In the Environment Court
at Wellington

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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 NZ**
(ENV-2010-WLG-000155)

and: **Wellington Fish & 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 Dr Michael Robert Scarsbrook for Fonterra Co-operative Group Limited

Dated: 18 April 2012

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STATEMENT OF EVIDENCE IN REPLY OF DR MICHAEL ROBERT SCARSBROOK FOR FONTERRA CO-OPERATIVE GROUP LIMITED

INTRODUCTION

1 My full name is Michael Robert Scarsbrook 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 Dr Olivier Ausseil, Dr Russell Death and Corina Jordan who appear for the Wellington Fish & Game Council (*Fish & Game) (*Dr Ausseil also appears for the Minister of Conservation).

3 I also attended two days of expert conferencing on Water Quality (21 and 29 March 2012) and comment on matters arising from the statements agreed at the conferencing.

4 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*).

SCOPE OF EVIDENCE

Matters in reply to Dr Ausseil

5 My evidence will consider the following matters raised in Dr Ausseil's evidence:

5.1 [Topic 1] POP standards are set at "good" or just passable levels, not 'pristine',

5.2 [Topic 2] The inclusion of nitrate toxicity as a potential issue,

5.3 [Topic 3] SIN load modelling and scenarios,

5.4 [Topic 4] Predicting water quality outcomes from SIN load modelling,

5.5 [Topic 5] Concerns over limited range of values considered by Horizons.

Matters in reply to Dr Death

6 My evidence will consider the following matters raised in Dr Death's evidence:

6.1 [Topic 6] The need to recognise and manage multiple stressors of aquatic ecosystems,

6.2 [Topic 7] The value of water quality trend information in resource management decision making,

6.3 [Topic 8] His opinion that tcological health in many of the region's waterbodies is poor.

Dr Kelly

7 My evidence does not include rebuttal of Dr Kelly's evidence:

7.1 I have limited knowledge of the ecology of dune lakes. I'm generally comfortable with agreed positions determined through expert causcusing on the dune lakes and Lake Horowhenua.

Matters in reply to Ms Jordan

8 My evidence will consider the following matters raised in Ms Jordan's evidence:

8.1 [Topic 9] Evidence for declining fish populations.

Matters arising from expert caucusing

9 My evidence will consider the following matters arising from Expert Caucusing on the topic of Water Quality:

9.1 [Topic 11] A summary of water quality trend analyses presented during caucusing,

9.2 [Topic 12] Predicted SIN loads resulting from Fonterra's proposed land use scenarios.

EVIDENCE OF DR OLIVIER AUSSEIL FOR FISH & GAME AND THE MINISTER OF CONSERVATION

[Topic 1] – POP standards

10 POP standards are set at "good" or just passable levels, not 'pristine':

10.1 In his statement of evidence (3.11), Dr Ausseil states that water quality standards set within the POP (Schedule D) were set to a "...*"good" state of the water quality in relation to the waterbody values, not at a "pristine" or a "passable" level*".

10.2 In my opinion, there are a number of situations where the limits set for developed catchments in Schedule D have been set at near pristine levels. In most cases this generates unrealistic or unachievable limits. For this reason, it is important that the values in Schedule D should be considered as numerics, rather than targets/standards or "limits" in the sense "limits" is used in the National Policy Statement for Freshwater Management (*NPSFM*).

10.3 As highlighted by Dr Ausseil (sections 3.14 – 3.17), the nutrient limits in Schedule D were significantly influenced by expert ecologist opinion, because the NZ Periphyton model "was found to provide stringent nutrient concentration outputs, sometimes unrealistically low (i.e. lower than natural levels)". While Dr Ausseil considers the limit setting process to be pragmatic (3.17), it must be accepted that a limit-setting process driven largely by aquatic ecologists may not fully account for multi-stakeholder interests and potential impacts on social, economic and cultural values.

