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FARMS test farms project

Testing the One Plan approach to contaminant management and linking the FARM Strategy to the SLUI Whole Farm Plan design

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AgResearch Ltd, 2008

DISCLAIMER: While all reasonable endeavour has been made to ensure the accuracy of the investigations and the information contained in this report, AgResearch expressly disclaims any and all liabilities contingent or otherwise that may arise from the use of the information.

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EXECUTIVE SUMMARY

Introduction

Rule 13.1 of Horizons proposed One Plan requires all intensive farms operating within sensitive catchments to prepare a FARM Strategy (Farmer Applied Resource Management Strategy). A FARM Strategy outlines specifically how an intensive farming operation plans to:

1. Operate within One Plan nitrogen-leaching limits determined by Land Use Capability (LUC),
2. Minimise freshwater contamination from nitrogen (N), phosphorus (P), and faecal microbes, and
3. Achieve all other Rule 13.1 regulatory requirements (activities concerning water takes and potential contaminant sources).

Six case study farms have been examined by AgResearch to test the FARMS approach. Study objectives include:

1. Prepare FARM Strategies using workbook specifications and a design template similar to SLUI whole farm plans.
2. Identify and discuss any difficulties or inconsistencies encountered.
3. Clarify the steps taken to prepare a FARM Strategy.
4. Evaluate the economics of preparing and implementing FARM Strategies for each case study.
5. Compare N-leaching limits calculated using two scales of LUC classification.
6. Provide recommendations for FARM Strategy development and improvement.

Case Studies

FARMS Workbook specifications where applied to six case study farms. Each was described and reported using a design similar to SLUI whole farm plans (full reports on each case study appended). OVERSEER® nutrient budgets model[1] (v 5.2.6.0), hereafter referred to as OVERSEER®, was used to estimate current N-loss and P-loss risk, while farm-scale LUC classifications were prepared for the calculation of One Plan N-loss limits. Promising contaminant-minimisation options were evaluated in terms of potential effectiveness, cost and practicality. Clean Streams Accord status assessed for dairy enterprises, and other Rule 13.1 requirements were applied to all cases (including compliance cost estimates). Requirements and recommendations were summarised as objectives in a five-year plan for each case study. Case studies include:

1. Irrigated Dannevirke dairy farm.
2. Rain-fed Hukanui dairy farm.
3. Rain-fed corporate sand-country dairy and drystock farm near Parewanui.
4. Rain-fed sheep and beef farm near Pahiatua.
5. Proposed Pahiatua dairy conversion.
6. Irrigated mixed sheep/beef/dairy/cropping agribusiness near Marton.

Lower than expected N-leaching losses across all the case studies were explained by the type and quality of information used to build an OVERSEER® model, which has implications for the consistent region-wide application of FARMS. Standards to achieve regional consistency are provided.

Case study farms with higher capability land had more generous N-loss limits. The majority of intensive farms in the Manawatu-Wanganui (>70%) appear to have a similar predominance of high class land, and are therefore likely to attract similarly generous N-loss limits. Conversely, hill country farms with low capability land are likely to attract less generous N-limits.

Farming within N-limits would be achievable for all the case studies. Half the cases would need to decrease their farm's N-leaching losses by 1-6 kg N/ha, while the other half were in credit by 1-9 kg N/ha. None required major changes to their farming systems to achieve N-targets. Generally the targets were readily

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accommodated by fulfilling other requirements such as existing consent conditions, Clean Streams Accord obligations, other Rule 13.1 requirements, or by adopting supplementary mitigation practices such as N-inhibitors. All the case studies had a variety of additional mitigation options available for future consideration (e.g. standoffs, wintering barns, advanced effluent systems). However, fewer practical options are available for lower intensity land uses such as sheep and beef.

Similar results are expected for most pastoral livestock farms in the Region, particularly those in traditionally intensive areas, and those operating at average to above-average levels of production. Possible exceptions may include ultra-intensive operations, new intensive uses venturing into traditionally marginal landscapes, and areas with particularly high-risk combinations of land use and environment. Options to identify these areas are discussed.

Twenty-year N-targets would also be achievable for the case studies, albeit slightly more challenging because of reductions in N-loss limits. Farms with generous Year 1 N-loss targets will need to make greater reductions over the 20 years relative to farms with not so generous Year 1 targets. However, the degree of achievability will be dependent on long-term rates of intensification relative to the advancement of N-mitigation practices, both of which are difficult to foresee over 20 years. Under an absolute worst case scenario of unabated intensification and nil mitigation development, future farming under N-caps could represent a serious challenge. Conversely, the opposite absolute best case scenario could make N-caps a non-issue.

Farming within N-targets alone has only minor financial implications for the case studies. Most would achieve their targets by fulfilling Clean Streams Accord obligations and 'other' Rule 13.1 requirements. However, costs associated with these other obligations and requirements were high, often disproportionately, particularly for cases failing to meet existing consent conditions (mainly around effluent disposal), and those with lower levels of infrastructure development. Properties that had already invested in expensive capital items as a normal part of farm development tended to incur lower compliance costs. It is suggested that proactive and more environmentally aware farmers that have well developed farms are least likely to incur higher costs.

Other Rule 13.1 requirements represent the single largest cost, although there is much uncertainty regarding expensive capital items (e.g. bridges, extensive riparian fencing, sealed silage storage) because of inconsistency or ambiguity regarding the interpretation of both One Plan and FARMS Workbook specifications, particularly as they apply to less intensive farms and farm blocks. Interpretation problems are highlighted and discussed. If case study implementation costs are higher than those deemed acceptable for controlling freshwater contamination, then it is recommended that the Council seek to clarify or review those FARMS requirements that may involve expensive capital investments.

Reporting formats and preparation guidelines

Suggested guidelines for the preparation of FARM Strategies are presented according to three levels of *minimum*, *medium* and *comprehensive*. Minimum level strategies are likely to suffice in most cases, with medium and comprehensive levels retained for complicated and/or challenging farm operations.

Preparation costs are estimated at approximately $1,500 for minimum level FARM Strategies, between $2,300 to $5,000 for medium level strategies depending on the nature of the farm, and over $10,000 for comprehensive strategies that require deeper investigations and expert input.

