BEFORE THE ENVIRONMENT COURT

IN THE MATTER OF	appeals under clause 14 of the First Schedule to the Resource Management Act 1991 concerning the proposed One Plan for the Manawatu-Wanganui Region
BETWEEN	**FEDERATED FARMERS OF NEW ZEALAND** ENV-2010-WLG-000148
AND	**DAY, MR ANDREW** ENV-2010-WLG-000158
AND	**MINISTER OF CONSERVATION** ENV-2010-WLG-000150
AND	**HORTICULTURE NEW ZEALAND** ENV-2010-WLG-000155
AND	**WELLINGTON FISH & GAME COUNCIL** ENV-2010-WLG-000157
	Appellants
AND	**MANAWATU WANGANUI REGIONAL COUNCIL**
	Respondent

STATEMENT OF EVIDENCE OF DR ALISON DEWES ON BEHALF

WELLINGTON FISH & GAME COUNCIL

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1. INTRODUCTION

Qualifications and experience

1.1 My full name is Alison Mary Dewes.

1.2 I have a BVSc from Massey University (1987) and Nutrient Management and Advanced Nutrient Management Courses from Massey University (2009). I am presently undertaking a Masters in Biological Science (Ecology) at Waikato University.

1.3 My higher education in the past decade has included the following courses:

(a) Financial advisory courses for Tier 111 registration for Agribusiness; Commonwealth Bank of Australia 2007;

(b) Certified Adult Trainer, Melbourne 2004;

(c) Dairy Leadership Course Melbourne 2004;

(d) In Calf Training, Certified 2006;

(e) Advanced Dairy Nutrition, Australia 1999;

(f) Dairy Nutrition Course, Lean, Massey 1990;

(g) Soils and Pastures Course, Massey 1993; and

(h) Milking Machine Testers Course, Flockhouse, 1992.

1.4 I have spent the past 20 years farming with my husband. We started sharemilking in the Waikato and then in Western Victoria, Australia, where we bought and developed three pasture based dairy and support farms over the 2001 to 2008 period.

1.5 In the period from 1997 to 2001, I held a position in Milk Procurement, for Nestle (now owned by Fonterra), in Warnnambool, Western Victoria, Australia. During this time, I was involved in technical extension and animal health management and the development of the quality assurance programme.

1.6 In 2001, I took over as Business Development Manager for Intelact in Australia. The business services were based on full farm analysis for intensive pastoral farms, and farm system modelling using UDDER and Red Sky strategy scenarios for agricultural businesses faced with major constraints in surface and ground water allocations during two major droughts.

1.7 In 2006, I became Agribusiness Lender for the Commonwealth Bank of Australia and was heavily involved in the appraisal and risk assessment of new business for the bank.

1.8 In 2009, I returned to New Zealand and undertook post graduate study in Nutrient Management at Massey. I was contracted to Agfirst at this time, and undertook the Upper Waikato Nutrient Efficiency Study. As part of that study, I analysed more than 380 overseer files for eco efficiencies for MAF farm monitoring during 2009 and 2010.

1.9 I am presently Lead Consultant for Headlands, a consultancy company based in Te Awamutu, which focuses on developing farm systems for optimal profit while minimising farming's environmental footprint. Headlands is undertaking a project in the Upper Waikato specifically focussed on understanding which farm systems have the highest profit and lowest environmental footprint. Tools to assist in farm analysis and strategy design plans include UDDER, Farmax Dairy Pro, Red Sky, and Overseer. I am a competent user of these modelling programmes.

1.10 Headlands main role is the application of whole farm planning services for farms in sensitive catchments.

Expert Witnesses Code of Conduct

1.11 I have read the Environment Court's Code of Conduct for Expert Witnesses, and I agree to comply with it. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise.

1.12 I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of evidence

1.13 My evidence will address the following:

(a) The rate of change in New Zealand dairy farming systems in the past decade (Section 3).

(b) The externalities from farming – intensive and extensive (Section 4).

(c) Intensive and extensive farming (Section 5).

(d) Mitigations available for dairy farming (Section 6).

(e) Profitability of farming if faced with potential constraints (Section 7).

(f) LUC nitrogen leaching limits (Section 8).

(g) Reductions in nitrogen leaching limits (Section 9).

(h) Farm strategies, nutrient management plans, and stock exclusion from waterways (Section 10).

(i) Time for farmers to adapt (Section 11).

(j) Limited database information (Section 12).

(k) Technology and support to manage transition to change (Section 13).

(l) Desire to change and be more sustainable (Section 14).

1.14 A summary of my evidence is set out below.

2. SUMMARY OF EVIDENCE

2.1 There has been significant change in NZ pastoral based farming systems over the past decade.

2.2 There are externalities from intensive and extensive farming that affect receiving water bodies. These externalities include nutrient (nitrogen and phosphorus), pathogen and sediment loss to water bodies which result in degraded water quality and adverse effects on aquatic ecosystems.

2.3 The effects from farming, both intensive and extensive, need to be managed using a suite of measures in order to ensure protection of surface water bodies.

2.4 Extensive farming cannot be excluded from a proposed approach, due to the risk of phosphorus, pathogen and sediment loss which also contribute to degraded water quality. This is especially the case given that market forces may drive unpredictable change, especially when there is a trend to using more cropping and dairy support on extensive farms. Therefore, a policy framework needs to account for this, and this sector may have to be included in the future.

2.5 Management of farming should occur across all catchments in a staged approach as, if this is not done, it will lead to inequities in land values and the risk profiles of investments in farms as different catchments progressively become managed in the longer term.

2.6 We do have knowledge and a range of mitigation choices on how to manage many of the N, P, sediment and pathogen losses that occur. However, this is not a one size fits all, and the risk of making assumptions on how an “average” farm may respond may be erroneous. Databases that detail profit, efficiencies, and related environmental effects are not well populated; hence drawing conclusions from small sample sizes that may not be representative of the demographic profile of the farming sector can be flawed.

2.7 Mitigations, if worked into a farm system, can be cumulative and can have both costs and benefits. The inclusion of more cereal based feeds as per the Braeburn FARMS example illustrates this.

2.8 Productivity and profitability for most farms need not be adversely affected if there is a well-planned transition time to adapt. The notified version of the One Plan provided for an appropriate transition over the next 20 years in relation to reducing leaching rates but it is possible to achieve this faster. Those dairy farms on land with >1500 mm rainfall and >4-8 LUC should have an alternative policy gateway.

2.9 I support the LUC nutrient allocation framework (original notified version) as it is the most appropriate way to allocate nitrogen emission allowances in the present circumstances. It also is a suitable framework under which other land uses including extensive farming can be included now and in the future.

2.10 Many intensive farms are already well within the year one and year 20 LUC limits. The average dairy farm is leaching below what was perceived, and a large portion of the industry may not be required to make significant change. There is significantly more technology and capacity available to support change in the industry now.

2.11 The risk with only focusing on existing and new dairy farms, as proposed by Horizons, is that it allows the shift in nutrient loads to other land uses including to the extensive farms. Horizons has assumed that the extensive sector is only leaching 10 kg N per ha per year in perpetuity. However, it is likely that this figure is too low, especially if cropping is undertaken as part of the farm practice.

2.12 The long term effect of the approach of regulating only dairy, and not extensive farming and other land uses, is that the total load is unlikely to reduce by any significant amount as the nutrient load may well be shifted from the regulated sector of the industry to the unregulated sectors.

2.13 There are now a significant number of trained agricultural professionals available to the pastoral industry. This increase in capability means that more rapid change and adaptation is possible by all sectors of agriculture.

2.14 Some form of education or self assessment of nutrient losses and efficiencies (eg NMP as per P Taylor's evidence), along with a business plan, can be a positive thing for farms in that it encourages high levels of nutrient efficiency and entices them to assess their profitability. This can be positive for business performance and, as a result, this improves the wider Regions long term resilience.

2.15 Grand parenting rewards polluters and penalises innovators and is not a sound approach in my opinion.

2.16 Benchmarking can be useful but it does not engage the highest risk profile of the agricultural sector – the slow adopters and the laggards. It is this sector that puts the entire industry and the nation's image at risk.

2.17 Voluntary approaches have merit as innovators and early adopters tend to engage in this process. However, this approach alone is unlikely to achieve the desired environmental outcomes as it will not capture the worst polluters, nor will it account for rapid changes in land use that can occur in short time frames as a result of unpredictable changes in market forces.

3. THE RATE OF CHANGE IN NZ FARMING SYSTEMS IN THE PAST 10 YEARS

3.1 The key feature of New Zealand farming systems has been the ability to maintain a "low cost' production base, this has been achieved historically through pasture based production. These pasture based systems were based on the utilisation of home grown feeds and sound pasture management as a perceived low cost way of increasing profitability. However, the expanding use of nitrogen and phosphorus in the 1980's and 1990's resulted in productive responses, which facilitated increases in stocking rates on a range of land classes.

3.2 This phenomenon reflected an increase in pasture harvested per hectare, largely through better feed quality, and more overall energy being generated and utilised from the forage base. It was largely accepted that continuing to increase stocking rate, would continue to drive pasture grown and harvest per hectare. This resulted in increases in stocking rate, coupled with increased nitrogen use, and the resultant increased productivity, in most cases, also led to an increased profitability. The assumptions that increasing stocking rate was correlated in a linear manner to increased pasture harvest and subsequently profit have continued largely unchallenged to the current day.

3.3 In the past decade, the operational profile of farming has changed significantly. Responses to increased stocking rate and fertiliser use on intensive systems have provided fewer gains, and in many cases the risk profile has increased, eg: the fluctuations between good years and difficult years have increased, leading to less certainty with regards to returns. To manage this risk, more intensive farming systems have moved to importation of feeds to decrease the threat of lowered production that can result from the combination of difficult seasons, high stocking rates and impaired feed management.

3.4 In 2002, New Zealand began to import Palm Kernel Expeller (PKE) to supplement locally sourced supplementary feeds in order to maintain milk output and animal body condition, and reduce the risk feed deficits, and the resultant lowered milk production, had on farms. New Zealand now imports 1.4 Million Tonnes of PKE annually, which would equate to around 300 kg per cow per annum. Increasingly, cereals and a range of by products from offshore markets are being imported to maintain production levels. This trend has not necessarily reflected higher productivity or increased profitability[1] as discussed further in my evidence under section 7.

3.5 The factors that drove business decisions in NZ in the decade from 1998 to 2007 have now altered. Capital gains have become less of a factor in business strategy and planning, and the requirement to produce a sound cash return in a business and reduce debt is now more significant.

3.6 This has led to a situation where there is a wide range of farming systems in operation, for example, the Dairy NZ systems 1-5[2].

3.7 System 1: All Self Contained, System 2: 4-14% feed imported, System 3: 10-20% feeds imported to extend lactation, System 4: 20-30% of overall feeds imported. System 5: 25-50% of feeds imported, all year. Many farms are now importing over 25% of their feeds in the Lower North Island area (Agfirst Waikato, 2009)

3.8 In my view, the costs to a business determined by Neilds and Rhodes were based on single mitigations on an "average farm" and the extrapolation of that single cost associated with a change to structure a lower leaching farm. A simplistic approach was adopted, rather than a whole farm system approach, potentially leading to unreliable assumptions especially when extrapolated to a catchment scale.

4. INTENSIVE & EXTENSIVE BASED PASTORAL FARMING – EXTERNALITIES OF CONCERN

4.1 The public are clearly concerned about the state of their freshwater resources. Neels Botha cites a very clear summary in his evidence where he states that:

> *"Freshwater related issues are the single biggest environmental concern for New Zealanders (Hughey et al, 2010). From the 2010 survey it became very clear that the public wants:*

[1] "Increased profit that is ideally measured as an increase in total return on assets"

[2] Dairy NZ systems 1-5 is a classification system of farm types based on the different amounts of feed that are imported to the milking platform, from external sources.

(a) *Development that does not wreck fresh water environments they recreate in.*

(b) *Environmental and recreation values of rivers protected, but are also willing to see water used, although not at the expense of these other values.*

(c) *An economic value on the commercial use of water and for charging users.*

(d) *Economic and Regulatory approaches for achieving desired outcomes.*

(e) *The ecology and nature of fresh water resources protected because these are highly valued by them."*

4.2 It is now well recognised that pastoral agriculture, dairy farming and sheep and beef farming, are key contributors to water quality decline in New Zealand's waterways due to the externalities associated with pastoral agriculture. The Wanganui Manawatu Region is no different. Horizons have presented extensive technical evidence (as contained in the TEB lodged with the court, and further technical evidence) on the impacts pastoral agriculture is having on the regions waterbodies. As stated by Dr Clothier (2008, TEB) "*Current nitrogen (N) loadings in the Upper Manawatu River and Mangatainoka are more than twice the water quality standard set for each Water Management Zone (WMZ) by Horizons Regional Council* ".