10.4 The Macroinvertbrate Community Index (MCI) is widely recognised as a robust indicator of ecological health in New Zealand streams and rivers (Clapcott et al 2011). Within Schedule D, the limits proposed for MCI are set at values of either 120 or 100. Values of 120 or greater are considered to reflect a "clean water" state (Stark 2011) and sites meeting this limit are termed "Excellent" in relation to ecological health. Sites scoring in the range 100-119 are classed as "Good" and sites scoring between 80 and 100 as "Fair". Sites scoring less than 80 are deemed of poor ecological health. Therefore, any zones that are required to have MCI scores greater than 120 are expected to have ecological health equivalent to natural state, clean water or near pristine conditions.

10.5 There are a number of WMZs where the limit set for MCI imposes an expectation of near pristine levels of ecological health. 35 out of 116 sub-zones have an expectation of meeting "Excellent" ecological health (i.e. 30%), while 70% are expected to achieve "Good" ecological status. For reasons I have not been able to determine, the "Fair" category was not considered appropriate for any sub-zones in the region,

despite 33% of sites currently fitting this category (Stark 2011).

10.6 It is my opinion that a number of Schedule D limits for ecological health have been set at unachievable levels reflecting natural state aspirations rather than "good" ecological health, which I would consider more appropriate in highly modified catchments.

10.7 There is also evidence that nutrient limits have been set at unrealistic levels that do not match with the outcomes being managed for.

10.8 In their review of the first 12 months data from the periphyton monitoring programme implemented by Horizons, Kilroy et al (2010) state "*…we considered the relationship between the proposed One Plan nutrient and periphyton standards. A disconnect is evident between the two sets of standards: many more sites and samples exceed the nutrient standards than the periphyton standards*". What this means is that the existing nutrient limits in Schedule D are conservative with regard to algal biomass outcomes that the limits were designed to indicate. This suggests that nutrient limits could be relaxed in some zones, without significant risk of breaching periphyton limits.

10.9 The most permissive SIN limit set in Schedule D is 0.444 g/m^3. This is based on the ANZECC (2000) guidelines for protection of aquatic ecosystems, although the ANZECC guideline values are based on $N0_x$-N not SIN (noting that SIN is the sum of NO_x-N (nitrate/nitrate nitrogen) and NH_4-N, which is ammoniacal nitrogen).

10.10 Dr Death provides evidence (Fig. 7, pg. 23) of relationships between nitrate and DRP levels and measures of ecological health (MCI and QMCI). The data comes from 24 streams in the Manawatu region. Based on these relationships, it is possible to estimate levels of nitrate and DRP that will, on average, provide for "good" (MCI>100) ecological health. Dr Death's data suggests that a good level of ecological health is achievable at nitrate concentrations below 0.800 g/m^3 and DRP concentrations of 0.05 g/m^3. These values are significantly higher than the most permissive N and P limits currently in Schedule D (i.e., SIN = 0.444; DRP = 0.015). Note that Dr Death (para 66) incorrectly characterises "good water quality" as being indicated by an MCI score of >120. Actually, it is generally recognised that MCI > 100 indicates

"Good" conditions and MCI > 120 indicates "Excellent", clean-water or pristine conditions (Stark 2011).

10.11 Based on my preliminary analysis of periphtyon-nutrient relationships (Fig. 2, pg 21 of my evidence) there is also evidence that nutrient concentration limits could be relaxed while maintaining appropriate periphyton biomass levels for specific values. For example, where the periphyton biomass numeric of 120 mg/m^2 applies, the SIN concentration could be relaxed to 0.421 g/m^3. Where the 200 mg/m^2 biomass numeric applies, the SIN concentration could be relaxed to 0.855 g/m^3. It would be appropriate to set the acceptable MCI level to 100 for any site where periphyton biomass or nutrient concentrations exceed "natural state" levels. (SIN = 0.855 g/m^3 gives a periphtyon biomass of 200 mg/m^2 (my Fig. 2); periphyton set at 200 mg/m^2 is consistent with MCI = 100 (my Fig 1); Dr Death's data indicates that 0.8 g/m^3 Nitrate gives an MCI of 100, which is consistent with my data analysis.)

