-quarter would be unchanged while one-half would intensify resulting in a 10% increase in N leaching. The result is little change in N leaching from the average for this group from 19.3 kg N/ha/year to 19.2 kg N/ha/year. This is considered to represent a worst case option.

4 Scenarios were then developed based on different combinations of these options. These scenarios are:

Scenario 1: Option 1 for the top 25% category and option 2 for the lower 75% category.

Scenario 2: Option 1 for the top 25% category and option 3 for the lower 75% category.

Scenario 3: Option 1 for the top 25% category and option 4 for the lower 75% category.

Modelled existing dairy farm N-loss

5 This resulted in overall N leaching losses for existing dairy farms as follows:

Scenario	Average N-leaching (kg N/ha/year)	Current average	Difference (%)
1	20.2	22.8	-11.4
2	20.6	22.8	-9.6
3	21.0	22.8	-7.8

6 I note that these analyses excluded the effects of addition of any dairy conversions. I set out below, some scenarios with conversions included.

7 Based on the evidence in chief of Dr Terry Parminter on adoption of practices and farmer behaviour and my own experience, I believe that scenario 2 is a realistic option in that it recognises potential for intensification by a proportion of dairy farmers. It also recognises that a significant component of the farmers in the lower 75% category will be influenced by the current regulatory process and the strong extension programme by DairyNZ and Fonterra to increase N use efficiency and decrease N leaching, and will adopt some practices to reduce N leaching.

Modelled total dairy farm N-loss (dairy conversions included): 10 year time frame

8 The effects of inclusion of land converted from sheep and beef farming to dairy farming was then included in the scenario analyses and was accounted for by adding the increase in N leaching loss from dairy conversions over that of the sheep and beef farms onto that for the existing area in dairy farming (for simplification in analysis of overall system changes at a catchment level). It was assumed that the relativity of the different LUC classes remains the same as for current dairying in the region and that the conversions would operate at the LUC class N leaching limits (i.e. an overall average of 22.8 kg N/ha/year).

9 A ten year timeframe was used for inclusion of effects of dairy conversions, as outlined in the evidence of Mr Willis. For an assumed area of conversions equivalent to 5.5% of the existing dairying area, overall results in N leaching losses are as follows:

Scenario	Average N-leaching (kg N/ha/year)	Current average	Difference (%)
1	20.9	22.8	-8.3
2	21.3	22.8	-6.5
3	21.7	22.8	-4.8

Modelled total dairy farm N-loss (dairy conversions included): 20 year time frame

10 For completeness, a 20 year modelling timeframe was also used for comparison with the modelling work of Dr Roygard and Dr Ausseil. However, I note that Mr Willis views the 10 year period as likely to provide a more accurate representation of actual N-leaching outcomes.

11 The 20 year modelling, which included dairy conversions on an additional 11% area, resulted in overall N leaching losses as follows:

Scenario	Average N-leaching (kg N/ha/year)	Current average	Difference (%)
1	21.6	22.8	-5.3
2	22.0	22.8	-3.5
3	22.4	22.8	-1.7

12 These scenarios will be used in model calculations for different catchments in the Region in the rebuttal evidence of Dr Mike Scarsbrook.