Depending on services made available by the regional council and fertiliser companies, it is conceivable that a minimal level FARM Strategy could incur no direct financial cost to the farmer (other than the farmer's time).

Calculating N-limits at two scales

One Plan N-limits were calculated using regional-scale LUC classifications contained in the New Zealand Land Resource Inventory (NZLRI) database, and farm-scale LUC classifications prepared through special farm survey. Differences between N-limits using the two scales of information were compared, and the potential of irrigation increasing land capability was considered.

For most of the case studies it appears that farm-scale mapping will have an effect on the calculation of N-loss limits. Scale may increase or decrease a farm's permissible N-loss, but the degree is dependent on the farm in question. Opting for farm-scale mapping may therefore result in N-loss limits that are either more permissible or more constrictive.

Assigning higher capability classes for irrigated land is rational, and will make N-loss limits more permissible particularly when irrigation is practiced across a large area of land.

A recommendation is made to retain the current option available to farmers for calculating One Plan N-loss limits; namely that initial limits be calculated using regional scale LUC, but with the option for farmers to have property-scale LUC prepared if they wish to do so. It should be at the farmer's discretion to choose which N-limits are used for FARM Strategy purposes. It is also recommended that any decision regarding LUC adjustment for irrigated land be deferred until the experts have addressed the issue in the LUC Handbook update. If it is not adequately addressed, then the recommendation is to allow LUC adjustment at Council discretion, and such adjustments should only be made by a qualified surveyor.

Key recommendations for FARMS development

It is recommended that the current design of the FARM Strategy Workbook be reconsidered to improve usability. A checklist and reference guide approach proved particularly useful with the case studies.

Requirements specified in the FARMS Workbook were sometimes difficult to apply in practice. Similarly, there were discrepancies encountered between Workbook and One Plan specifications. A list of suggestions has been made.

Property boundaries straddling targeted and non-targeted catchments were encountered with three of the case studies. It was not always fully clear if these farms would qualify under Rule 13.1, and the issue could potentially involve a large number of farms. It is recommended that Horizons specify how the problem of straddled catchments will be managed. Suggestions include:

- If any part of the legal property boundary falls within a priority catchment (as defined by regional-scale data), then a FARM Strategy is required.
- If a pre-specified percentage of the legal farm boundary falls within a regional priority catchment (e.g. 25%, 50%, 85%) then a FARM Strategy is required.

Several cases had intensive and non-intensive enterprises (e.g. support blocks, neighbouring runoffs), the inclusion of which has implications for whole farm N-loss, N-limits, and other Rule 13.1 requirements. A four-step approach is recommended if similar situations are encountered with future application of FARMS.

There is a risk that OVERSEER® can be misused, intentionally or otherwise. To avoid misuse and encourage consistent modelling, a suite of assurance protocols is recommended.

- Standardising OVERSEER® inputs where possible. Rainfall is a key example, where Horizons supply the rainfall input parameter from one consistent source, rather than independent operators using their own variable sources or estimates.
- Only qualified OVERSEER® operators are permitted to undertake nutrient budgeting for FARMS purposes.
- Using accurate measurements of total farm area, effective area, and nutrient modelling blocks. This consideration had a large impact on the calculation of case-study N-leaching losses.
- Encouraging 'no change' to default OVERSEER® settings where possible. If defaults are changed, then the operator is required to note and justify why these changes were made in the Information Check.
- Every FARM Strategy is required to submit an Information Check as an appendix. This records all OVERSEER® input information, assumptions, and justification for adjusting default settings. Both the farmer and consultant would be expected to sign this as being true and correct.
- Including key OVERSEER® output tables as an appendix (e.g. nutrient budget reports for each block).
- Stipulate ongoing monitoring of key activities (N-fertiliser use and effluent application) as a consent condition.
- If tighter standards are required, a random audit system can be introduced to check OVERSEER® modelling.

Most difficulties encountered with modelling nutrient losses have either been addressed in the most recent release of OVERSEER®, or they are under consideration for incorporation with future releases. OVERSEER® is the most suitable and robust model for use with FARMS, and the OVERSEER® development team would be interested in any feedback regarding model application for FARMS purposes.

Endeavouring to fit new policy with actual farming situations resulted in several unanswered questions recommended for further research. Topics include:

- Limited N-mitigations for hill country.
- N-fertigation and N-use efficiency.
- Regional extent and contaminant implications of substandard effluent systems.
- Accounting for N-attenuation processes not captured by OVERSEER.
- Accounting for contaminant sources not captured by OVERSEER®.
- Sheep yards as a potential source of freshwater contaminants.
- Silage stacks as a potential source of contaminants and soil toxicants.
- N-leaching behaviour with artificially drained Pallic Soils.
- Conceptual difficulties regarding the use of Land Use Capability as a basis for distributing N-leaching caps.
- Longer term implications of farming under N-caps, and the cost to the farming industry of delaying actions and investments.
- Achievability of One Plan N-limits across different farming landscapes and environments within the Manawatu-Wanganui Region.

In summary, the FARM Strategy approach appears to be a workable solution to an otherwise difficult problem. Application difficulties were encountered, but they were not overly challenging and potential improvements are discussed and recommended. Farming within N-limits would definitely be achievable for all of the cases examined, and it is expected that this finding will be transferrable to most of the Region's intensive pastoral farms. Exceptions should be closely scrutinised as they potentially represent high risk farms. Similarly, major farming changes, such as reduced stocking rates, would not be envisaged for most farms. Many lower-impact contaminant minimisation options are available. As such, the cost of farming within N-limits is most likely to be a minor consideration. However, costs to achieve compliance with other Rule 13.1 requirements could represent significant capital investments, particularly on less developed farms, and should therefore be viewed with more concern.

INTRODUCTION

Background

Horizons Regional Council notified the proposed One Plan (regional plan) on May 31, 2007. Under the new Rule 13.1, resource consents are necessary for intensive farming operations located within sensitive catchments. Application for a resource consent requires the preparation of a FARM Strategy (Farmer Applied Resource Management Strategy) according to workbook specifications[2]. Purpose of a FARM Strategy is to group One Plan consent requirements into a cohesive whole-farm package for improved manageability. A key component is the identification of contaminant strategies to minimise environmental impacts associated with nitrogen, phosphorus, and faecal bug contamination of freshwater resources.