10.12 Overall, there is strong evidence for the relaxation of some nutrient numerics in Schedule D of POP. I make this recommendation principally as a result of my concerns over conservative numerics being used to build a picture of water quality degradation in the Region. Furthermore, my recommendation is based on information that was not available at the time POP was notified. In my opinion, many of the limits (SIN, DRP and MCI in particular) in Schedule D are set at unrealistically high levels for developed catchments in the region. New information collected since notification of POP would support my recommendation for a relaxation of some limits. Due to the conservative nature of some of the current Schedule D limits, I recommend that they should continue to be considered as numerics to guide management action, rather than as limits (in the sense of the NPSFM).

[Topic 2] - nitrate toxicity

11 Discussion:

11.1 Dr Ausseil introduces the topic of nitrate toxicity and refers to a report by Hickey & Martin (2009), which recommends "trigger values" for protection of aquatic communities in Canterbury. It is important to note that the report of Hickey & Martin (2009) reviewed overseas literature on nitrate toxicity, as there have been no studies of nitrate toxicity relating to New Zealand species. Furthermore, the recommendations of Martin & Hickey (2009) were strongly

influenced by results from studies on several salmonid species, including chinook salmon and lake trout, neither of which occur in the Manawatu. A review of the ANZECC guidelines is currently underway and is considering nitrate toxicity. In my opinion, it would be unwise to incorporate nitrate toxicity numerics into consideration of the Manawatu regions WMZs at this stage.

[Topic 3] - SIN load modelling scenarios

12 Load calculation methods:

12.1 Through expert caucusing it was agreed that the estimates of SIN load produced from the modelled land use scenarios have resulted from calculations that effectively remove variation. For example, average N losses for different land uses have been used, despite significant inter-property variability. Long-term average flow rates and SIN concentrations have also been used. As a result, the outputs of these modelling scarios are presented as single numbers (e.g. percentage change in SIN loads). These numbers provide a useful method for comparing the relative change in SIN load across different land use scenarios.

12.2 However, there is still an unresolved issue with how the outcome of these scenario results might inform resource management decision makers. In my view, it needs to be acknowledged that natural variability in river nutrient concentrations, river flows and ecological processes in soils, groundwaters, riparian areas (= stream margins) and in-stream will all introduce uncertainty in what the "actual" outcomes will be in relation to SIN load in receiving waters. For example, the scenario modelling may predict a SIN load reduction of 10% over 20 years, but this reduction may not be measured, because it is masked by natural variability.

12.3 In his scenario modelling, Dr Ausseil assumes that measured load is the product of cumulative losses from land and an attenuation factor. There is significant natural variation in the measured load (see footnote 2 below 5.8 of Dr Ausseil's evidence) and in cumulative losses from land. Dr Ausseil removes all the variability in measured load and land use losses by calculating an attenuation factor as "*…the ratio between the estimated in-river nutrient load and the estimated current nutrient load lost from land*" (8.10). Not only is this method circular, it appears to generate counter-intuitive results. The only example of attenuation factor given by Dr Ausseil is for the Mangatainoka at SH2, where 98% of

the Total Nitrogen lost from the land is measured in the river as SIN. This is not possible because SIN is only a fraction of Total Nitrogen (for the Manawatu River at Weber Rd SIN is 64% of TN; see attached Figure 1 below). Nitrogen is not conservative in the environment, shallow groundwater processes, riparian (stream margin) and in-stream processes operate in complex ways to deliver the SIN concentrations observed in rivers. The approach taken by Horizons of setting a constant attenuation factor (i.e., 0.5; para 61 in Roygard & Clark, 24 Feb 2012) is more appropriate when the actual attenuation factor is an unknown.