4.3 As discussed by Ms McArthur, water quality is a major issue in the Manawatu River, which is among the worst polluted rivers in New Zealand. Water quality in the upper catchment is classed as '*moderately nutrient enriched'* but significantly degrades rapidly downstream, with around 80% of the dissolved reactive phosphorus (DRP) load and 98% of the Soluble Inorganic Nitrogen (SIN) load sourced from diffuse nutrient runoff from agriculture (McArthur s42a Officers report as contained in the TEB). Ms McArthur goes onto say "*the state of Horizons' rivers is poor when compared to the state of water quality nationally and many sites do not comply with the POP water quality standards or nationally accepted guidelines*" (McArthur, s42a officers report, paragraph 19, page 9),

4.4 I have read the evidence and respective reports prepared for Horizons Regional Council and agree with them in regards to the externalities of concern from pastoral agriculture and their respective pathways (Clothier. B). The externalities of concern from pasture based agriculture are: effluent/ pathogen run off from the land which contributes to the contamination of waterbodies; erosion and soil loss from the land leading to increased sediment loads to waterbodies; loss of riparian vegetation, and erosion of stream banks, leading to streambank instability; phosphate loss across land (effluent run off, soil loss and connectivity points); and nitrate loss through the land and via run off. The impacts of these externalities are discussed further in the evidence of Associate Professor Death, and Dr Olivier Ausseil.

4.5 All of these externalities can contribute toward declining aquatic ecosystem health (water quality and habitat) and issues of public health significance such as coliforms, campylobacter, cyanobacteria, and salmonella among other potential pathogens. I therefore recommend measures to restrain these externalities from pastoral agriculture, as far as practicable, in order to prevent further degradation of shared aquatic amenities.

4.6 Point source discharges are also a source of contaminants to water bodies, this also requires improved management; however this is outside my scope of discussion.

Summary – Externalities of Concern

- Freshwater related issues are the single biggest environmental concern for New Zealanders (Hughey, 2010)
- It is now well recognised that pastoral agriculture, including dairy farming, is one of the key contributors to water quality decline in New Zealand.
- Horizons has presented extensive technical evidence on the impacts pastoral agriculture is having on the regions waterbodies
- The Manawatu River is among the worst polluted rivers in New Zealand. Diffuse pollution from pastoral agriculture contributes 80% of the DRP load, and 98% of the SIN load to the river
- The externalities of concern from pasture based agriculture are: Effluent/ pathogen run off from the land which contributes to the contamination of waterbodies; erosion and soil loss from the land leading to increased sediment loads to waterbodies; loss of riparian vegetation, and erosion of stream banks, leading to streambank instability; phosphate loss across land (effluent run off, soil loss and connectivity points); and nitrate loss through the land and via run off.

5. INTENSIVE & EXTENSIVE FARMING

DAIRY FARMING

5.1 The contribution of non-point source N loading from dairying and sheep and beef farming in the Upper Manawatu catchment, was established through the Farm Strategies for Containment Management (Mackay et al, 2007). This study found that more than 90% of the total N in the river was from these two sources, with dairying contributing half of the leaching, despite being only 17% of the land area, while sheep and beef which occupied 77.3% of the catchment, contributing approximately the other 50%.

5.2 The relative contribution of dairy farming to mass nutrient loads in the regions waterbodies is usefully summarised in the end of hearing officers report by McArthur et al (2009). Dairy farming was identified as contributing proportionally greater volumes of nutrients to surface waterbodies than other land uses. Furthermore, research investigating intensification scenarios along with implementation of best management practices demonstrated that total nitrogen loads for the Upper Manawatu Catchment were most sensitive to management of dairy farming. Modelling predicted that if per hectare production of dairy farming was increased from an average of 1,000 to 1,2000 kg of MS (milk solids) per ha, the nitrogen loading from this part of the catchment would increase by 33% (Roygard, 2009).

5.3 As notified Intensive agricultural land uses were regulated under rule 13.1 (controlled) and rule 13-27 (discretionary), these rules also applied to other intensive land uses as discussed below. As notified both new and existing intensive land uses had nitrogen leaching limits applied through table 13.2 which progressively declined over time. However, the council level decision on the One Plan removed the requirement to meet a N leaching limit for existing dairy farming, and also removed the progressive reduction in the N leaching allowance for new dairy farms.

5.4 Horizons are currently proposing to regulate dairy farming, under rules 13.1 existing dairy farms in target catchments (shown in Table 13.1), Rule 13.1A existing dairy farms in target catchments which don't meet the standards/ terms/ conditions of rule 13.1, rule 13.1B (new dairy farms), and rule 13.1C New dairy farms which do not meet the standards/terms/conditions of rule 13.1B, in order to address the regional issue of impacts of agriculture on the regions waterbodies.

5.5 Dairy farming as defined in the notified version of the One Plan "refers to properties greater than 4ha and mainly engaged in the farming of dairy cattle". This definition was amended by the decision to "any area of land greater than 4ha for the farming of dairy cattle for milk production. This includes land uses as a dairy cattle grazing runoff but excludes any dairy grazing arrangement. A dairy grazing arrangement is a third party commercial arrangement between the owner of dairy cattle and another landowner for the purpose of temporary grazing".

5.6 I have read the evidence presented by Neilds & Rhodes and also Newman of Fonterra with regard to intensification scenarios. In my opinion, in some of the catchments, there is still significant potential for dairy expansion. I concur with Newman pt 31 of his S42a evidence that dairying is unlikely to be constrained by the availability of suitable land in the region.

5.7 The growth over the decade up to 2007-08 according to Newman showed an increase in milksolids of 28% over the decade, while the increase in land area for dairying increased by only 5%. Newman predicts that this scenario is likely to continue for the next decade.

5.8 Intensification scenarios are assumed from analysis of historical patterns. In Rhodes report, the growth cited over the decade to 2008 was based on fewer larger herds, with 16.5% more cows, and increased milk solids output of 28%, and an increased effective milking area of 9.1% over a 10 year period.

5.9 Over the next 20 years, both Horizons and Wellington Fish and Game Council (WFGC) have modelled scenarios based on 11% expansion of dairying in the region, this would seem sound given the evidence by Newman.

5.10 However, given continued strong commodity prices and the improved business returns from dairying, if the present level of milk commodity pricing continues there is a possibility of increased dairy intensification in some catchments with large amounts of suitable land still available. On this basis, I consider that there is the potential for a more significant move to dairying in some catchments over the next 20 years. Therefore, I asked Dr Ausseil to include in his modelling an 18% (9% per decade) growth scenario. This is presented in Section 8 and 9 of his evidence.

5.11 The impacts associated with pastoral agriculture have been discussed above and have been addressed by the technical evidence of Horizons (TEB and further evidence 2012), Associate Professor Death (2012), and Dr Ausseil (2012). In my opinion, it is appropriate that a management framework is put in place to guide pastoral agriculture and future intensification. This is discussed more fully in my evidence to follow.

CROPPING, INTENSIVE SHEEP AND BEEF & EXTENSIVE FARMING

5.12 As notified, the One Plan regulated ‘Cropping’ ‘Market Gardening’ and intensive sheep and beef farming’ under Rule 13.1. These land uses have been subsequently removed from the regulatory regime by the decision. The WFGC has sought the re inclusion of these land uses back into rule 13.1 and 13.2, due to concerns that these land uses have the potential to leach high amounts and if left unregulated may negate any improvements achieved through the management of only dairy farming on water quality.

5.13 Non-irrigated sheep and beef farming (“extensive farming”) was not controlled in the notified version of the One Plan and nor is it controlled in the decisions version of the One Plan. While the WFGC is not proposing that extensive farming be controlled via the One Plan, the WFGC is concerned that not controlling extensive farming could result in increased leaching from these farms to greater amounts than have been assumed by the Regional Council’s technical experts.

5.14 I consider the concern that failure to manage agricultural land use that have the potential to leach higher rates (>10kg/N/ha/yr), which could undermine current One Plan management approaches including regulation, which are designed to reduce the impact of non-point source pollution on water bodies, is well founded for the reasons set out below.

5.15 In the case of the Manawatu - Wanganui Region, sheep and beef farming, including extensive and intensive farming, occupies 51.33% of the total land area and contributes about half of the N load to waterways. Intensive farming is assumed to be farming that has a stocking rate of 10 -20 SU/Ha as compared with extensive farming, which have a lower overall stocking rate, ie, <10 SU/Ha. However, sheep and beef farming can leach low to high amounts of N depending on farming practices.

5.16 Horizons has assumed a leaching rate of 10 kg N/ha/year from extensive sheep and beef farming. There is also an assumption that this will remain constant. As illustrated in my evidence, this may in fact not be the case. It is on this basis that I asked Dr Ausseil to run scenarios to investigate the risk to water quality if there is a lift from an assumed 10 kg N leached per ha to 12 kg N leached per ha. This is shown in section 8 of Dr Ausseils evidence and the water quality outcomes of these scenarios are discussed under section 9 of his evidence (Dr Ausseil, 2012).

5.17 Horizons has also assumed that the total cropping area will remain constant and will continue to leach an average of 50.5 kg N/Ha/year. In my opinion, there may be a shift to increased support for the dairy industry, by the extensive sector, as discussed in my evidence.

5.18 On this basis, I asked Dr Ausseil to run a scenario of assuming that in each catchment the extensive sector move to undertaking more cropping on their better land classes. The "increased cropping by extensive farms" assumes that there will be 15% of their LUC 1, 2 and 3 land cropped and 10% of their Class 4 land cropped. This is shown in section 8 of Dr Ausseils evidence and the water quality outcomes of these scenarios are discussed under section 9 of his evidence (Dr Ausseil, 2012).

5.19 For the respective catchments, this equates to a total cropped area on extensive farms of 2.4% in the Mangatainoka, 1.6% of total extensive farm area in the Hopelands catchment, and 4.6% of total extensive farm area in the Coastal Rangitikei. Should there be an increase of dairying in the catchment of a further 11% to 18%, then it has been assumed there may also be a trend towards 50% of extensive farms adopting some sort of cropping on their better land classes, either for dairy support, the growth of cereal crops for the dairy industry, or alternatively for the support of their own stock finishing purposes.

5.20 As discussed by Dr Alec Mackay "*Typical leaching losses from sheep and beef pastoral systems in New Zealand are as little as 6 kg-N ha-1 yr-1 in the less intensive systems (<10-12 SU ha-1) , up to 60 kg-N ha-1 yr-1 in the more intensive sheep and beef systems, with 10-20 kg-N ha-1 yr-1 often used as a more typical range (Meneer et al.,2004). Annual losses of P from sheep and beef systems have been reported at 0.1-1.6kg-P ha-1 yr-1, with the losses lower under sheep grazing at 0.1-0.7 kg-P ha-1 yr-1*"(Mackay et al, 2007). It is the potential higher rate of leaching that is of concern, as it can match the nutrient loss levels of intensive dairy farming.

5.21 Higher N leaching can be the result of a range of activities, including cropping operations, and a shift to dairy support systems, on sheep and beef farms. For example, Dr Clothier has identified the potential N leaching losses associated with cropping as follows:

TABLE 1. ASSUMED AVERAGE LEACHING RATES FOR LAND USES – (Clothier – original report 2007)

1. Farm Types and the Potential Impact on Water Quality.

Horizons Regional Council have identified the 4 intensive forms of farming as being dairying, irrigated sheep and beef, market gardening and cropping. These we rank for nitrogen (N) and phosphorus (P) as

Ranked Nitrogen Loss		**Ranked Phosphorus Loss**	
Market Gardening	(100-300 kg-N ha^{-1} yr^{-1})	Market Gardening	
Cropping	(10-140 kg-N ha^{-1} yr^{-1})	Cropping	
Dairying	(15-115 kg-N ha^{-1} yr^{-1})	Dairying	(0.2- 1.0 kg-P ha^{-1} yr^{-1})
Sheep/beef	(6-60 kg-N ha^{-1} yr^{-1})	Sheep/beef	(0.1-1.6 kg-P ha^{-1} yr^{-1})

5.22 The recent evidence presented by Dr Roygard and Ms Clark (Feb 24, point 93) notes that: "Loss rates from cropping activities presented in Horizons' evidence showed rates of nitrogen loss from cropping are variable depending on the crop type. Clothier et al. (2007) identified likely losses from cropping to be 10 to 140 kg N/ha/yr. Data from the Pencoed FARM Strategy test farm shows winter wheat, spring wheat and maize leaches nitrogen at 67, 8, and 29 kg/ha/yr respectively. Maize grown for maize silage on a number of the FARM strategy test farms showed nitrogen leaching losses of 99, 132, 46, and 85 kg/ha/yr. This data shows cropping can leach a significant amount of nitrogen and the amount will depend on crop type, time of year it is grown and its occurrence in rotation**.**"

5.23 As with dairy farming, sheep and beef farming can result in contamination of waterbodies from phosphate, pathogens and sediment runoff, if it is poorly managed. Losses from cropping (as part of the sheep and beef farm or as an independent farming operation) can result in significant amounts of nitrogen leached[3] to waterbodies as well as, phosphate, pathogen, and sediment contamination of waterbodies. It is therefore important to consider the current and likely future impacts of these land use types on waterbodies in the region, and to establish them within management approaches. It is also important to consider the establishment of appropriate criteria for categorising extensive to intensive farms.