FARM Strategies follow on from Horizons SLUI (Sustainable Land Use Initiative) Whole Farm Plans, which are aimed at helping hill country farmers minimise environmental impacts associated with accelerated erosion and sediment loss.

The project

AgResearch was contracted to test the proposed FARM Strategy approach on seven case study farms, and develop a FARMS reporting template similar to that used for SLUI whole farm plans. Objectives include:

1. Prepare FARM Strategies for seven case studies using workbook specifications and a design template similar to SLUI whole farm plans.
2. Identify and discuss any difficulties or inconsistencies encountered.
3. Clarify the steps taken to prepare a FARM Strategy.
4. Evaluate the economics of preparing and implementing FARM Strategies for each case study.
5. Compare permissible nitrogen-loss limits calculated using two scales of Land Use Capability classification (farm scale vs. regional scale).
6. Provide recommendations for FARM Strategy development and improvement.

PART 1: CASE STUDIES

Seven farms were nominated by Horizons Regional Council to be test case-studies. Two later withdrew from participation, one was added, and another was examined twice to explore implications associated with a proposed dairy conversion. The largest and most complicated of the original seven was put aside for later consideration using alternative lines of investigation.

Case study farms

Case studies were nominated to cover a range of landscapes and farming types found within the eleven catchments targeted under Rule 13.1 (Map 1). Preference was given to higher performance systems more-likely to have elevated contaminant risks and associated challenges. The six case studies completed include:

1. Irrigated Dannevirke dairy farm.
2. Rain-fed Hukanui dairy farm.
3. Rain-fed corporate sand-country dairy and drystock farm near Parewanui.
4. Rain-fed sheep and beef farm near Pahiatua.
5. Proposed Pahiatua dairy conversion.
6. Irrigated mixed sheep/beef/dairy/cropping agribusiness near Marton.

Two additional farms withdrew partway through the programme for their own private reasons. They would have represented a high intensity sand-country dairy farm under irrigation, and a corporate lowland dairy farm on poorly drained soils.

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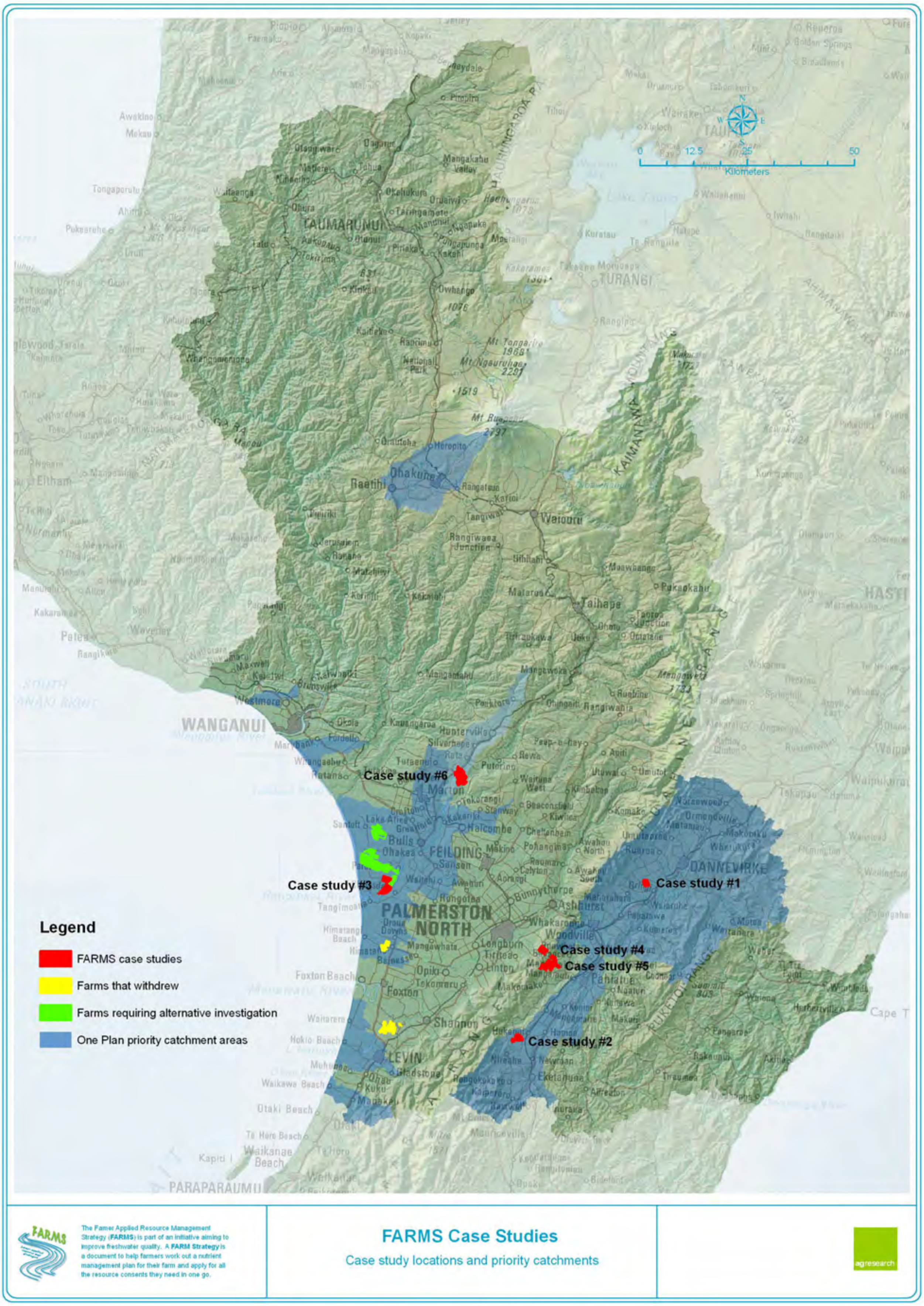
[2] FARM Strategy Workbook www.horizons.govt.nz/default.aspx?pageid=182



Map 1: Case study farm locations and priority catchment areas

One case study has been deferred pending the identification of a more suitable investigation method. This is a large and somewhat complicated agribusiness spanning 2560 ha of sand country under a low rainfall (900 mm), with irrigation and a diversity of intensive enterprises.