[Topic 4] - Predicting water quality outcomes from SIN load modelling

13 Discussion:

13.1 Dr Ausseil goes further than just predicting SIN loads as a result of land use change scenarios. He also estimates reductions in periphyton biomass, using the NZ Periphyton Guidelines' model, which he recognises as environmentally conservative (8.20). Furthermore, he states "*…the NZPG model is useful to provide an indication of the direction (i.e. increase or decrease) and scale of change in periphyton biomass that is likely to result from a given change in nutrient concentration"*. I would suggest that the NZPG model over-estimates the periphyton biomass for a given SIN concentration in Manawatu rivers. Therefore, the estimated percentage changes in periphyton biomass will be exaggerated using this model.

13.2 In his evidence, Dr Death states "*As aquatic ecological communities are complex ecosystems that are affected by multiple interacting stressors, the effects for ecological communities of specific management practices that focus on controlling only one of these stressors (e.g. reductions in nitrogen loadings) is difficult to predict.*" (para. 20). I agree with this statement. In para. 100 of his evidence, Dr Death states "*It is therefore impossible to say if nitrogen loads reduce by 4% there will be a certain percent increase in ecological health*". Caution is required when attempting to predict the "outcome" (e.g. periphtyon biomass) from increases/decreases in SIN.

[Topic 5] - Concerns over limited range of values considered by Horizons

14 Discussions:

14.1 Dr Ausseil points out that he was the principal author of technical reports outlining the values and standards framework in the POP (para 1.6). In para. 3.9 of his evidence, Dr Ausseil provides a valuable insight into the assessment of "values" within POP. He states (underlined words are his emphasis) "*It is important to note that 'value' does not equate with activity. For example, applying the Irrigation value to a waterbody recognises that some of the water may be used for irrigation, and thus should be of a certain quality to be able to be used for that purpose. It does not relate to the activity of taking that water (i.e., recognising the irrigation value does not presume that any of the water should, must or will be made available for this use."* His meaning to me is clear - the Irrigation value defines an environment state objective, not a use objective.

14.2 In my EIC (para 39-42), I raised concerns over what appears to be a rather narrow range of values applied by Horizons in POP. In particular, there appears to have been limited regard given to social and economic values, and the inevitable trade-offs between economic and environmental values appears to have been largely ignored.

14.3 The absence of trade-offs between conflicting values has also been highlighted in the evidence of Ms Corinna Jordan for Wellington Fish & Game. She states (para 11.11) that "*Out of the 36 sites identified in the notified version of Table 13.1 which included the Coastal Rangitikei catchment, 50% of sites have essential trout spawning habitat, 27.8% of sites have "regionally significant" trout fisheries including the Mangatainoka and Makakahi (which have local water conservation notices), and 16.7% of sites have locally significant "other" trout fisheries."* These values have been recognised through setting numerics in Schedule D of the POP. 94.5% of sites are therefore managed for a recreational fishery value. This leaves very little room for other human use values, particularly those that might impact on recreational fisheries.

14.4 The National Policy Statement on Freshwater Management is clearly sets out the range of values of importance to New Zealanders. These include human use values (e.g. takes of water for industrial and agricultural use, recreation, fisheries) along with intrinsic values (e.g. indigenous biodiversity). No values are given priority within the NPSFM, as it is recognised that local communities may need to make trade-off decisions between conflicting values in managing resources. In my

opinion, the POP takes a narrow ecological and recreational focussed view, in assigning values and subsequent numerics.

EVIDENCE OF DR RUSSELL DEATH FOR FISH & GAME

[Topic 6] - need to recognise and manage multiple stressors of aquatic ecosystems

15 Discussion:

15.1 I agree with Dr Death's statement that "*Improvement in the ecological health of these waterbodies will require the management of all the interacting stressors, however, any reductions in nutrients, deposited sediment, faecal contamination and restriction on stock access to waterbodies will result in an improvement from the current state*" (Para 20). However, I note the complex interactions between multiple stressors that need to be taken into account by policy makers. For example, improvements in water clarity through reducing sediment can increase light penetration and increase algal growth. Shading of waterways can reduce growth of plants and algae, which can result in reduced uptake of nutrients, leading to potential increased transport of N and P downstream. A focus on a single parameter (e.g. SIN loads in POP) may not achieve the desired outcome (e.g. improved ecological health) if other stressors are also not included in management action.