5.24 Higher commodity prices and global demand, are likely to drive a change in systems to out of season supply of protein sources, such as more novel lamb finishing systems emerging with more cropping (brassicas and cereals).

5.25 Extensive farms may choose to support dairy farming through cropping or grazing support in the face of improved commodity prices and this may lead to intensification of extensive land areas. Cropping support occurs when extensive farmers grow crops on their farms and then sell the crops to dairy farmers as feed for dairy cattle. Grazing support occurs when dairy farmers winter their stock off on an extensive farm, wintering stock off has the potential to transfer leaching to another property that may be in the same catchment or in a different catchment.

5.26 In time, both cropping and grazing support could contribute increased N loading from sheep and beef farms. Phosphate and sediment loss also has the potential to increase, as the market favours intensification, as a result of increased demand from dairy farmers for support services. (eg: young stock grazing, cropping). On this basis, it is feasible that the average leaching of 10 kg N per ha per year assumed by the Regional Council's experts from extensive farming may in fact be too low.

5.27 In my opinion, if only existing dairy farms and new conversions to dairy farms are to be captured in the regulatory framework there is the potential for the regulated portions of the industry (existing and new dairy farmers) to shift their nutrient load to the unregulated sectors.

5.28 The cumulative effects of all of these factors would lead to increased risk of nitrogen, phosphorus, sediment and pathogens lost to the receiving environments.

5.29 I also note the concern raised by Dr Roygard in his latest evidence as to the possibilities that may be resulting in higher than anticipated land loads from a range of land uses, especially those of sheep and beef farming. Dr Roygard's evidence states the following:

> *"141. The higher results for loss rates from Sheep/beef in the Mangatainoka may be attributable to a range of factors including but not limited to*

[3] Appendix 5 of Roygard Evidence feb 2012 Nutrient Budget Summary point 3 notes the average crop block losses in the nutrient budgets averages 50.5 kg N leached per year.

(i) *Higher rainfall in the Mangatainoka catchment*

(ii) *Poor practice of sheep/beef farming occurring in the catchment*

(iii) *Nutrient budgets for dairy underestimating the actual loss from dairy. For example due to the assumptions of best practice discussed above.*

(iv) ***The areas of sheep/beef including more intensive blocks such as cropping blocks or grazing for dairy cattle.***

(v) *The area of sheep/beef being overestimated by the analysis method.*

(vi) *The attenuation rate in this catchment is lower i.e. more of nutrient that is lost from the land is measured at the water quality monitoring site."*

5.30 Table 39 of the evidence of Dr Roygard et al (2012) demonstrates that the potential load from currently unregulated agricultural land uses, including sheep and beef, cropping, and horticulture, could be contributing a significant portion of the load when the "by difference" approach is assumed. This highlights the issue and challenge faced should these sectors remain without any constraints on a trend to increased cropping or dairy support.

5.31 However, this also highlights that it is essential that a more robust database of up to date OVERSEER files is required in order to quantify the risk posed from these sectors, and also ascertain trends in this sectors.

5.32 This trend, towards altered land use or increased leaching (>10 kg N/ha/Yr) is especially so for those in the sector that may be carrying higher levels of debt in the face of lowered commodity prices. In these instances it is not unusual for sheep and beef farms for example to sell their own stock, and move to a policy of taking in dairy replacements or winter grazing, thereby increasing the risk of soil disturbance, N, P, sediment and pathogen losses in the higher rainfall months.

5.33 As mentioned, it is probable that many sheep and beef farms in some catchments will choose to move their better classes of land from pasture to cropping to produce cereals, in response to a growing appetite for these "feed crops" to complement or replace PKE for regional dairy herds. This could occur in a short time frame (<5 years) as Lucy Waldron has pointed to in her evidence.

5.34 In my opinion, the shift towards more cows, dairy intensification and a corresponding increase in support from the non-dairy sector is likely.

5.35 Land use change can happen very rapidly. An example of rapid land use change in response to market forces is in the Waikato Region, where there has been in the order of

34,000 ha of conversion of production pine forestry to pasture in the years between 2006 and 2010. There was no policy framework in place to negate this mass land use change and the subsequent mass loading of nutrients that has resulted. As a consequence, this is likely to have a significant cumulative effect over time on the receiving water bodies in the Upper Waikato Catchment. In the Upper Waikato Catchment the load has increased, due to the conversion of ~34,000 ha of land that was in production pine forest, from an average leaching amount of 4 kg N per ha per annum to approximately 39 kg N leached/Ha (Central Plateau Dairy Average Benchmarks: 2012: Dairy NZ).

5.36 We cannot assume that sheep and beef farming, or other agricultural practices, will move in a predictable pattern either maintaining current leaching rates, or moving toward lowering stocking rates or lowered intensity farm systems with a consistently low leaching loss of 10 kg N leached per ha per annum, or less.

5.37 It is my opinion, the externalities from unregulated agricultural land uses will contribute to an increased load of nutrients in the sensitive receiving catchments, along with other externalities of concern (stock damage to riparian zones and stream banks, sediment and pathogen contamination of waterbodies). Failure to manage all land uses which contribute to degradation of freshwater resources could significantly undermine the proposed management framework of the One Plan and the goals sought in regards to the protection of the regions waterbodies.

5.38 I recommend the re inclusion of Intensive sheep and beef and cropping into the management framework. In regards to cropping, I consider that cropping as a component of sheep and beef farming should also be included in this management framework. I recommend that extensive sheep and beef farming be monitored and if it is seen to be contributing to the continued degradation of the regions waterbodies that it be brought into a regulatory framework subject to best management standards and leaching limits.

Summary – Intensive & Extensive Farming

- Dairy farming appears to contribute proportionally higher inputs of nutrient loads to the regions waterbodies than other land uses. In the Upper Manawatu Catchment it contributes approximately half the nutrient load while only occupying around 17% of the catchment. Sheep and beef farming contributes approximately the other 50% , however it occupies a much greater percentage of the land area at around 77.3%
- Intensification of dairy farming in the region is predicted at between 11% and 18%

- I believe it is appropriate that a management framework be put in place to guide current and future pastoral farming in order to protect the shared aquatic resources.
- Market forces can lead to reasonably rapid changes in land use that at times can be unpredictable.
- The classification of the risk of N, P, pathogen and sediment loss from a pastoral activity is not necessarily correlated with SU/Ha or stocking rate. It is influenced by a range of practises undertaken with in a farm system.
- If only some parts of a sector are under an obligation to meet certain Best Management Practices including discharge allowances nutrient loads may be shifted from a “regulated portion” of the industry to an “unregulated portion” of the industry.
- Also, the establishment of discharge allowances for one farming type but not others may be deemed inequitable (as discussed by Mr Andrew Day). A discharge allowance should be viewed in the same way as a water take allowance, in that it provides certainty and security for the farm business in regards to natural resource use. Agricultural land value, along with farm productivity and profitability are often associated with these consented allowances.
- Changes in the sheep and beef pastoral sector may pose more of a long term risk than dairy, which is presently the only sector that is proposed to be controlled.
- There is a trend toward feeding lower protein (cereals) and lower fibre feeds (as discussed by Dr Waldron) by the dairy industry. It is likely that this could provoke a change in land use towards supporting this demand from other sectors of agriculture.
- Sheep and beef farms may also respond to market trends by carrying more dairy support, undertaking lamb or beef finishing with more cropping to provide out of season feeds, and also increasing the proportion of female cattle carried, all contributing to higher than assumed nitrogen, phosphate and sediment losses over time.
- This may result in an increase in overall N leaching from sheep and beef farms. This higher leaching amount may be occurring currently. At present, Horizons has assumed leaching to be 10 kg N leached per ha for extensive sheep and beef farms.

- Cropping practises on farms may result in significant adverse cumulative effects within a catchment.
- Failure to send a regulatory signal (i.e Doing Nothing Approach) in how intensification and support for dairying may occur is likely to result in increased loads of N, P, sediment and pathogens to receiving catchments.
- In my opinion, management approaches to control and guide agricultural land uses to reduce their impact on waterbodies should include all of the following sectors: Dairy, Irrigated Intensive Sheep & Beef, and Cropping. Extensive Sheep and Beef should be assessed and monitored over the next 5-7 years.
- Removal of certain land uses from the management framework has the potentially to undermine the framework and may result in the goals in regards to the protection of the regions waterbodies not being achieved.

6. MITIGATIONS FOR DAIRY FARMING DISCHARGES

6.1 As I have noted in my introductory section 3 above, there are many "assumed outcomes of intensification" such as: "increased fertiliser use will allow increased stocking rate through increased pasture harvest, and consequently increased productivity". It is also assumed that this may result in subsequent increases in the diffuse N loss as per the intensification scenarios (Clothier, B).

6.2 These historic linear intensification models for example of a dairy farm making a transition to 1200 kg MS per ha, has historically assumed that these benefits would occur, by utilising more nitrogen per ha, more stock per ha and potentially more high protein supplements per ha (grass silage).

6.3 However, as discussed under section 3 above there is now a range of farming approaches in New Zealand. In my recent experience in the Waikato, intensification scenarios now take a variety of pathways reflective of the range of dairy farming systems now in operation. Many of those altered scenarios now may involve more supplementary feed importation, increased use of feeding infrastructure and the associated standing off areas, and <u>not necessarily a higher stocking rate.</u>

6.4 There is now evidence of a range of systems in operation whereby milk solids per hectare have increased significantly (+ 30%) without an associated increase in nitrogen leached. In some cases, these systems that demonstrate high feed conversion efficiency in the cows, associated sound infrastructure are leaching less than the average. These cases illustrate that there is potential for further milksolids to be produced per cow and per hectare with reduced nitrogen leached from the system and there are many examples in the Waikato Region where this is occurring.

6.5 These diverse farming systems open up the potential for a diverse range of mitigation approaches to reduce externalities, but while still maintaining the ability for farms to be both profitable and productive. To determine the appropriate mix of mitigations comprehensive analyses of each farm business is required. Full farm system modelling is highly recommended.

6.6 There are a range of mitigations available to assist on dairy farms in reducing the adverse effects of the discharges from their farms. Many of these mitigations, when integrated in to a whole farm system do have initial capital costs to implement, however, they also have significant benefits including productivity and profitability benefits. Some benefits that result include:

(a) increasing effluent irrigation areas and the associated reduction in fertiliser required;

(b) the use of supplementary feeds to optimise feed conversion efficiencies;

(c) use of feed pads and in shed feeding systems to deliver alternative feed sources, that also increase feed utilisation and reduce feed wastage; and

(d) standing cows off on pads or utilising wintering infrastructure, and the associated pasture productivity that occurs as a result of the pasture protection.

6.7 Mitigations approaches need to address all externalities of concern which have been discussed in sections 3, 4, and 5 above. Therefore a structured consistent approach to reducing nutrients (nitrogen and phosphorus), sediment and pathogens, is necessary.

6.8 I support the use of auditable Nutrient Management Plans (NMP) as an approach for managing nutrient losses from the farm activity. These plans take into account not just nitrogen, but also phosphorus, sediment and faecal losses from the farm. These plans need to demonstrate the progressive reduction of environmental risk from year to year, and the farms ability to meet the required LUC targets for Nitrogen leached.

6.9 Phosphate losses from the farm, contribute to algal growth and water quality decline. Control of phosphorus loss from the farm to surface water bodies offers some of the most cost effective opportunities to reduce environmental impacts. Therefore these should be addressed sooner rather than later in any planned approach.

6.10 A comprehensive analysis needs to be completed for each farm business to ensure maximum efficiency, including maximising productivity, maximising profitability, and minimising externalities, and applied to the farm system under review. Under this approach, more significant reductions in discharges are achievable.

6.11 I concur with Dr Monoghan in his s42a evidence where he states that "*there is usually no 'one size fits all' approach to mitigating N and P losses from farms, as these factors need to be considered on a farm- specific basis*" (Monoghan s42a Officers report, para 7, page 2, TEB). On this basis, I do not believe that robust conclusions can be made from assessing the costs of <u>one off farm system mitigations</u> as has been presented in a lot of the evidence to date.