Case study method

A comprehensive approach was used to apply FARM Strategy Workbook specifications to the case study farms. This was necessary from an investigation perspective, and helped identify several important considerations that may have been missed with a less comprehensive approach. Approaches more suitable for the regular preparation of FARM Strategies are presented and discussed in Part 2.

Six steps were used in the preparation of each case study FARM Strategy (Figure 1).

1. **Farm description**: Each farm was described in terms of physical character, land use, and land management. Clean Streams Accord status was assessed for dairy farms, and benchmarking of farm performance was undertaken where possible. The farm description provides context to subsequent assessments, and allows checking by all participants to ensure the information is correct. Detailed mapping was undertaken to identify and measure relevant features (e.g. fenced and unfenced streams), and to precisely estimate effective vs. total farm area for representative nutrient modelling.
2. **Nutrient budgeting and environmental risks**: One or more models were prepared using OVERSEER® nutrient budget model[3] (hereafter referred to as OVERSEER®) for each property, firstly to determine nitrogen and phosphorous loss risks, and secondly to evaluate the potential effectiveness of promising mitigations. Nutrient processes not yet captured by OVERSEER® (e.g. N-loss to water via direct stock deposition), were calculated independently using conservative values. Gaps in research understanding limited the methods available to fully assess faecal microbe contamination risks.
3. **Evaluation of N-loss limits**: Detailed soil and Land Use Capability (LUC) mapping undertaken to determine One Plan N-loss limits for each farm (over 20 years). Results assessed against N-loss limits calculated using regional LUC classifications to determine LUC scale effects. Permissible N-loss (from farm-scale LUC) compared against modelled farm N-loss to identify if N-reductions were required.
4. **Mitigations evaluation**: A comprehensive list of accepted mitigation practices was compiled (with an emphasis on N-loss mitigations). Most promising options for further evaluation nominated according to likely effectiveness, probable cost, magnitude of N-loss, and farmer acceptability. Existing mitigations and environmental performance was also acknowledged. Potential effectiveness of new mitigations assessed by OVERSEER® remodelling and auxiliary calculations. Potential costs estimated using local values provided by consultants and service providers. Production modelling (e.g. Udder) was used in some cases if enterprise and/or mitigation mixes were particularly complicated. Best options were presented to the case study farmers as recommendations.

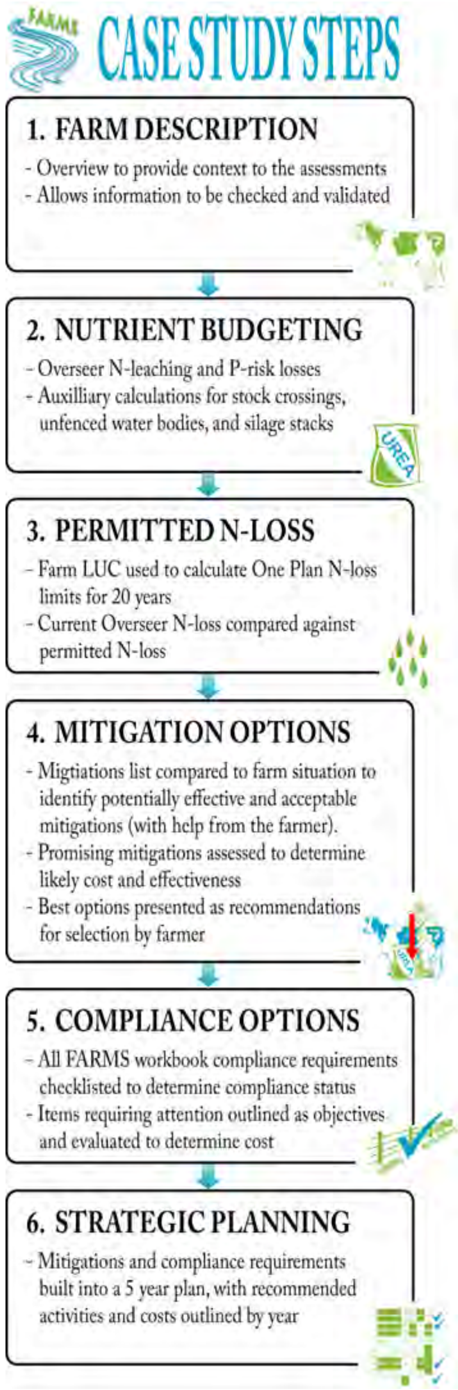


Figure 1: Key steps used in each FARMS case study

[3] ® OVERSEER is a registered trademark of AgResearch Ltd.

5. **Compliance assessment**: All FARMS Workbook requirements and specifications summarised as a checklist. Compliance status assessed by site visits and interview. Full compliance until proven otherwise was assumed for a small number of requirements that could not be fully assessed due to their seasonal or occasional nature (e.g. no application of fertiliser directly to water bodies). Non-compliant items requiring attention where stated as objectives, and compliance-cost estimates were provided.
6. **Strategic planning**: A strategic plan represents a very specific road map to One Plan compliance for the farm in question. Compliance requirements and recommendations were built into a five-year strategic plan for each case study, with recommended activities and costs outlined by year. Strategies include a works map showing where and when to implement activities.

The six 'steps' are somewhat stylised, and while they reflect the general structure of each case study report, the actual process applied to each farm was far less categorical. The full process is detailed in Appendix 7.1.

Economic evaluation

Evaluating the economics of <u>preparing</u> and <u>implementing</u> FARM Strategies is an objective of this project. Case-study preparation costs are distorted by research requirements, so preparation cost estimates are provided separately in Part 2 according to alternative options (Minimum, Medium, and Comprehensive options).