15.2 I agree that deposited sediment needs to be included in Schedule D. As Dr Death states "*Avoiding the sediment issue runs a serious risk of not achieving many of the important goals of the POP*" (para 41). In principle I support the inclusion of sediment numerics in Schedule D, but I do not accept the values applied to Schedule D proposed by Dr Death. I suggest that agreement on what the limits should be set at for different WMZs and sub-zones needs to be a consultative process involving the range of professional interests and disciplines. I also propose that these limits be used as guidelines, rather than standards or targets.

[Topic 7] - value of water quality trend information in decision making

16 Discussion:

16.1 In para. 75 of his evidence, Dr Death states "*My principal area of concern here is the assertion in the evidence of Dr Scarsbrook that short-term improvements in water quality at some assessment sites indicate agricultural impacts on water*

quality are not as severe as thought". Dr Death misrepresents my interpretation of the results of trend analysis (see section 14 below). The results of trend analyses over a 10 year period (2001-2010) indicate that the imperative for radical changes in management action to deal with degraded water quality in the region has reduced. This is in part because increasing trends in nutrient levels in the 10-year period leading up to notification of POP was used as evidence for the need to increase controls over point-source nutrients. My previous evidence did not indicate that agricultural land use does not significantly affect water quality in some waterways in the region. My agreement to caucusing statements about water quality state in relation to Schedule D limits is evidence of my position on this.

16.2 Of concern to me is the opinion of Dr Death that discussions over whether water quality in the region is declining, improving or remaining constant are "*pointless*" (para 29). He suggests, quite correctly, that aquatic ecosystems are influenced by state of water quality more than by trends, but my understanding is that the matter before the Court is a policy-related matter, and that is the proper context for a discussion on ecology. Understanding whether water quality is improving or deteriorating is relevant to the ability to evaluate the effectiveness of current policies (i.e. RMA (1991) s. 32). State of the Environment programmes are implemented to allow the state (snapshot in time) and trends (changes in state over time) to be estimated. If water quality is deteriorating and degrading values, then management actions may need to be reviewed. If water quality is improving under current management regimes, there may be little imperative for dramatic shifts in current management approaches.

[Topic 8] – Opinion that ecological health in many of the Region's waterbodies is poor

17 With reference to para. 106 of Dr Death's evidence:

17.1 Dr Death's view of the ecological health of the Region's waterbodies is not supported by the recent SoE report by Stark (2011). Sampling at 48 sites in 2011, Dr Stark found that 16 could be classified as "Excellent" (MCI>120), 16 as "Good" (MCI>100), 12 as "Fair" (MCI>80) and only 4 as "Poor"(MCI<80). When looking at Mean MCI values (i.e. internnual averages) across the sites there were 13 sites in the "Excellent" category, 17 in "Good", 16 in "Fair" and only 2

in "Poor". The two sites in the "Poor" category were in the Lake Horowhenua catchment.

17.2 When the current Schedule D numerics are used as the basis for defining state, it can be shown that many waterbodies in the region are degraded. My response is that many of these Schedule D limits are set at unrealistic and unachievable levels and an exaggerated picture of the degradation of the region's waterways results. Should the nutrient and MCI numerics be relaxed, a much higher proportion of sites would meet the numeric and management action could focus on those sites that are truly degraded.