6.12 Dr Monaghan in his S 42a evidence also makes the following point that farmers will only make changes if there is a benefit to them. This depends on their farm, values and goals. Farmers will adopt change if they can see that it will not negatively affect profit, and will enhance efficiency, while also not increasing their workload. However, Dr Monoghan then goes on to state that based on the 'Enhancing water quality in managed landscapes project' (funded by FRST) and other published work that farmers require both a combination of voluntary and regulatory approaches in order to ensure the optimum uptake of GEPs (good environmental practices). Lack of time and / or money, excessive documentation associated with EFP (environmental farm plans as a GMP), and uncertainty around environmental and economic impacts of uptake are all noted as restricting the optimal uptake of GEPs (Monoghan s42a Officers report, pages 13 – 14, TEB).

6.13 I concur with Dr Monoghan in his findings. In my own experience, I have found that if farmers can see a benefit to themselves, and if a proposed change to their farming system can deliver them both benefits and gains in their operating efficiencies, then they will take on the change. However, not all mitigations deliver these benefits, and it is in these cases that some farmers will require more than a voluntarily obligation in order to ensure they incorporate some essential mitigations in to their systems.

6.14 Taking a "do nothing" approach is likely to result in many farmers continuing to take a system pathway that they have been familiar with in the past. As I have already said, more cows, more nitrogenous fertiliser, continued use of high protein feeds, and correspondingly more nitrogen lost per ha does not always reflect a more profitable farm system in my own experience.

6.15 The dairy industry is pouring a huge amount of resource into both research and extension on how to mitigate environmental effects from their sector. This is resulting in increased awareness and change amongst those farmers that are engaging with the industry.

6.16 In my opinion, if there is an appropriate policy framework in place to guide how intensification occurs, then the negative effects of intensification in an "inappropriate direction" can be mitigated and planned for by a farm business over time (i.e. 5 -20 years)

6.17 In my view, there cannot be a reliance on voluntary approaches alone. I agree with Neels Botha where, in his evidence, he illustrates that voluntary approaches alone are unlikely to be as effective as a mix of policy instruments.

6.18 The biggest challenge is not the innovators, or early adopters within the agricultural industries, but it is those who have the most difficulty in adapting. (i.e. the lower 25 % of the industry.) This group, who do not take action unless they need to, can effectively put the whole of the nation's industry at risk on an international scale through unwanted media attention (eg: Crafar Farms 2008).

6.19 The result of the Crafar Farms media attention was a significant negative public reaction to the industry image as a whole. This is a case where a failure to manage intensification among a proportion of the demographic profile that contributed to a higher environmental risk resulted in both national and global brand damage. This component of the pastoral sector needs management, guidance and coercion, and voluntary measures will not be enough to manage these farmers. The proposal to ensure some processes of intensification are controlled is a way to manage this potential risk to the pastoral industry's image.

Summary - Mitigations for Dairy farming impacts on water bodies

- There are a range of mitigation options which can be adopted on farm to reduce environmental impacts associated with Dairy farm practices. These are discussed in the evidence of Dr Ledgard, Mr Smeaton, Mr Taylor, Dr Shepherd, Dr Monaghan and others. However, mitigation options are not a 'one size fits all' and they should be tailored to each individual farm business, in order to ensure that mitigations that are recommended are suitable for the operators involved.
- There are a range of mitigations available to the dairy industry now to reduce environmental effects. The industry is putting a lot of resource in to support change at farm level.
- Increased stocking rate does not always correlate to a linear increase in leaching. It depends on the farm system adopted. Where a lot of nitrogenous fertiliser is used to drive pasture growth, in order to accommodate the increase in animals, this can result in increased leaching.

- There are a range of systems and mitigations that are used to lift production and efficiencies now without resulting in negative environmental effects.
- Phosphorus mitigations are generally low cost and should be encouraged and utilised on farm whenever possible.
- Whole farms should be included in the framework – the dairy milking area and the support land for the dairy business.
- The “do nothing approach” in regards to regulation is likely to result in more of the same behaviours, that are not necessarily any more profitable, but which result in increased environmental effects.
- If the appropriate regulatory signals are sent to pastoral agriculture, then farmers are more likely to strategically plan to improve their output without the corresponding increase in environmental effects.

7. PROFITABILITY

7.1 As mentioned above, increases in productivity (and profitability) do not always result in increased N leaching and, on the flip side, decreasing N leaching from farming does not always result in lowered profitability. This is especially so if the farmer undergoes a process of self-analysis, for profitability and efficiency, and has farm system modelling undertaken.

7.2 In most cases, when one is faced with assessing a farm system for lowering nitrogenous losses, a strategy can be designed to achieve more profit, productivity and resilience without long term adverse effects to the business.

7.3 In my experience, when undertaking different farm system modelling scenarios for the Waikato Regional Council, the Landcare Trust, and the Department of Conservation, for farms around sensitive peat lakes in the Waikato Region, some of the farms dropped their leaching by up to 30% in less than 5 years, without adversely affecting overall farm profitability. Gains have been, and are being, made through a range of areas, such as more strategic fertiliser use, improved dietary management with the inclusion of low protein feeds in order to enhance feed conversion efficiency, and the extension of effluent areas to 30+% of the farm area.

7.4 In all of the farm plan cases, a pathway has been demonstrated towards improved profitability with moderate farm system change over time.[4] Half of these farms have dropped leaching significantly within three years due to their increased awareness. Their

[4] Six Farm Plan Reports Generated for DOC, Landcare Trust, and Waikato Regional Council on Hayes, Hendersons, Reese, Fullerton, Serpentine &Moondance Farms. 2009-2011 by Dewes.

confidence to change at a more rapid rate has been a result of them understanding how they can be more profitable at the same time as reducing environmental effects.

7.5 As a result, I believe that if farmers were clear that they had to farm within an emission constrained environment, and if there were appropriate regulatory signals, and industry wide support, they would innovate and adapt their farm systems over time in a manner which may not necessarily result in substantial lifts in nitrogen leached to groundwater and that would not adversely affect their long term profitability or risk profile.

7.6 The option for many farmers to build in a degree of system change by introducing infrastructure, such as stand-off or feeding areas, may require an initial expense in order to mitigate externalities. This outlay can sometimes be a barrier to implementation. However, if the infrastructure is subsequently well utilised, and the farm system adapted to capitalise on the expense, there can be corresponding financial gain over a longer period. This is contrary to what was presented in evidence provided by Neild and Rhodes in their report to Horizons (Rhodes). I do not agree with Neild and Rhodes for the reasons outlined below.

7.7 In the case of a feed pad, for example, pasture protection, improved feed utilisation, improved effluent capture and storage in winter months and its subsequent re use at more appropriate times of year, along with improved feed conversion efficiencies and subsequent production that arise from better dietary management are all co–benefits that can only be recognised and assessed through full farm system modelling and full economic analysis.

7.8 I would also note that a narrow range of mitigations was used by Drs Neild and Rhodes for many of the farms studied, and cost extrapolations drawn from this. In my experience, a farmer will use a mix of a whole range of mitigations, in line with the whole farm system. This approach was lacking in the FARMS study.

7.9 In my opinion, the cost analysis performed by Drs Neilds and Rhodes for Horizons (Rhodes) was lacking in that it was difficult to ascertain some of the assumptions used. For example: a lowered stocking rate. In this report, there was no farm system modelling undertaken. (as noted by Smeaton in his sect 42a evidence 2009, whom I also concur with on this point).

7.10 The technology commonly available allows a far more thorough approach to assessing a range of farm system mitigations, and the impact on a farms profit.

7.11 Farm system modelling would have assessed both costs and benefits and Farmax pro for example would have derived an operating profit, which should have then been related to total asset value (including the costs of infrastructure and mitigations, and an overall return on assets ROA[5]derived for the farm businesses).

7.12 This would then have reflected the capital cost in the asset value, and also related this to the net operational profit from the business. In my opinion, this (full farm system modelling with the economic effects of suitable mitigations) should have occurred for all the test farms as well. Margin calculations or partial cost calculations can lead to flawed assumptions, as can the assumption that a farmer will only adopt one or some mitigations, which may be represented as a cost to the business.

7.13 Decisions also need to be made on robust data for farm system models that reflect a current long term milk price ($6.00 or $6.50 vs $4.55 as I understand was used by Monaghan in the Toolbox assessment). For example, if a farmer puts in a herd home, one cannot just look at the costs of the infrastructure without taking into account the full suite of co benefits that can occur with this, and the associated subsequent savings and efficiencies:"*The costs versus the benefits of housing a herd of cows in a Herd Home (HH) for 50 days over winter and for 20 days in August and September were assessed to ascertain the net financial outcome. The farm that was used for this assessment was an actual case study from a high-altitude 350 cow farm in central Taranaki; with an annual pasture harvest per hectare of 10.8 T and an annual milk solid production per cow of 430 kg milk solids. At a milk payout of $5.00/ milk solid the net financial benefit of the HH was $10,940. This benefit was increased by approximately $10,000 per $1.00 increase in milk solid payout.*" Refer: Appendix 1 for full cost benefit analysis of a herd home prepared by Headlands Consultancy (Sophie Parker 2012).

7.14 The inclusion of more cereal feeds (lower protein), for example, into the diet of the cow over the course of the year can result in up to a 40% reduction in urea excretion in urine, through reduced urea loading on the cow as Lucy Waldron presents in her evidence. This can significantly contribute to a reduction in N leaching. However, to ensure that this option is profitable for a farm system, there are a number of essential factors that need to occur, these being: improved dietary management; sourcing of cost effective feeds; high feed utilisation, suitable cows[6], and a proportional increase in milk output.

7.15 The Braeburn farm used in the FARMS study is a good illustration of a low leaching, highly productive system in practise. Production was 190% more than the regional average farm and, with relative ease, Braeburn was able to meet the year 1 and year 20 N limits through extension of the effluent system to 75 Ha. This farm, for example, was

[5] Return on Total Assets (Operating Profit (EFS) – Lease on Land and Buildings) Total Assets at start of Year x 100. This should be assessed with capital gains/losses both included and excluded. This percentage measure of profitability records the return on total assets employed in the business and is arguably the most important measure of business performance. It can be compared between businesses.

[6] "suitable cows" refers to cows of medium to good genetic merit, that demonstrate high levels of feed conversion efficiency.

feeding 20 % of the total diet as cereal feeds in order to generate the 1700 kg MS per ha.

7.16 Dr.Mike Scarsbrook, Sustainability Team Leader from Dairy NZ, states "related research that has shown us that an average Waikato Dairy Farm can reduce urinary N by up to 40% and increase profit by $700/ha (25%) suggesting that environmentally friendly productivity gains are to be had." (Scarsbrook)

7.17 This is endorsed by modelling work presented in 2012, which states: "Lower emissions intensity farms tended to be more profitable and achieve greater feed conversion efficiency. (kg MS per kg DM consumed") (Virbart R).

7.18 I have read the evidence of Mr Smeaton and Dr Ledgard (S 42a) and agree that around 10% of a reduction in N leached can be made without any significant effects on profitability in most cases. I concur with Smeaton also, in pts 48-50 of his S42a evidence, that the application of the findings seen in the Waikato and Rotorua districts suggests that it may be possible to achieve an average reduction in leaching of 10-15% N loss from farms across the region over 10 years without significant impact on profitability. In my own experience in the Waikato Region where we are monitoring the annual profitability of farms[7], this also applies in most cases; however, 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.

Summary – Profitability Effects & Good Environmental Practice (GEP)

- The costs of infrastructure to negate effects of leaching need to also take into account the full range of co- benefits that are also experienced as a result. Basic extrapolations of costs from single mitigations to a region wide scale (as per Neilds report) can be erroneous and lead to misleading conclusions.
- Samples of farms (as per the FARMS study) that have been used do not necessarily reflect a true and accurate demographic profile of dairy farm systems that are operating at the present time. Hence, conclusions that are drawn from these small, unique samples need to be treated with caution in my view.
- Most: 62% of the sample of 21 FARMS strategy test farms were chosen to represent worse case scenarios eg high stocking rates, high rainfall, and large portion of LUC class 4 – 8 land. They were assessed to determine the worst cases in regards to meeting the NV POP 13.2 Table and 13.1 Rule. These 13

[7] Full Farm Plan Reports Generated for DOC, Landcare Trust, and Waikato Regional Council on Hayes, Hendersons, Reese, Fullerton& Serpentine Farms. 2009-2011 by Dewes.(two farms have had follow up monitoring of profitability completed)

farms are essentially outliers, they do not represent the ‘population’ of farms in the region eg the results cannot and should not be extrapolated to the region.

- Reductions in nitrogen leaching of 10 to 15% across dairy farms in the Region are likely to be achievable without affecting profitability.
- In some cases, where farm system changes and improvements in efficiencies are undertaken there can be an opportunity to reducing leaching significantly more, (30-40%) however in these cases, a degree of system change may be required.
- The “Do Nothing Approach” is likely to result in a tardy uptake of technologies that can lead to improved operating efficiencies at farm level. With no signal for farmers to review their farm system, and subsequent effects, it is likely that loads from pastoral agriculture will continue to increase.
- Decreasing nitrogen leaching does not necessarily relate to reduced profitability. Where farm system modelling highlights opportunities in a farm system, efficiencies are gained in the process and, there can be an upside for the business.