Implementation costs were estimated for each case study. Local prices were used, as determined through farm business consultants, service providers, and in one case an engineer was contracted to estimate the cost of installing a new bridge (total cost was dependent on site characteristics). Likewise, full costing of the dairy conversion case-study was undertaken by a consultancy. Three types of 'cost' were considered:

1. **Capital cost**: Generally once-off investments such as fencing waterways, installing culverts or troughs, and relocating offal holes or dumps. Depending on mitigations and current degree of non-compliance, capital costs may also include major items such as bridges, silage bunkers, wintering pads, herd homes, and upgrading non-compliant effluent application systems.
2. **Seasonal costs**: Variable costs are associated with management-related mitigations such as changing N-fertiliser use, wintering dairy cows off-farm, or altering supplementary feed management. These costs can change throughout the year, so only cost estimates at the time of investigation were used. High seasonal volatility in supplement and fertiliser values at the time of the assessment resulted in some costs being under estimated.
3. **Revenue implications**: Only direct revenue implications were considered. Revenue implications can be positive or negative. Examples include loss of productive land by fencing streams, increased pasture production due to N-inhibitor use, decreased yields by reduced N-fertiliser use, and improved responses from effluent-use efficiency improvements.

Overlap with Clean Streams Accord obligations (dairy only)

The dairy industry entered into the Clean Streams Accord in 2003. Under the Accord dairy farmers are obligated to exclude cattle from water bodies (lakes, streams, rivers, crossings) and fence important wetlands. Considerable overlap with Clean Streams Accord obligations and One Plan requirements has implications for the allocation of compliance costs.

Clean Streams obligations take precedence over similar One Plan requirements in this project. Reasons are twofold. Firstly, the Clean Streams Accord is a dairy industry obligation that predates the One Plan. If the One Plan was completely removed from consideration, then dairy farmers would still be required to implement the specified freshwater protection practices (fencing streams, etc.). Secondly, most Clean Streams obligations should be near complete by the time Rule 13.1 comes into effect. Several Accord obligations have already passed their performance target dates (2005, 2007), and the key date (2012) matures either just before, or just after, Rule 13.1 implementation dates (2009-2015 depending on the catchment in question). Requirements and costs associated with Accord obligations are therefore treated as being completely separate from similar One Plan requirements.

Allocating overlapping compliance costs required an assessment of Accord status for each farm, and a comparison of how and where the two obligations overlap (Table 1). Specifications for both obligations were difficult to apply in practice, particularly the minimum criteria for qualifying streams. In the first case-study a 1.5m deep stream did not technically qualify because it was less than a metre wide (smaller than a stride). This resulted in the use of a more consistent definition - 'streams that flow all year, in most years' – in which the perennial nature of a stream is considered more important than its dimensions.

Table 1: FARMS Workbook and Clean Streams Accord overlapping requirements

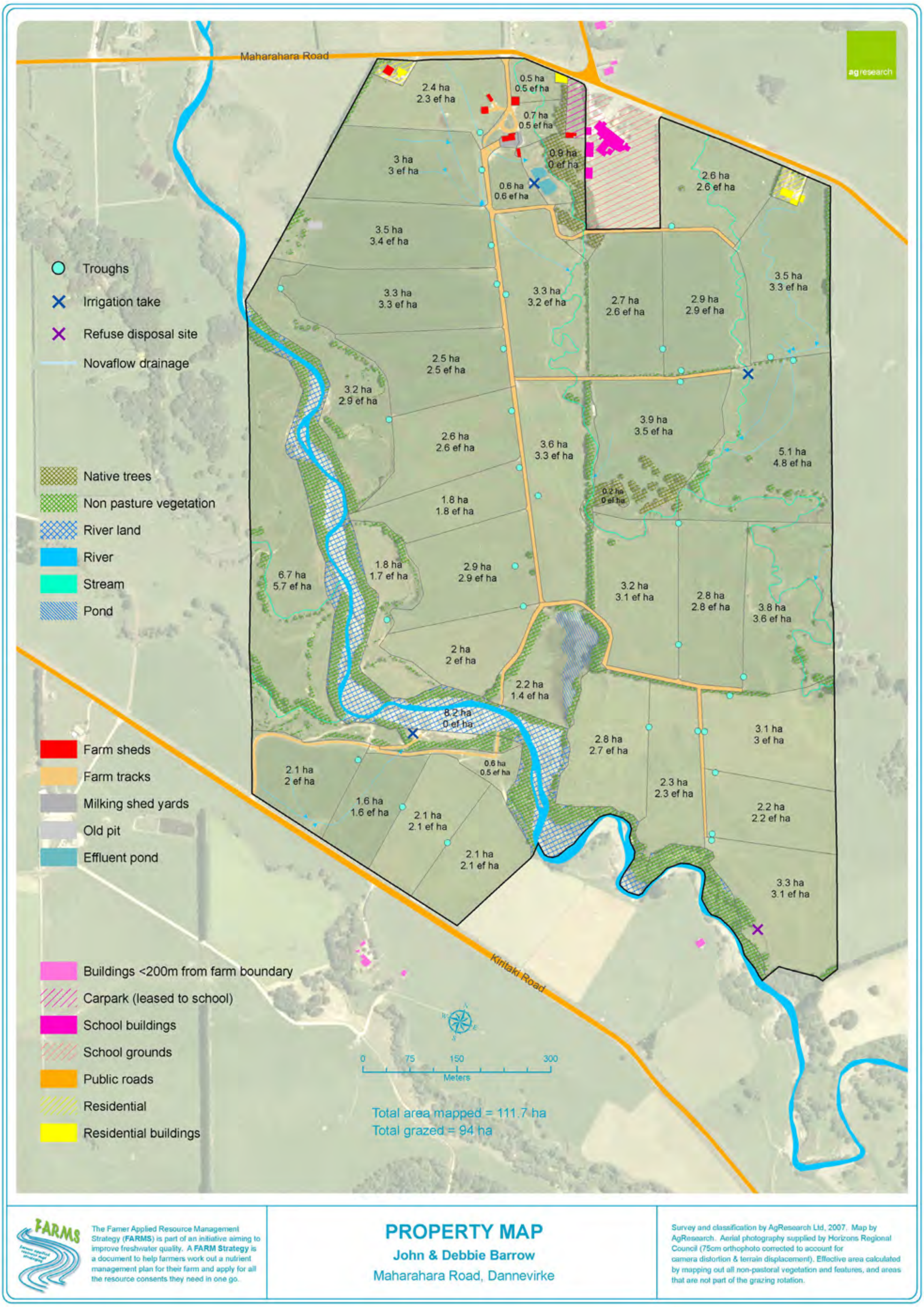
Requirements		*Key differences and issues*
Clean Streams Accord	***FARMS Workbook***	
Cattle excluded from streams deeper than a Red Band gumboot <u>and</u> wider than a stride	All stock physically prevented from streams deeper than a Red Band gumboot <u>and</u> wider than a stride	- Differences in targeted stock types - Stream dimension requirements are vague and difficult to apply in both cases
Cattle excluded from lakes	No direct equivalent	- There is an implicit assumption that FARMS 'waterways' include lakes, but 'waterways' is not clearly defined in the One Plan - The assumption extends to include all stock and not just cattle - There is no definition of lakes in the Accord (when does a pond become a lake?). Several Manawatu-Wanganui landscapes are noted for their 'small lakes' (e.g. sand country).
Laneways with regular (>twice/week) stream stock-crossings bridged or culverted	All points where stock cross waterways require a bridge or culvert	- The Accord targets laneways but FARMS implies all stock crossings, including non-laned crossings within paddocks - The Accord's 'regular crossings' can be difficult to apply in practice - FARMS requires a bridge or culvert irrespective of how regular the crossing is used
Implicitly, stock-water sources other than lakes, streams and rivers are required in each paddock	Troughs or dams required in each paddock	- One requirement is implicit and the other is explicit - Few implications for dairy farms; considerable implications for mixed cropping and intensive sheep/beef
Important or significant wetlands fenced	Not directly required for FARMS	- Wetlands are protected under Rule 12.8 which refers only to clearance, disturbance, discharges and diversions – stock exclusion is implicit rather than explicit
Dairy effluent discharges must comply with existing resource consents	Dairy effluent discharges must comply with existing resource consents, but a new effluent discharge consent is required as part of the FARM Strategy process	- Most effluent discharge consents will predate the One Plan. - Incurring costs by failing to comply with conditions in an old consent therefore represent an existing cost, and are more properly allocated as Clean Streams costs rather than One Plan costs - There is a 'regional council compliance cost', but in this case it is not the same as a 'One Plan compliance cost'.