EVIDENCE ON MS CORINNA JORDAN FOR FISH & GAME

[Topic 9] - Evidence for declining trout populations

18 Discussion:

18.1 In para 4.10 of her evidence, Ms Jordan claims *"Wellington Fish and Game Region's trout fisheries are under threat, with many rivers showing declines in trout abundance. The once trophy fisheries which were protected under local water conservation notices are now struggling. Poor water quality from point and non point source pollution, low flows due to high abstraction volumes in some catchments, and the degradation of trout spawning habitat is significantly adversely impacting on the sustainability of our recreational fisheries and adversely impacting on our anglers recreational, intrinsic and amenity values."* Ms Jordan presents no evidence of the links between trout numbers in the regions rivers and water quality. Indeed, she refers to several pieces of evidence suggesting that the trout fishery is not in as poor a state as she claims. In Para 4.9, she refers to the National Angling Survey showing a 6% and 19% increase in angler days in both the Rangitikei and Manawatu rivers, respectively between 1994/95 and 2007/08. Based on a 2009 report (para. 6.7) "*The Manawatu River is the most used fishery by anglers in the Wellington Fish and Game Region, rating higher than the Hutt, Ruamahanga and Rangitikei Rivers…Nationally it ranks 10th of all rivers fished excluding those inflowing to Lake Taupo.*". In para 6.9 "*The lower and coastal Manawatu river offers tidal angling opportunity for sea run brown trout, which are common along the West Coast of New Zealand. Recent accounts by local anglers have reported good angling opportunity from Tokomaru down to the Opiki Bridge, with up to eight pound river run brown trout*

caught (Steve Brown, Manawatu Freshwater Anglers Club, pers comm, 2009)."

MY EVIDENCE ON MATTERS ARISING FROM EXPERT CAUCUSING ON THE TOPIC OF WATER QUALITY

[Topic 11 - Summary of water quality trend analyses presented during caucusing

19 Discussion:

19.1 Maree Clark carried out an informative set of trend analyses across several sites in target catchments and for differing time periods. This summary, presented during expert caucusing on the Water Quality topic (March 29th) and agreed by all other experts, confirmed the interpretation of trend analyses I presented in my EIC. In summary, the 10-year period leading up to the development of the POP was a period of increasing nutrient levels, and the proposition of increased controls on non-point source derived nutrients was, in my opinion, a valid approach to the concerns raised by these trends. However, more recent trends (e.g. my analyses of 2001-2010) indicate stable or improving trends and these suggest that the imperative for strict controls on nutrients has weakened.

19.2 The importance of utilising these trends in deciding on the most appropriate methods to achieve the regional plan objectives cannot be understated. While we do not have the information to assess exactly what has caused the improving trends, messages to farmers from Council (e.g. move to land disposal of effluent) and industry (e.g. Clean Streams Accord) over the last decade will have contributed to these improvements in my opinion.

19.3 In the Manawatu River at Weber Rd, there has been a 3% **per annum** reduction in median SIN concentrations over the ten-year period 2001-2010. This 30% reduction in SIN load has been achieved under a more permissive regime than some submitters are requesting for the POP.

19.4 I note that even the most dramatic reductions in SIN proposed by Fish & Game and the Minister for Conservation for the Manawatu Riverfall short of the improvements that occurred in the river between 2001-10. In his evidence, Dr Ausseil indicates that a 13% reduction in average SIN could occur over 20 years if farmers have N-losses strictly controlled under the 20-year LUC–loss limits where applied in

the Manawatu (Hopelands) catchment. This is under the scenario of no new dairy conversions (para 9.12).

[Topic 12] - predicted SIN loads resulting from Fonterra's proposed land use scenarios

20 Discussion:

20.1 The land use scenarios modelled by Dr Roygard for Horizons and Dr Ausseil for Minister of Conservation and Wellington Fish & Game did not include consideration of land use scenarios proposed by Fonterra because, at the time of lodging evidence, it was not known what regimes were being proposed (record of Technical Expert conferencing, 29th March 2012).

20.2 In his Evidence in Reply, Dr Ledgard has provided a range of N- loss estimates based on land use scenarios relevant to the approach Mr Willis has proposed to managing loss from dairy farms in priority catchments (supported by Fonterra). I note that Dr Ledgard and Dr Parminter consider that scenario 2 is the most likely outcome expected under the regime proposed by Mr Willis. These land use scenarios lead to single figure estimates of N-loss from dairy farms and can be compared with the loss estimates derived by both Dr Roygard and Dr Ausseil in their evidence. Because these numbers fall within the range of single figure N-loss estimates modelled by Dr Roygard (see Tables 40-42 of the Supplementary Statement of Roygard & Clark, 24th Feb 2012) I have been able to estimate the SIN load that would result from the the scenarios outlined by Dr Ledgard. Essentially, the modelling of Dr Roygard is based on a linear relationship between N-loss from dairy farms in the catchment (with 11% intensification over 20 years) and predicted SIN load in the river. Using the equations in Table 1 below, it is possible to convert any N-loss estimate to an SIN load under the assumptions used by Dr Roygard.