8. APPROACH FOR ESTABLISHING NITROGEN LEACHING LIMITS

8.1 As notified, rule 13.1 required new and existing intensive agricultural land uses meet the LUC based Nitrogen leaching limits established under table 13.2 in order to be a controlled activity. Intensive farm practices which did not meet the LUC Nitrogen leaching limits were a discretionary activity under rule 13-27. The council level decision removed the requirement for existing dairy farming to meet the LUC based Nitrogen leaching limits set out in Table 13.2, instead replacing this standard with the requirement to produce a nutrient management plan, and in regards to matters of control *“(a) the implementation of reasonably practicable farm management practices for minimising nutrient leaching, faecal contamination, and sediment losses from the land*”. The council level hearing also removed the progressive reduction in LUC based Nitrogen leaching limits from Table 13.1.

8.2 I concur with Ms Barton’s summary in her planning evidence 2012 where she summarises the <u>inadequacy of the approach</u> as recommended by the Commissioners to adopt *“reasonably practicable farm management practices:” “That it is open to inconsistent interpretation and application which is particularly problematic in the context of a controlled activity rule which must be approved. The potential for the term to be open to inconsistent interpretation and application poses a risk for both the farmer, in terms of what will be required of them, and an environmental risk given there is no standard or* *benchmark used as a measure to work towards the achievement of the maintenance of water quality*".

8.3 With inconsistent clarity, or interpretation of what is actually required, it is very difficult for any farmer to formulate a plan, or strategy, in order that they may adapt and ensure their business remains resilient for the future.

8.4 In support of the original approach which established LUC based Nitrogen leaching limits as standards, I concur with the evidence as detailed below in the report prepared by Clothier et al (2008, TEB) "*Of the approaches listed, allocating the nutrient loss limit based on the natural capital of the soil in the catchment offered a basis for developing policy that is linked directly to the underlying natural biophysical resources in the catchment. It is independent of current land use and places no restrictions on future land-use options. It also provides all land users in the catchment with certainty by defining a nutrient loss limit based on the suite of soils they own, beyond this resource consent would be required and that includes a nutrient budget and mitigation strategy.*" (Clothier. B, 2009, TEB)

8.5 In my opinion, the LUC based standards are one of the more equitable approaches to allocate nitrogen emissions. It offers a way to allocate a right to emit that correlates well with the productive capacity of the land. In most cases, the pasture harvested from various LUC classes is typically closely correlated to the natural carrying capacity and the subsequent suitability of that land to carrying a certain stocking rate.

8.6 The LUC approach is not linked to current land use but to the potential of the land resource for sustainable production, it provides for continues economic growth, ongoing flexibility of land use, and potentially most importantly it does not penalise efficient farmers or reward inefficient farmers as the grandparenting approach does. Ms Barton provides an excellent summary of the strengths of the LUC approach in her officers report to the court (2012, page 32, pt 82), which I support.

8.7 Due to rapid changes in land use that occur under different market forces in a short space of time, the allocation framework used in regards to allocating nutrient allowances needs to be future proofed in order to manage these risks. In the Waikato, for example, we have seen more recent expansion of intensive farming systems into the marginal land classes. Although the entry price is lower for the more marginal land types, there are additional costs involved in setting these farms up in order to both mitigate their effects and enhance their long term productive capability.

8.8 Mr Day also points to the concept of "Moral Hazard," in his evidence,. *One of the key strengths of LUC allocation to me is that it brings to land ownership the concept of moral* *hazard ("Moral Hazard occurs when a party insulated from risk behaves differently than it would behave if it were fully exposed to the risk." . You don't necessarily need to know your actual leaching rates at any point in time but you need to know that in time you will be held to account for your intensity relative to your share of the catchment allocation." Andrew Day.* The LUC allocation system essentially allocates Nitrogen allowances across a catchment. In that respect land uses that are not currently caught within the management framework can easily be brought into the framework over time.

8.9 It is important to note that the LUC Nitrogen allocation system is not just about setting a limit on nitrogen emissions, it is also about allocating a resource to land uses. In this respect it should be viewed as the same as a water permit/consent. It is an allocation of a resource to someone for their use. The capital value of land, and often is productive capabilities, are enhanced through the ability of the land manager to access natural resources, for example, water for irrigation, or through essentially pollution rights.

8.10 However, the LUC approach is not without its critiques. Ms Barton also cites in her evidence February 2012 that the LUC allocation method has been criticised for

> *"(a) Resulting in unachievable N loss limits for areas of high rainfall on LUC Class IV and above, and*
>
> *(b) Being unduly restrictive in the Region's sand country (predominantly along the west coast around Foxton)."*

8.11 As shown by the test FARMS studies, farms with a high proportion of their land as class IV to VIII and under high rainfall >1500mm will have difficulty meeting LUC leaching limits. This has been discussed further in the technical evidence of Mr Taylor (2012). The establishment of a policy gateway has been proposed by Ms Barton in her planning evidence (2012). I would endorse that these cases are treated separately via an alternative policy gateway.

8.12 Ms Barton also states the following: "In relation to the region's sand country which is located on the west coast of the region (primarily around Foxton), Mr Grant concludes that if the physical limitations are reduced i.e. by recontouring and irrigation then the LUC class will also be improved. The N leaching numbers that would apply under the new re-classification would then be less restrictive." (Pt 84 page 33)

8.13 I have read the evidence of Lachie Grant and concur with his approach to make amendments to ensure that the leaching numbers that would apply under the new re classification are less restrictive. I believe that whole farms (dairy platform plus support blocks) should be included in the approach to ensure that all support blocks that are used for support for dairy farms for example are included in the assessment for N allocation.

Grandparenting

8.14 By comparison, grandparenting tends to reward polluters for being less efficient with their nutrient usage within their farm system and penalise the innovators. There are many farmers who are leaching below the average and are running efficient farm systems and have attempted to mitigate their effects. Under the grandparenting system, these innovators, often better farmers, would be penalised. This is not the best approach to allocate nitrogen emissions in my opinion and, in some cases where farmers are anticipating this approach, there can be a tendency to run inefficient farm practices in the hope they may gain a high allocation through a policy change. Farmers are essentially rewarded for poor management with high externalities. Ms Barton states the following in her planning evidence (2012):

> *"The grandparenting option was considered to be less efficient than the LUC allocation method because while it recognises historical investment in production, it fails to recognise investment in N loss mitigation and does not provide equal opportunities for all land users to consider alternative land use options."(2012, pt 87 (d) page 34)*

8.15 I concur with this statement.

Benchmarking

8.16 Roygard et al (2012) produced a set of scenarios which included reviewing set numbers in regards to leaching to meet water quality outcomes, scenario 10 resulted in a water quality improvement at a set leaching limit of 18kgN/ha/yr. Benchmarking has some merit in my opinion, in that it encourages self- analysis and allows farmers to consider their position against their peers.

8.17 This then can result in quite substantial change (improved efficiencies and in most cases, reduced impacts) by the innovators, the early adopters and the early majority in the industry. This can result from the exercise of assessing their nutrient efficiency, and their farm economic performance. Again, the challenge with benchmarking is that it does not engage the poorer performers who have difficulty in engaging with new technology, and adapting to change, and hence in my opinion will be ineffective in gaining change from what may the highest risk group that can contribute to pollution, amongst the farming demographic profile.

8.18 The other issue with establishing a flat cap on emissions is that it does not take into account the natural capital of the land, its natural productive capabilities. In this respect it does not necessary promote sustainable management as you essentially could see marginally productive land converted to unsuitable agricultural land uses if allowances are set to high.

8.19 Although benchmarking can be useful for farmers to compare their own performance with others and make improvements, it is not linked to ecological outcomes, and if it is used for legislation or as a “flat cap” it can result in some inequities on those farms that have higher inherent biophysical risks.

8.20 As with the use of LUC, If benchmarking is to be used as an allocation mechanism the cap set must be established in order to achieve a water quality outcome.

Summary – LUC Framework and the merits and challenges of LUC

- Reasonably practical farm management practises in my opinion offer no clarity or interpretation of what is actually required, and it is very difficult for any farmer to formulate a plan, or strategy, in order to adapt their business to remain resilient for the future.
- LUC approach is based in the natural capital of the soil resource. It allows farmers to mitigate, innovate and focus on management of their outputs.
- The LUC approach takes into account the capital value of the land.
- LUC approach ensures that land use is tied to productive capability, and helps to ensure that the land resource is used sustainably in regards to future trends and rapid changes that occurs in response to market forces.
- Allocation of nitrogen emissions via land use capability, in my opinion, is the best framework to use.
- Grandparenting is not an appropriate way to distribute nitrogen emission allocations. It rewards the polluters and penalises the innovators.
- Although benchmarking can be useful for farmers to compare their own performance with others and make improvements, it is not linked to ecological outcomes, and if it is used for legislation or as a “flat cap” it can result in some inequities on those farms that have higher biophysical risks.

9. APPROPRIATNESS OF TABLE 13.2 POP NITROGEN LEACHING LIMITS AND REDUCTIONS OVER TIME

9.1 In my opinion, the original Table 13.2 as notified in the One Plan is an appropriate way of allocating nitrogen emission allowances. I have discussed the ability to achieve Nitrogen losses while maintaining productivity and profitability under section 7 above.

9.2 In my experience farms can reduce leaching by 10 to 30% or in some cases more, with some system modifications, and time to adapt. Recent research by Dairy NZ has shown reductions in leaching by 40% (Virbart R). I do acknowledge however that this needs to be assessed on a case by case basis.

9.3 From the evidence of Mr Taylor, 5 farms were selected for study, followed by another 16 farms. 13 of these farms were selected to test high rainfall, high LUC and high stocking rates. There were a total of 20 farms tested of relevance to the notified version of rule 13.1 (18 dairy farms, 1 intensive sheep and beef farm, and 1 cropping farm). Of those farms:

(a) Nine farms, or 45%, were already compliant with year 1 leaching standards (7 which were dairy so 39%).

(b) Six farms, or 30%, were already compliant with the year 20 leaching standards (5 were dairy which equals 28%).

(c) Four farms, or 20%, all of which were dairy, could not meet year 1 leaching standards without a farm system alteration. However, they can meet 56-82% of year one leaching standards.

(d) One farm of the four that would not be compliant with year 1 targets have rainfall over 1500 mm and 50% or greater of their land are LUC class 4 to 8 so are given a policy gateway, ie: they are not required to meet LUC limits to be a controlled activity.

9.4 The current policy gateway may be too constraining and broader consideration should be applied to farms in exceptional circumstances. I am in favour of an alternative policy gateway.

9.5 LUC year 1 leaching limits average around 22 kg -25 kg N leached/ha/yr, dependent on catchment characteristics (LUC class composition). It would appear, from the Dairy NZ benchmark data, that the regional average is around 22 kg N leached/ha/yr. The corresponding data sourced from Horizons in their nutrient budgets indicates a regional average of 22.7 kg N leached/ha/yr. Therefore, the POP approach seeks to essentially regulate intensive farming so that those leaching the most will have to firstly reduce leaching down to what are average numbers. I support this approach.

9.6 The corresponding benefit of the POP approach is that it restricts access of cattle to the regions rivers, which will have significant benefits for aquatic ecosystems.

9.7 The Waiwaka current leaching from dairy farming appears to be 16 kg N leached per annum, which is on a par with the proposed year 20 proposed levels for this catchment. (Year 20 average is 16 kg leached per annum). This catchment has 23.6% dairying as a land us, but also contains other land uses that are likely to be significantly contributing to water quality degradation.

9.8 While Dairy farming in the Waikawa catchment comprises 24% of the land use, and an estimated 29% of the non point source nitrogen load, sheep and beef comprise 26% of the land use, and an estimated 53% of the nitrogen load (Table 39, Roygard et al, 2012). horticultural land use activities are also likely to be contributing to the non point source nitrogen load. Roygard et al (2012) discusses the issues associated with horticulture in the catchment, concluding that if leaching rates are as assumed by Clothier et al (2007) at 80kg/ha/yr, then the contribution from horticulture could be up to 10% of the total non point source load. However, if the leaching rates are the same as the experiments at Levin show (of over 200kgN/ha/yr), then Horticulture could account for 22.9% of the nitrogen load, even though horticulture only makes up 1.3% of the catchment. Changes in the assumptions in regards to leaching rates would alter the overall proportions sheep and beef and horticulture land use makes to total nitrogen loads in the catchment. The contribution of dairy is assumed based on the provision of nutrient budget from the catchment. It is my opinion that in order for water quality outcomes to be achieved in this catchment that all agricultural land use should be managed.