It should be noted that the economic objective of this project includes evaluating the cost of implementing a FARM Strategy. In effect this represents an evaluation of One Plan compliance costs, which are defined here as direct costs to the farm business arising from having to implement requirements of the One Plan. This excludes all other compliance costs associated with the Regional Council, particularly those that predate the One Plan (i.e. existing resource consents). Costs incurred by failing to comply with current effluent-discharge consent-conditions are therefore existing costs - not new costs created by the One Plan - and are therefore more correctly allocated as Clean Streams Accord compliance-costs (because effluent discharge consent-compliance is a requirement under the Accord).

Estimated compliance costs for the Clean Streams Accord and the One Plan are both reported in the case-study results section.

Case study results

Full case study results are supplied as appendices. Key findings are summarised here, while challenges and opportunities encountered during each case study are discussed in Part 4.



Map 2: Property map for Case Study #1

Case study #1: Irrigated Dannevirke dairy farm

Description: Irrigated owner-operator 112 ha dairy farm located near Dannevirke, with 2.7 cows/ha yielding ~400 kg MS/cow (above local average) under moderate rainfall (1200 mm). Older river-terrace land with high capability (loess and old alluvial soils).

Contaminant assessment: Current N-leaching estimated at 25 kg N/ha/yr (OVERSEER® N-loss of 30 kg N/ha/yr was adjusted to reflect use of N-inhibitors and contributions to unfenced streams). P-loss risk to water assessed as LOW.

One Plan N-loss limits: Calculated at 24 kg N/ha/yr for 2011, and gradually decreasing to 18 kg N/ha over twenty-years. Current N-loss is 1 kg N/ha/yr above the 2011 N-limit.

Mitigation options: Seven promising options were identified and evaluated. Options recommended to the farmer included fencing waterways, install culverts, construct bridge, and enlarge the effluent area. These actions are sufficient to achieve N-loss targets for year 2011, and most are required anyway either under the Clean Streams Accord or other parts of the One Plan.