20.3 The major difference between the scenarios of Dr Ledgard and those of Dr Roygard and Dr Ausseil is that Mr Willis' proposed approach to managing N-loss from dairy farms covers a 10-year timeframe, rather than a 20 year period proposed by Horizons and Fish & Game. This does alter the level of intensification that might reasonably occur over the 10-yr period proposed by Mr Willis (i.e. 11% intensification over 20 years is equivalent to 5.5% intensification over 10 years). To account for this in the SIN load estimates based on Roygards relationships, I have multiplied the Y-intercept of

the relationship by 0.945 for each river site. The rationale for this was that the Y-intercept is where N-loss from existing farms is zero and the SIN load therefore reflects non-dairy contributions + any new dairy farms (i.e. 5.5% expansion).

20.4 Table 2 below summarises the estimates of changes in SIN load that result from reductions in average N-loss from dairy farms within target and non-target catchments. For the sake of brevity, I will discuss the results for only Manawatu at Hopelands and Mangatainoka at SH2. These sites are also highlighted by both Dr Ausseil and Dr Roygard in their evidence. Note that the difference in time period for change needs to be considered when comparing values in Table 2 with values presented by Dr Roygard (Table 41 of the evidence of Roygard and Clark, 24th Feb 2012) and Dr Ausseil (Tables 18 and 19 of his evidence). It is not clear whether changes over 20 years can be halved to compare with the 10-year changes in Table 2, as some scenarios may not represent a constant level of change over time.

20.5 SIN loads in the Manawatu River at Hopelands are estimated to decrease by around 9% in 10 years under Mr Willis' scenarios (Table 2). The only Horizons scenario that leads to greater overall change is the LUC 20 year approach (12%; see Table 41 in evidence of Roygard & Clark 24 Feb 2012), but this would be achieved over 20 years, rather than 10. The greatest load improvement estimated by Dr Ausseil for this site (Table 18 in his evidence) is 13% when the NVPOP LUC20 loss limits apply to all dairy, with no conversions.

20.6 SIN loads in the Mangatainoka at SH2 are estimated to decrease by around 11% in 10 years under Mr Willis' scenarios (Table 2). Dr Ausseil estimates load improvements of up to 23% based on LUC 20yr loss limits applying to all dairy farms, with no conversions. Dr Roygard's scenario modelling at this site shows a maximum improvement of 12% over 20 years under LUC20 loss limits with 11% conversion.

20.7 Overall, it appears that Mr Willis' approach, as described through the scenarios of Dr Ledgard, can maintain or improve SIN loads to a similar degree to the scenarios based on LUC limits applying to all dairy farms as proposed by the Council and Fish and Game.

Dr Michael Scarsbrook
18 April 2012

Table 1: Linear regression fits between "Single Number Limits Approaches" N-loss values (X; i.e. 15, 18, 21, 24, 27, 30 and 33) and predicted SIN load (Y; T/yr) from Table 40 of Roygard & Clark (24 Feb 2012).

Site	Regression line equation	R^2
Manawatu @ Weber Rd	y = 3.0595x + 220.29	1
Manawatu @ Hopelands	y = 11.202x + 487	1
Tiraumea @ Ngaturi	y = 0.6667x + 270	1
Mangatainoka @ Larsons	No change	
Makakahi @ Hamua	y = 2.7857x + 100.14	1
Mangatainoka @ SH2	y = 7.1667x + 352.71	1
Mangahao @ Ballance	y = 1.4524x + 79.143	1
Manawatu @ Upper Gorge	y = 24.929x + 1648.1	1
Manakau @ SH1	No change	
Waikawa @ Nth manakau	No change	
Waikawa @ Huritini	y = 0.881x + 28.857	1
Rangitikei @ Mangaweka	y = 0.0714x + 248.71	0.75
Rangitikei @ Onepuhi	y = 0.2024x + 339.29	0.95
Rangitikei @ McKelvies	y = 8.2619x + 378.14	1
Rangitikei @ McKelvies	y = 6.5714x + 396.14	1