9.9 The coastal Rangitikei Catchment also demonstrates that the current estimated average leaching (average leaching is 22 kg N/ha/yr) is lower than the current LUC year one average limits of 25 kg N leached per ha per year. The year 20 LUC limits average 19kg/N/ha/yr, which would equate to a further 14% reduction in average N leaching if these numbers were applied.

9.10 In regards to the Coastal Rangitikei Catchment and Waikawa Catchment, LUC leaching limits should be set to not allow an increase beyond current leaching if water quality is to be maintained.

9.11 Mr Smeaton (evidence 42a 2009) also notes that, in his experience in Rotorua, farmers were able to reduce N leaching by 5-25% and have a minor negative to slightly positive effect on profit. He also noted that case studies demonstrated that it would be possible to reduce N leaching to the catchment wide basis of 12% reduction without a negative effect on profit.

9.12 A case study undertaken by Massey University, in one of the target catchment for regulation in the region, has also shown that nitrogen leaching reductions can be achieved at no to minimal cost. The Mangatainoka Study done by Massey University shows that 5 farms in the Manawatu district could reduce their leaching within 10 years to achieve the year 10 LUC leaching standards, as long as they improved their milk solids output by 2.5%. "*Extrapolating these values to a catchment producing a total of*

12,289,125 kg MS the catchment compliance implementation cost for no increase in MS production would be $614,456, and a profit of $245,783 with a 2.5% increase in MS production."(Yates L, 2008).

9.13 This study demonstrated that the net cost to the busniesses for meeting the 10 year targets ranged from a mild negative to an increase in overall profit. The study stated that the "…..*The result is that each farm with lower cow numbers is able to comply with the 10 year LUC for significantly lower cost or increased income, ranging from a cost of -$0.22kgMS to an increase of $0.40/kgMS. Across the whole catchment there is a net return of $0.02/kgMS*", and concluded that the most cost effective method for farmers to minimise compliance costs is to increase per cow MS production in association with wintering off more cows and feeding more maize silage to reduce on farm N fertiliser use (Yates L, 2008).

9.14 The challenge arising from the Massey study conducted above is that there was only "partial change to the system" and, in my view, the milksolids increase of 2.5% which was modelled with additional maize silage was simply not far enough to demonstrate significant changes across all levels of the business.

9.15 In my opinion, the inclusion of low protein[8] feeds needs to be revisited with more robust farm system modelling and economic assessments done. Importing low protein feeds (cereals), for example, can aid in enhancing rumen efficiency. This leads to improved feed conversion efficiency, lowered urea production as a by-product of protein from the gut, and a subsequent "lower load" for the cow to have to excrete. Lucy Waldron elaborates on the science behind this in her evidence as well. NZ pasture based cows consume a diet of around 26% crude protein all year round. The requirement is actually a lot lower, at around 16% all year.

9.16 Hence there is a surplus of protein in the diet, this comes as a cost to the cows, and to the environment, as it is excreted as urea in the urine, which then leaches as nitrate N to groundwater. Cereals which are typically 8-9% crude protein if combined with pasture in the diet at around 40% of the total diet can greatly enhance nitrogen conversion efficiency within the system, and reduce the amount of urea in cow's urine by up to 40%. This can have a significant and positive impact on the overall nitrogenous losses from the farm system.

[8] Low protein feeds such as maize, grain or cereals, wheat, barley etc, that have protein levels lower than 10%, and that balance out the crude protein in pasture which is usually around 22-28%.

Figure 1 N Excretion on different diets

	Pasture	Pasture + 25% maize silage	Pasture + 50% maize silage
Mean dietary CP	26%	21.8%	17.5%
Dietary N intake (g/day)	711	594	478
Lactation N (g/day)	118	118	118
Urine N excreted (g/day)	403 (57% of N intake)	294 (49% of N intake)	179 (37% of N intake)
Faecal N excreted (g/day)	146	161	171
Urea Cost (MJ/Day)	9.8	5.9	2.0

9.17 The use of low protein supplementary feeds (in this case from <1 tonne/Ha to 2.6 T per ha) has been modelled in the Waikato on average farm systems in combination with a suite of mitigations to achieve reductions in nitrogen leaching while achieving production benefits (Agfirst Waikato , 2009). Mitigations included spending capital on feeding infrastructure, improved effluent capture and storage and the subsequent extension of the effluent area, and the reduced requirement for soluble fertiliser, and improved milk output form the herd. These approaches combined resulted in a higher output and more profitable business model. In this modelled approach in the Upper Waikato Study, up to 40% leaching reductions were achieved while the Return on Total Assets improved. However, to reduce leaching significantly, and retain profitability, the farm system production had to be lifted significantly. In this case, after infrastructure costs were accounted for, the overall profit improved from average at 4.5% return on assets to the best case scenario of 6.7% return on assets assuming that milk output improved and management skill was not lacking. This was modelled using Farmax, Dairy Pro and OVERSEER. This was modelled, and the assumption was made that the capability of the farmer was not lacking in order to achieve this. However, I do acknowledge that good quality cows, if fed well with a well-balanced ration, with sound management in place, are able to lift significantly in their output to close to a kg of milksolids per kg bodyweight in output. (for example: a typical 450 kg NZ cow, could conceivably produce 450 kg MS with the appropriate dietary management). This is possible to do with a mix of pasture and cereals.

9.18 This would mean that the average NZ cow would need to lift production by around 25% in order to achieve this sort of result. This can occur in a relatively short time frame.

9.19 Amongst our consultants client base (Intelact[9]) across New Zealand and Australia, we are also familiar with being able to lift milk solids per cow by 30 – 40% per cow (300 kg to around 420-450 kg MS per cow), with sound nutritional management and better feeding practises, over a 1- 2 year period when working closely with clients.

9.20 Many of our consultancy clients across both New Zealand and Australia also demonstrate higher than average production per cow and per hectare without the corresponding lift in nitrogen leached modelled by OVERSEER.

9.21 Braeburn farms, one of the test FARMS study farms, is one of our clients and illustrates this situation clearly, giving a local example of reducing nitrogen leaching while maintaining high productivity returns and profitability. Low leaching on this farm is a result of a combination of mitigating factors in operation within this particular farm system including:

(a) Large quantity of cereals and other lower protein by products made up 20% of the total diet, resulting in significantly reduced urea excretion in the urine. (1 T cereal type feeds/cow);

(b) Feed pad to enhance feed utilisation efficiency;

(c) High levels of milk production representing high levels of feed conversion efficiency; and

(d) Moderate levels of nitrogen use, with the opportunity to use less in future as the effluent area is extended to a 75 hectare area of the farm.

9.22 The Average Waikato Farm modelled for the Upper Waikato Nutrient Efficiency Study (Agfirst 2009) can be used to demonstrate that more productive farms, that use a range of mitigations, can also be more profitable farms. In this case, an average farm was modelled at a milk price of $5.50 per kg milksolids and a range of mitigations and efficiencies were incorporated into the farm system. These included the following:

(a) Slight lowering of stocking rate;

(b) Increased effluent area for spreading;

(c) The use of direct drilled summer feed mixes such as chicory, plantain and herbs into the pastures, in the extended effluent areas;

9 Intelact is a NZ Farm Management Consultancy Business that has 55 Agricultural consultants, throughout NZ, Australia, and South Africa. The consultants specialise in full farm management, business and environmental strategy planning for pasture based dairying in a range of countries.

(d) Importation of low fibre and low protein supplements, to give higher per cow productivity and improved feed conversion efficiency;

(e) More strategic nitrogen use and lowered overall use due to effluent area extension; and

9.23 Table 1 shows the key performance indicators of an average farm business modelled for improved nutrient efficiency and increased profitability.

Table 1. Case Study Farm: Example of the Average Waikato Farm.

	Av Waikato	**Average**	**Average**
	Base	**Winter off**	**Winter on**
Scenario		2	3
Kg N Leached/ha	**50**	**26**	**26**
Op Profit per ha	$1490	$2013	$2429
Op profit less debt/ha	$896	$1008	$1424
Return on Assets %	**4.15%**	**5.61%**	**6.77%**
Op Profit Margin%	26%	34%	37%
Kg MS/Ha	967	1016	1118
Kg MS/Cow	328	414	458
Past.harvest T DM/ha	11.2	10.9	10.8
T/Supp/imp/ha	1.6	0.37	2.18
Kg DM/kg MS	13.2	11.16	11.9
Diff.kg N leached		-24	-24
N conversion efficiency	26	47	38
GHG/kg MS	11.3	8.5	8.8
*$ change in kg N leached		**+$21.81**	**+$35.62**

9.24 Table 2 below lists the range of mitigations which are considered when farm system modelling is undertaken and shows Potential Mitigations and % Decline In N leaching as Demonstrated in Upper Waikato Nutrient Efficiency Study. (Agfirst Waikato , 2009).

Table 2

OPTION	POTENTIAL % REDUCTION in N LEACHING	ISSUES TO CONSIDER IF USING THESE OPTIONS
Self Assessment		Whole farm business and systems analysis should be undertaken prior to adoption of mitigation options. This will clarify land capability and the most suitable mitigation options**.**
Lower Nitrogen Use (No winter Use, and lowered overall use)	15% (10-20%)	No N use in the winter period, along with N applications only at the high growth times of year (10-12 kg DM Response) Where N use is high, this can be a profitable option at present prices.
Better Capture of Effluent and use on Graze- able forage crops without extra N use.	12% (10-15%)	Crops must be graze able forage crops such as chicory or regrowth crops that do not allow a prolonged soil mineralisation period. Minimum tillage & effluent application was used in the crop establishment and yields reflected this.
Lower Stocking Rate by 10-25%	12% (3-20%)	Results can be variable depending on soil types. This can be a profitable option on highly stocked farms, but pasture management skills need to be sound to maintain pasture harvest levels.
Nitrification Inhibitor DCD	10% (0-10%)	The response to this was variable and greatly depended on the level of leaching and the soil type.
Infrastructure Change/Feed pad/Standing cows off and capturing effluent	9% (3-15%)	This was variable, and assumed effluent capture in to ponds/storage and re use on summer crops. Costs of infrastructure changes included. Time standing on pads in winter and autumn need consideration. Generally was a cost to the business. Needs to be considered in line with better effluent capture and usage.
Higher per cow production /lower stocking rate, using low N supplements	7% (3-10%)	Via improvements in N conversion efficiency of the system, this was a sound option, but only if feed was at 5-7% of milk solids price. This option allowed productivity levels to be retained, and can reduce negative effects on profit if managed well. This will need to be done with a sound skill level.
Alter sources of bought in feeds from high protein to low protein sources	3% (0-5%)	In cases where a low protein feed source is available at a similar price, this did not negatively impact on profitability. Improved nutrient efficiency through higher N conversion efficiency.
Land Use Change	3%	Where small areas or sidling could be retired from pastoral use and planted, this was used, an income from the agro forestry was assumed.
Alternative Options		**Issues to Consider if Using these Options**
Grazing Off In Winter within the Catchment	20% (15-25%)	Where this practice was used, it allowed the most effective, and profitable way to lower N leaching. However this practice is not suitable as an option in a sensitive catchment.

9.25 In the Upper Waikato Study, the economic effect of the cost of compliance on a business was compared to a change in milk price of $1.00 and revealed that milk price has a far more significant effect on profitability than the cost of making a transition to lower leaching farm system models.

9.26 It is essential with all these pastoral based systems to align the stocking rate to pasture harvested (carrying capacity) and ensure careful use of supplements with appropriate infrastructure. This can lead to higher pasture harvested overall due to maintenance of longer rotations and the more appropriate grazing systems to suit the plants and animals. As mentioned earlier in my evidence, where stocking rate is not well aligned to long term average pasture harvest, there can be measurable lifts in productivity from lower stocking rates.

9.27 It is also essential that we relate stocking rate to pasture harvested and profitability. A lot of assumptions are based on the premise that increasing stocking rate leads to increased profit. We do not see this in practise all of the time. In my experience, this is the case when properties are under stocked. That is not the case on most farms now.

9.28 The above cases and the associated anecdotal evidence illustrates that farm systems can make a transition to improved production, in many cases improved profit (if all systems are managed well and efficiently), with resultant reductions in nitrogen leaching of 10-40% As mentioned previously, this needs to be considered on a case by case approach.

9.29 Based on evidence given above in regards to the ability of farming systems to achieve reductions in nitrogen leaching, it is my opinion that Table 13.2 LUC based nitrogen leaching limits are achievable in most cases. Based on the modelling work undertaken by Olivier Ausseil, and the scenarios run by Dr Roygard in his technical evidence (2012) it appears that the year 20 numbers are required to achieve a reasonable net improvement in water quality. In order to meet our community goal of protecting the catchments from further decline, we will need to aim for gradual reductions in N leached as per the notified version of Table 13.2.