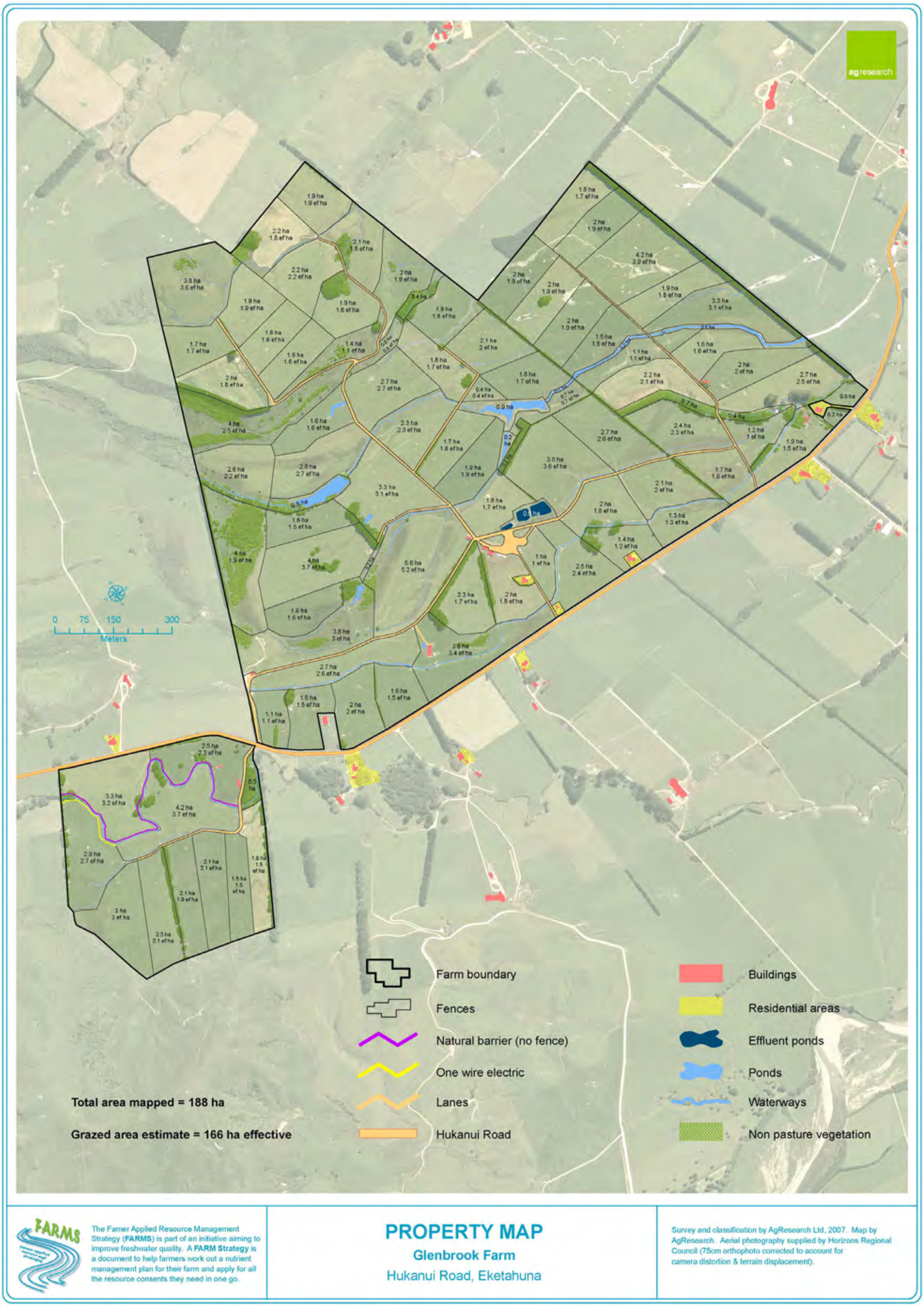
Option	Potential effectiveness	Economic implications	Practicality
High-E/low-N supplement	N-loss ↓ **2 kg N/ha/yr**	No appreciable change	High
Off-farm winter grazing	N-loss ↓ **9 kg N/ha/yr** & bug risk↓	Potential revenue increase of $7,000 to $13,000	High (but risky)
Enlarge effluent area 3ha	N-loss ↓	No appreciable change	High
Fence waterways	Bug risk↓ & N-loss ↓ **0.2 kg N/ha/yr**	$17,400 cost and $2,860/yr lost revenue	Low (required)
Planted riparian buffers	Bug risk↓ & N-loss risk↓	$10,000-$13,000 cost and $28,000 to $86,000/yr lost revenue	Extremely low
Construct bridge	Bug risk↓ & N-loss ↓ **0.6 kg N/ha/yr**	$73,000 cost	Low (required)
Install 2 culverts	Bug risk↓ & N-loss risk↓	$3,400 cost	High (required)

Compliance requirements: Items requiring attention include installing culverts, fencing streams, bridge construction, pond overflow, storm water discharge to ponds, farm dump location, and inadequate availability of trough water.

Compliance cost estimate: Total cost of One Plan compliance is estimated at $99,100. Bridge construction is the single most significant cost at $73,000. However, total cost reduces to $74,500 if Clean Stream Accord obligations are taken out ($24,600 for waterway protection), and would decrease further to a comparatively nominal $1,500 if the bridge also qualified as a Clean Streams requirement (debatable).

Conclusion: This property will have no difficulty achieving One Plan N-targets. Fulfilling other compliance requirements will accommodate the necessary 1 kg N/ha/yr reduction, and there are many other mitigation options available to the farm going into the future. Compliance cost will be high at ~$73,000 (excluding Clean Streams obligations), the bulk of which would be incurred by having to construct a bridge.

FARMS development: Issues concerning the implementation of FARMS are discussed more fully in Part 4. Key issues identified with Case Study 1 include: a) Unknown N-inhibitor effectiveness, b) The importance of correct farm area information, c) Fertigation as a potential N-mitigation, d) Inconsistencies in Workbook and One Plan specifications, e) An unavoidable heavy-reliance on the farmer for information necessary for nutrient budgeting, f) N-loss sources and mitigation practice effects not accounted for in OVERSEER®, and g) Difficulties in the application of Clean Streams Accord definitions, particularly minimum dimensions for qualifying streams, and evaluating 'regular' crossings.



Map 3: Property map for Case Study #2

Case study #2: Rain-fed Hukanui dairy farm

Description: Rain-fed dairy farm (188 ha) located near Hukanui under higher rainfall (1865 mm), sharemilked with 2.2-2.9 cows/ha yielding ~375 kg MS/cow (above district average). Mostly high capability land (old river terraces) but also a sizeable area of low capability land (old Mangahao River bed).

Contaminant assessment: Current N-leaching estimated at 26 kg N/ha/yr (OVERSEER® N-loss of 23 kg N/ha/yr was adjusted to include contributions from unfenced water ways and an inefficient effluent system). P-loss risk to water assessed as LOW.

One Plan N-loss limits: Calculated at 20 kg N/ha/yr for 2010, and gradually decreasing to 16 kg N/ha over twenty-years. Current N-loss is 6 kg N/ha/yr above the 2010 N-limit.

Mitigation options: Eight promising options were identified and evaluated. Options identified as being most suitable include fencing waterways, improved effluent system, and adopting N-inhibitors[4]. Taken together, these options would likely put farm N-loss balance in credit by 2 kg N/ha/yr for 2010. Two of the options are required under Clean Streams Accord obligations, while the other promises significant production gains. Adopting other available mitigations, plus making allowances for advances in technology, would mean longer term targets would be similarly achievable.