Table 2. Predicted changes (% of current) in SIN load for target catchment sites resulting from reduced average N-loss from dairy farms. Scenarios are land use change scenarios presented in the evidence of Dr Ledgard. Following the approach of Dr Roygard, I present percentage improvement from current state as a positive percentage, and a percentage degradation from the existing state as a negative percentage. 'NA' These catchments did not have a regression line of best fit (see Table 1) so were not included.

	Scenario 1 (N-loss = 20.2)	Scenario 2 (N-loss = 20.6)	Scenario 3 (N-loss = 21)	Average
Manawatu @ Weber Rd	9%	9%	8%	9%
Manawatu @ Hopelands	**10%**	**9%**	**9%**	**9%**
Tiraumea @ Ngaturi	5%	5%	5%	5%
Mangatainoka @ Larsons	NA	NA	NA	NA
Makakahi @ Hamua	10%	10%	9%	10%
Mangatainoka @ SH2	**11%**	**11%**	**10%**	**11%**
Mangahao @ Ballance	6%	6%	5%	6%
Manawatu @ Upper Gorge	8%	8%	8%	8%
Manakau @ SH1	NA	NA	NA	NA
Waikawa @ Nth manakau	NA	NA	NA	NA
Waikawa @ Huritini	-2%	-3%	-4%	-3%
Rangitikei @ Mangaweka	5%	5%	5%	5%
Rangitikei @ Onepuhi	4%	4%	4%	4%
Rangitikei @ McKelvies	7%	6%	6%	6%

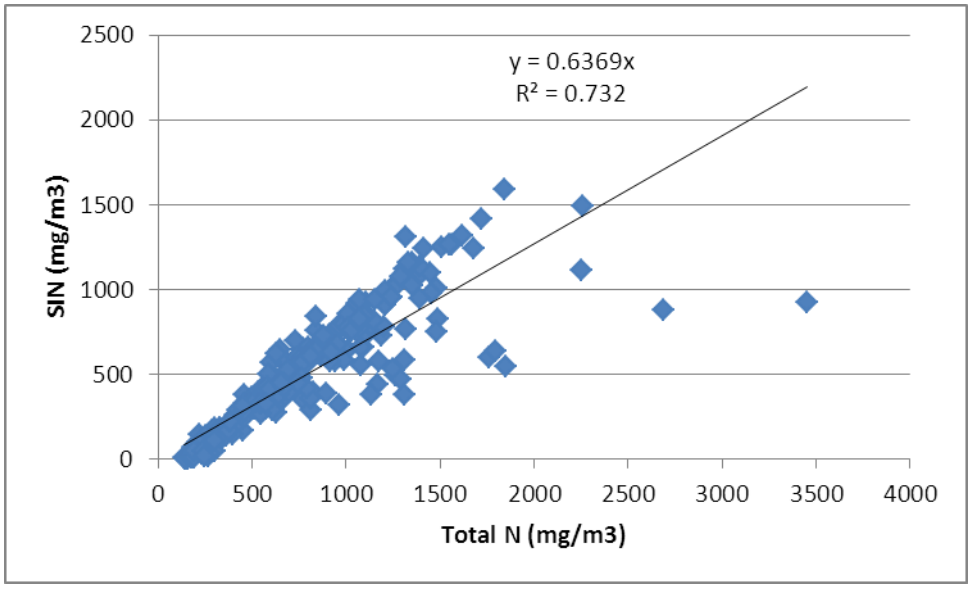

Figure 1. Relationship between TN and SIN in Manawatu River at Weber Rd. Data from National River Water Quality Network dataset

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