Summary – Table 13.2 Leaching limits and achievability overtime

- Table 13.2 with the step down approach to year 20 levels provide a framework within which adaptation times may occur, and further innovation may occur.
- The scenarios presented by Roygard, Mc Arthur and Clarke indicate that a sinking lid of nutrient allocation is necessary. Reductions to the notified year 20 levels for LUC allocations are required to improve water quality over time.
- The proposed one plan approach serves to regulate intensive farming so that the highest polluters have to reduce to average industry levels now.
- The proposed one plan approach serves to keep stock out of rivers which will give significant benefit to river health.

- The present level of leaching in the Coastal Rangatikei at 22 kg N leached per ha per year is well below the decisions version LUC year one level of 25 kg N leached per ha per year. The average drop in this region is a further 14% by year 20.
- The present level of leaching in the Waiwaka catchment from the dairy sector is presently at the proposed levels for year 20.

10. RULE 13.1 FARM STRATEGY, NUTRIENT MANAGEMENT PLANS AND STOCK EXCLUSION FROM WATERBODIES

10.1 I support a process that ensures that a farm business undergoes a self-assessment to ascertain what stocking rate and farm system is the most appropriate for the biophysical capability of the farm, the infrastructure, and the operator's skill level. The FARMS strategy was proposed initially, to ensure this process occurred. In my opinion, this was a sound approach to adopt.

10.2 I concur with Peter Taylor, that the FARMS strategy, or an obligation by the farmer to undertake a similar process to this, was a sound way of not only streamlining the consenting process, but also an effective and constructive way of engaging with farmers in the priority catchments. I understand that the Council now proposes that farmers on existing and new dairy farms in the target catchments will be required to prepare a nutrient management plan ("NMP") and provide it to the Council to demonstrate compliance with the nitrogen leaching limit for their farms. The FARMS strategy and NMPs are both useful tools that enable farmers to undertake a self analysis of their farming systems to determine what changes they can make to it.

10.3 In my own experience, the FARMS strategy and NMPs can be a successful way to raise awareness of what effects different farm systems have on the environment, and engage farmers in a process of change at farm level. The requirement to prepare an NMP ideally should be applied to all of dairy farming, cropping, horticulture, and intensive sheep and beef farming. For those farmers that may have difficulty in reaching the LUC year 1 and 20 targets, more support, similar to a whole farm plan, may be required.

10.4 This would create a process whereby they undertake an assessment of all the options available to them, and learn about what suitable practises they can adopt, that align with their values, and financial capabilities.

10.5 This assessment (to drop leaching for a farm) needs to be undertaken by a suitably qualified person/consultant that can offer farm system modelling in accordance with

OVERSEER and report on full economic impacts of a desired mix of mitigations that may be suitable for the farm to:

(a) Reduce N leaching;

(b) Improve the overall farm profitability at the same time; and

(c) Assist with change at farm level over a period of time.

10.6 The proposed NMP approach in regards to rule 13.1, which includes a compulsory process to analyse farm nutrient losses and efficiencies, is necessary (as discussed below) and in my opinion provides a satisfactory approach to address all of the above concerns. An example of an NMP is provided on page 56 of Mr Taylor's February 2012 Evidence: (The Seivwright Consent Application and NMP).

10.7 The original proposed rule 13.1, included intensive dairy, irrigated sheep and beef, cropping and horticulture. Although extensive farming is not proposed to be included presently, in my opinion it will need to be included over time, as dairy intensifies, and more of the load is carried by this sector of the industry.

10.8 Rule 13.1 – Stock out of water bodies. I fully support the Rule 13.1 proposal to exclude all stock from waterbodies. In my view, this should be extended to all catchments, but the staggered approach is acceptable. This would be good to have extended to the whole catchment in time.

11. ADAPTATION TIMES

11.1 Farmers need time to adapt to more modified systems. Cow genetics, infrastructure, and sound management skills are all key components to ensuring increased productivity and profitability while reducing environmental effects. It takes time to address all of these matters. The One Plan "as notified" (table13.2) allows 5 year time frames for adaptation to the gradual lowering of nutrient allocations to the respective land use classes.

11.2 Earlier in point 9.3 of my evidence I referred to the FARMS strategy test farms. Over a 20 year period, 12 of the farms needed to make a 20-50% drop in their nitrogen leached in order to meet the 20 year targets.

11.3 Mr Taylor presented data from the test farms in 2009, and in also in his appeal evidence (02 Feb 2012) his evidence also suggests that some farms that are faced with more significant reductions may need to drop their leaching by an estimated 30-37% by year 20.

11.4 I acknowledge that the original FARMS sample was largely made up of farmers who were likely to have significant difficulty in the adaptation process. I concur with Mr Smeaton in his evidence that it is not possible to assess the full impact or possibilities in regards to these farms meeting LUC leaching limits, without undertaking a full farm system modelling process, using UDDER, or Farmax or Red Sky, alongside OVERSEER in order that they might ascertain the effects and benefits (true cost of compliance).

11.5 Full Farm System modelling was not undertaken in the FARMS study, or in recent Nutrient Management Plans as presented by Mr Taylor in his 2012 evidence. Mr Taylor notes however that there is an opportunity for farmers to utilise this expertise should they be faced with significant nitrogen leaching reduction requirement of 30% or more, for example. I would support this.

11.6 In my opinion, those farms that are required to drop their N leaching by more than 30% should be strongly encouraged to take on a full farm system planning approach with an appropriately trained consultant that could run scenarios on Farmax, UDDER, OVERSEER and provide full farm economic analysis to ensure a profitable pathway is achievable for them. There were 7 of the case study farms, (2 were exempt) who would need to drop their leaching between 30-50% in order to reach the year 20 targets. On this basis, careful system planning along with a long adaptation time of 20 years is reasonable in my view.

11.7 The impacts of farming on the environment have been occurring cumulatively for many decades. I am a fourth generation farmer and I recognise that for over a century now previous generations have unwittingly contributed to negative effects on water bodies.

11.8 Collectively, it is acknowledged that it will take time and application of modified practices to prevent further degradation and protect our water bodies for subsequent generations. It is my personal view that it may take decades of changed behaviours and altered farming practice to see any significant improvement in water quality which will come about as a result of a combination of political, social and environmental factors.

11.9 I finally would add that all farmers are mindful that one day there will be a time when they have to relinquish their assets in order to realise their wealth. It is not always predictable when this event might occur. A sound exit strategy is always part of a good business plan. On this basis, it is always prudent to ensure that a farm is in a compliant state, with its infrastructure up to date to ensure a sale could be achieved should it be required. Structural mitigations for environmental risks are part of ensuring a farm is saleable. On this basis, one would presume that sound business practise, would mean that purchasers and vendors alike, consider the environmental risks associated with an asset.

11.10 On this basis, it is good reason for all farming sectors to be part of, or be monitored for, entry into this policy framework over time in order that environmental risks are shared across all business sectors moving forward.

Summary – Farm Strategy, Plans, and Adaptation Times

- The time frames for reducing N leaching in the notified version of the One Plan are sufficient to allow farmers to adapt to new systems to reduce N leaching.
- 10-15% reductions in N leaching can be achieved without impacting on profit –this was stated by Mr Smeaton in his evidence, and this is relevant to my experience also.
- Adaptation times are related to the farm owners motivation to change. If there is a clear benefit in associated with making the change, as in farm system modification that can also improve profit, the time taken to adapt can occur in less than 5 years in some cases.
- Where a significant change of (>30%) reduction in N leaching is required for a farm to meet a N leaching target, farms should be encouraged to undertake farm system modelling, and scenario planning.
- Whole farm plans can raise self-awareness and opportunities, resulting in faster rates of adoption and adaptation.
- Dietary manipulation and the subsequent feed conversion efficiency improvements can represent a lost opportunity on many of the mainly pastoral based dairy farms.
- There are a range of mitigations available to farmers that offer opportunities to reduce N leaching, These mitigations can result in cumulative effects when incorporated into a farm system.
- “Doing nothing” may result in a lack of uptake of new technologies that other countries are utilising at present. A result may be that NZ farmers eventually lag behind in technology and resource efficiency skills.
- A framework that results in all farms having to do some sort of compulsory self analysis of their system efficiencies and profitability can be good for business.

12. LIMITED DATABASES

12.1 In New Zealand we have limited databases of both intensive and extensive farming systems and the associated knowledge of relevant profitability, productivity and environmental effects. There are not large databases for the dairy industry that have been made publicly available and an even smaller database for the sheep and beef/extensive pastoral industries.

12.2 The dairy industry is presently making a concerted effort to have more farmers included in both profitability and environmental analysis. It is likely that this will assist with improved data for reference to in the next 5 years.

12.3 The extensive pastoral industry at present does not have an extensive database of their environmental effects. There are private and industry databases, that have been tracking profitability and productivity, but there is a lack of robust data on the present status of N and P losses from this sector. The only database at present is the 100 overseer files analysed by Agfirst, in 2009 and 2012 for the MAF farm monitoring report.(Agfirst Waikato, 2009)

Summary – Limited Databases Extensive Sector

- The dairy industry is developing more databases that reflect the demographic profile, profitability and the associated environmental effects from farms.
- The sheep and beef industry does not appear to have many databases in operation, apart from one that was analysed for MAF in 2009 and 2010. This sector therefore presents us with difficulty when we try to make assumptions about their assumed leaching rates. For this reason, it is important that this sector is monitored.
- Horizons has assumed an average 10 kg N per ha per year leached for all sheep and beef farms in their region. In my opinion, a more robust database on these farms would be useful in the process of drawing conclusions about overall catchment loads.

13. TECHNOLOGY AND SUPPORT TO MANAGE TRANSITION TO CHANGE

13.1 I believe OVERSEER is fit for purpose for establishing N loss limits for intensive and extensive pastoral agriculture. I have read Dr Ledgard's evidence (Sect 42a) and agree with his conclusions.

13.2 There is currently far more capability than ever before available amongst the supporting agricultural professionals. In comparison to 2006, there are 132% more professionals now that are accredited users of OVERSEER. There are now 271 professionals who have passed the Advanced Nutrient Management Course at Massey University, and 1040 have done the Intermediate Nutrient Management course at Massey University. (pers comm. Lance Currie, FLRC Feb 2012).

13.3 This illustrates a growing capability. The provision of technology is occurring at a rapid rate. There are agricultural professionals now available from a range of disciplines ready to assist farmers with required change, providing anywhere from basic assistance to completing an OVERSEER file, to consultants that can offer full farm system modelling and economic advice.

13.4 The scientists and professionals who support the pastoral industry now have a better understanding of the effects of agriculture on the aquatic environments and how to mitigate them. There is more data emerging on ways of ensuring profitability can still be retained at the farm level, while mitigating practices are being implemented.

13.5 The technology that is now commonly available allows a far more thorough approach to assessing a range of farm system mitigations and the impact on a farm's profit.

13.6 Farm system modelling assesses both costs and benefits and Farmaxpro, for example, derives an operating profit, which can be related to total asset value (including the costs of infrastructure and mitigations, and an overall Return On Assets (ROA) [10]derived for the farm businesses).

Summary - Technology

- In my opinion, overseer is fit for purpose, for use in establishing N loss limits for use in the intensive and extensive pastoral sector.
- When farmers are engaged in a process, and they realise that there are opportunities to improve their business and system efficiencies, more rapid uptake of technology occurs.
- There has been a rapid increase in both capability and numbers of suitably trained professionals to assist with change inside the farm gate.

14. DESIRE TO CHANGE AND BE MORE SUSTAINABLE

14.1 I acknowledge that many farmers do wish to do the right thing. I also acknowledge that the dairy industry is putting an enormous amount of resource towards improving knowledge around nutrient efficiency.

[10] Return on Total Assets (Operating Profit (EFS) – Lease on Land and Buildings) Total Assets at start of Year x 100. This should be assessed with capital gains/losses both included and excluded. This percentage measure of profitability records the return on total assets employed in the business and is arguably the most important measure of business performance. It can be compared between businesses.

14.2 There is significant motivation present in the industry to bring about reasonably rapid changes in practises. It is important to acknowledge this, and capitalise on this in part of the regulatory mix.

14.3 A survey performed in recent years by Livestock Improvement Corporation confirms what we also see as consultants in the field: "*In recent years LIC has undertaken a range of qualitative and quantitative survey work to determine farmer attitudes and intentions to a range of management issues facing farmers. Key findings of this work with respect to environmental management and sustainability are noted below.*

- *The key driver to undertaking environmental management is intrinsic in nature – personal satisfaction and pride in their farming practices.* ***Other key drivers are: the concern for the sustainability of their farm; concern for the image of NZ dairy farming; and the concern for the local natural environment.*** *Compliance to regulatory bodies was not as influential as intrinsic factors.*

- *Interestingly, the dairy processing company is seen as the principle driver behind the movement towards environmentally sustainable farm practices. Although not prompted (and therefore not quantifiable), dairy farmers also see themselves as the principle driver.*

- *Relative to other areas, reproduction is likely to be of more importance than milk quality, animal health, young stock, and/or genetics,* ***but is placed behind more significant management areas such as 'environmental sustainability'*** *and/or 'farm management'. The areas of closest comparison and relative importance were nutrition and pasture management.* Abstract from Letter, Greg Mc Neil, LIC:

14.4 I also acknowledged that if farmers are clear on what the environmental goals are that have to be achieved over time, they may work co-operatively to achieve the desired goals provided it is within a rational and consistent framework. Business needs certainty to plan and, on that basis, a well thought out framework that is fair and equitable across all land classes and sectors of agriculture is necessary. That is, dairy, intensive sheep and beef, cropping, horticulture, and ultimately, extensive sheep and beef will need to be part of the approach.

14.5 This "willingness to change" seems to be evident in other catchments around NZ, where farmers are interacting with their community in discussion, understanding the needs of other parties, and taking responsibility for their contribution to the issues.

14.6 Evidence of this occurring is what is happening in the Upper Waikato. Dairy Push is operating and is managed by Agfirst and looking at voluntary reductions in N loss of 20% over a 3 year life span of the SFF funded project. (50 farms in the project)

14.7 Our company (Headlands) is also project (Tomorrows Farms Today) managing a SFF and Dairy NZ funded catchment group in the Upper Waikato that is benchmarking 25 farms in detail and assessing their environmental performance, their nutrient emissions and their overall economic performance.

14.8 This is a project driven by the farmers in order to better understand what farm systems and mitigations are typical and appropriate in order to achieve a sound ROA (Total Return on Assets). The group is exploring what systems are most profitable (> 8% ROA and that are leaching < 30 kg N leached/ha).

14.9 Due to confidentiality agreements with the group I am not at liberty to discuss the initial results any further.

14.10 I also acknowledge that regulation can be costly and onerous and can result in perverse behaviours at times as cited by Willis in his 2009 S42a evidence. It is important to explore the best methodology that could allow a mix of regulation along with voluntary innovation and change, in order to meet the desired community goals. In my opinion, the rules proposed need to be equitable, future- proofed for potential trends, and consistent across all sectors that are participants in ensuring catchment health is at least maintained.

SUMMARY – DESIRE TO CHANGE

- Most farmers want to “do the right thing.”
- Surveys indicate that sustainability is one of the main concerns dairy farmers have.
- There are a range of activities across the country that are illustrating that improved efficiencies and reduced nutrient losses can be a “win- win.”
- Doing nothing will, unfortunately, not capitalise on a “willingness to change” that appears to exist, especially in the dairy sector.
- However, there are a range of farmers in the industry. Regulation will need to be part of the proposed policy approach, as voluntary obligation will not be enough to achieve the required change.

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APPENDIX 1 Herd Home Cost- Benefits

Economics of Investing in a Herd Home

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The costs versus the benefits of housing a herd of cows in a Herd Home (HH) for 50 days over winter and for 20 days in August and September were assessed to ascertain the net financial outcome. The farm that was used for this assessment was an actual case study from a high-altitude 350 cow farm in central Taranaki; with an annual pasture harvest per hectare of 10.8 T and an annual milk solid production per cow of 430 kg milk solids. At a milkpayout of $5.00/ milk solid the net financial benefit of the HH was $10, 940. This benefit was increased by approximately $10,000 per $1.00 increase in milk solid payout.

Farm Statistics	
Farm area	130 ha effective
Farm Owner	Murray and Pam Hitchcock
Sharemilker	Sam Taylor
No. cows (Nov 1st 2010)	346
Milk solid prodn 2010/2011 (kg MS)	149, 699
Milk solid prodn/ cow (kg MS/ c)	433
Pasture harvest (kg DM/ ha)	10.8
Supplement input (T)	
-Palm Kernel	346
-MaizeSilage	120
-Nitrogen (kg/ ha/ y)	130
-Straw	20
% of animals grazed off farm in winter	40
Capital cost of HH and slurry spreader ($)	310, 000
Length of time in HH in winter (d)	50

Costs	
Interest on capital @ 7%	$21, 700
Depreciation (3.3%/ y for HH and 7.5%/ y for spreader)	$11, 700
Maintenance, insurance and compliance costs	$16, 000
Increased feed costs	$24, 016
Total/ year	**$73, 416**

Benefits	
Supplement utilisation	$3, 772
Cow condition	$25, 950
Reproductive efficiency	$6, 920
Pasture protection (increased growth)	$18, 750
Winter pasture saved	$22, 215
Effluent (nutrients)	$6, 749
Total/ y @ $5.00/ MS	**$84, 356**
Profit margin/ y @ $5.00/ MS	**$10, 940**
Profit margin/ y @ $6.00/ MS	**$20, 573**
Profit margin/ y @ $7.00/ MS	**$30, 206**

Increased Feed Costs

An assumption was made that if there had been no HH and the animals were grazed on the farm, there would have been less supplement used as the cows would be consuming a higher proportion of their diet from pasture. It was decided to remove the maize silage (MS) used in the winter, whilst retaining the quantity of palm kernel (PKE) and grass silage (GS) fed. Feeding 4 kg of MS/ d for 50 days to a total of 230 cows amounts to 46 T of MS.

Due to the cows calving and entering the herd in the first rotation round the number of cows grazing would change over August and September. For 21 days in August there would be a mean number of 104 cows and for the 24 days in late August and September there would be a mean number of 203 cows in the herd.*[1] If 104 cows were fed 7 kg MS/ d and 4 kg/ d PKE for 10 days over August and 203 cows were fed 8 kg MS/ d and 5 kg/d PKE over September this would amount to 23.5 T of MS and 14.3 T of PKE.

MS costs $290/ T DM, equalling **$20, 155.**
PKE costs $270/ T DM, equalling **$3, 861.**
Total feed costs= **$ 24, 016**

*[1] Assuming three and six week calving percentages of 60% and 87%, respectively. Mean number of cows in each three week period is 50% of total number calved in period (DairyNZ, 2010).

Supplement Utilisation

Ten percent of PKE, MS and GS are wasted when fed out in bins. This compares to wastage rates of 30%, 25% and 20%, respectively, when these feeds are fed in the paddock (DairyNZ, 2010).

Bins: 230 cows * 50 days * (2 kg PKE * 0.90)………..………………………………..20.7 T
230 cows * 50 days * (4 kg MS * 0.90)…………………………………………...41.4 T
230 cows * 50 days * (2 kg GS * 0.90)……………………………………………20.7 T

Paddock: 230 cows * 50 days * (2 kg PKE * 0.70)……………………………………...16.1 T
230 cows * 50 days * (4 kg MS * 0.75)………………………………………34.5 T
230 cows * 50 days * (2 kg GS * 0.80)……………………………………….18.4 T

The feed that is saved when bins are used is 4.6 T, 6.9 T and 2.3 T for PKE, MS and GS, respectively. In dollar terms this equates to **$3, 772.*[1]**

*[1] Assumptions: Purchase prices for PKE, MS and GS of $270/T, $290/T and $230/T, respectively.

Cow Condition

Cows in a HH should put on one condition score (CS) more than grazing cows over 50 days in winter. This is due to less energy being expended walking; as well as an increase in energy from the cows reduced supplement wastage rates. Due to not walking around to forage, the HH cows will retain an extra 6 MJME/ d (300 MJ in 50 d) more than grazing animals. This value originates from 0.013 MJ being needed for grazing for every kg of body weight (BW) (Holmes *et al.*, 1978). Also, in 50 days in the HH the cows would have eaten 659 MJME more than grazing cows, due to less feed wastage ((20 kg * 11 MJ for PKE) + (30 kg * 10.8 MJ for MS) + (10 kg * 11.5 MJ for GS)). In BCS terms this extra 959 MJME equates to a weight gain of 27.4 kg, which is approximately 1 CS (DairyNZ, 2010). The value of this extra condition score in dollar terms is **$25, 950** (15 kg milk solids/ CS @ a $5.00 kg milk solid payout for 346 cows) (DairyNZ, 2010).

Note: The perceived notion that housed cows will retain more energy due to being in a warmer environment does not occur in reality (with the exception of very windy climates); due to the high heat production of cows consuming large amounts of feeds (NRC, 2001).

Reproductive Efficiency

A reduction of 1 CS at calving will increase the time to first oestrus by 7 – 10 days and reduce the final in-calf rate by 7% (DairyNZ, 2010). DairyNZ estimates this difference to equal $40/ cow over two seasons. This results in the improved CS of the housed cows valuing in at **$6, 920** for one year.

Pasture Protection

The reduction in the annual yield of pasture due to severe pugging of paddocks in winter has been reported to be up to 30% in Taranaki (Waikato Regional Council, 2010). If the grazing area over the dry period was 51.9 ha and 25% of this area was pugged, this would equate to an annual loss in DM of 40.9 T/ y.*[1] If the grazing area over the stand-off period in spring was 43.3 ha (60 day round in early lactation) and 25% of this area was pugged, this would equal 34.0 T/ y.

37.5 T * $230/ T for GS bought-in= **$8, 625**
37.5 T * $270/ T for PKE bought-in= **$10, 125**
Total feed costs= **$18, 750**

***[1]** 346 cows grazed on 30 sq. m/ c/ d for 50 d and an annual DM yield 0f 10.5 T/ ha

Pasture Sparing

- If 230 cows were grazed on the farm for 50 days over winter and were fed an iso-energetic diet similar to the one they consumed in the HH (with the exception of the MS being substituted for pasture) they would have consumed 3.8 kg DM grass/ c/ d (or 333 kg DM/ ha over the entire farm).

- If this 333 kg DM/ ha had not been previously eaten, it would be available for the spring calvers to eat in their first round.

- If the spring calvers had an early spring round length of 60 days, equating to 2.2 ha/ d, they would have had an extra 733 kg DM per day available to eat.*[1]

- Due to the cows calving and entering the herd in the first rotation round the number of cows grazing would change over August and September. For 21 days in August there would be a mean number of 104 cows and for the 24 days in late August and September there would be a mean number of 203 cows in the herd.*[2]

- As it is early lactation, these cows would also have had an intake limitation restricting them from consuming all of the extra feed (this would be a limitation of approximately 10 %).

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- If the extra DM eaten by the cows over August and September is converted to extra energy available for lactation it would equate to an additional 20 kg milk solids/ cow total for the 104 cows in August and an additional 12 kg milk solids/ cow total for the 203 cows in late August and September.

- By adding these extra kg milk solids together and multiplying by a milk solid payout of $5.00 it can be calculated that the extra value of the spared pasture is **$22, 215**.

Below are the calculations used to estimate the economic gains associated with the pasture sparing.

Calculation:	Value:
3.8 kg DM * 230 cows * 50 d:	43 T DM grass
43 T DM/ 130 eff. ha:	333 kg DM/ ha
130 ha/ 60 d round:	2.2 ha/d grazed in August and September*[1]
733 kg DM/ 104 cows * 21 d (August):	148 kg DM/ c*[2]
148 kg DM * 0.9 (intake limitation) * 11.5 MJME/ kg DM:	1532 MJME
1532 MJME/ 77 MJ per kg milk solid:	20 MS/ c
20 kg milk solids per cow * 104 cows:	2069 MS
733 kg DM/ 203 cows * 24 d in late August and September:	87 kg DM/ c*[2]
87 kg DM * 0.9 (intake limitation) * 11.5 MJME/ kg DM:	900 MJME
900 MJME/ 77 MJ per kg milk solid:	12 MS/ c
12 kg milk solid per cow * 203 cows:	2374 MS

2069 MS + 2374 MS= 4443 kg milk solids additional

4443 MS * $5.00/ kg milk solids= **$22,215**

*[1] Assuming a 60 day rotation length in early spring (DairyNZ, 2010).
*[2] Assuming three and six week calving percentages of 60% and 87%, respectively. Mean number of cows in each three week period is 50% of total number calved in period (DairyNZ, 2010).

Effluent Value

The value of the extra effluent captured was calculated using equations based on dry cows consuming forage rations (Lincoln College, 1984). Details of the calculations used are given in the table below. The extra quantity of effluent was estimated to be equivalent to 2.84 T of nitrogen (N), 0.50 T of phosphorus (P), 1.89 T of potassium (K) and 0.53 T of sulphur (S). The value of these nutrients as fertiliser inputs equal **$2, 258** for N ($796/ T urea) and **$4, 491** for P, K and S ($601/ T Superten 25K (50 % Potash Superten)).*

	N	P	K	S

1 cow using HH for 1 d:	0.164 kg/ d,	0.029 kg/ d	0.108 kg/ d	0.030 kg/ d
346 cows using HH for 50 d:	2837 kg	502 kg	1868 kg	529 kg

*Ballance Agri-Nutrientsprices (November, 2011).

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