Option	Potential effectiveness	Economic implications	Practicality
N-inhibitors[4]	~~N-loss ↓ **5kg N/ha/yr**~~	~~Only 6% yield response needed to break even; potentially considerably more profitable~~	~~High~~
Reduce urea 10%	N-loss ↓ **1kg N/ha/yr**	Modelled $22,750 reduction in gross revenue	Low
Reduce cows, supplement & urea scenario	N-loss ↓ **1kg N/ha/yr** & bug risk↓	Potentially +$50,000 in gross revenue but requires development investment (drainage, etc.)	Medium
Fence waterways	Bug risk↓ & N-loss ↓ **0.2kg N/ha/yr**	$11,200 cost and $6,400/yr lost revenue (gross)	Low (required)
Planted riparian buffers	Bug risk↓ & N-loss risk↓	$20,500-$23,700 cost and $33,800 to $42,300/yr lost gross revenue depending on buffer width (10-30m).	Extremely low
Travelling irrigator effluent system	Bug risk↓ & N-loss ↓ **1.6 kg N/ha/yr on average** (highly variable)	$31,500 cost (but would require pond capacity to double to be compliant) and requires high labour cost	Medium
Larall effluent system	Bug risk↓ & N-loss ↓ **1 kg N/ha/yr**	$49,360 cost (maybe less depending on pasture yield increases) but low labour costs	High
Wetland effluent system	Bug risk↓ & N-loss ↓ **0.9 kg N/ha/yr**	$15,000 cost	Low

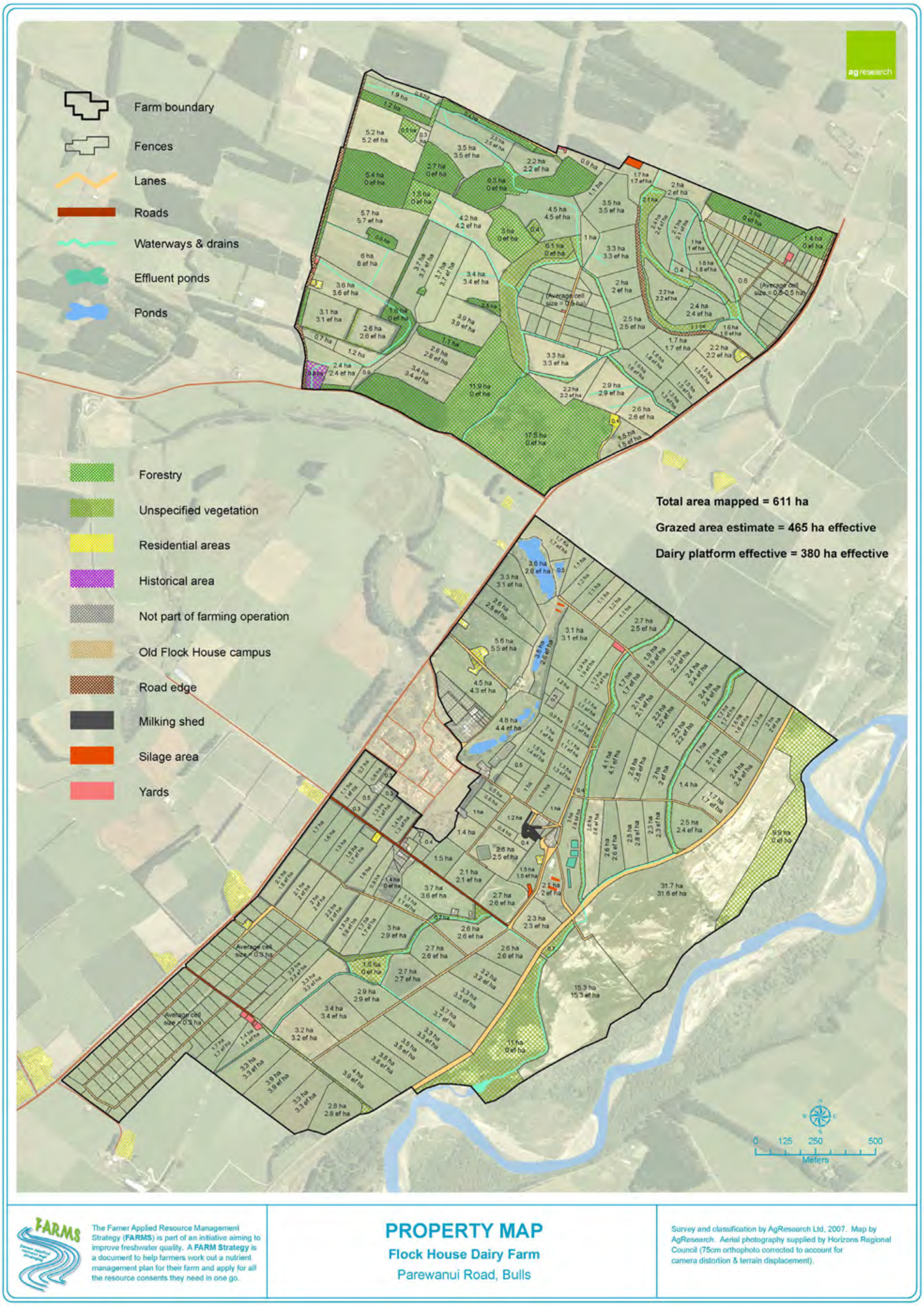
Compliance requirements: Fence waterways, upgrade effluent system, redirect milking-shed stormwater to land, install 3 culverts, and enlarge the effluent application area to 20 hectares.

Compliance cost estimate: Total cost of One Plan compliance is estimated at $62,120. However, upgrading the effluent system and fencing waterways can both be considered as Clean Streams Accord obligations ($60,560). Excluding Accord costs leaves $1,560 as the One Plan compliance cost.

Conclusion: This property should have little difficulty achieving One Plan N-targets, particularly after Clean Streams Accord obligations are fulfilled. Fencing waterways, upgrading the effluent system and adopting inhibitors[4] are sufficient to achieve the 6 kg N/ha/yr N-target for 2010, plus providing a 2 kg N/ha credit. Likewise, there are additional mitigation options available to the farm going into the future. Compliance cost initially appears high ($62,120), but becomes comparatively nominal when costs for Clean Streams obligations are accounted for (reduces to $1,560).

FARMS development: Key issues identified include: a) An unavoidable heavy-reliance on the farmer for information necessary for nutrient budgeting, b) Conflict between information provided by the owner and the sharemilker, c) Nutrient modelling using information from the preceding year, when that particular year may not have been representative, and e) Effluent discharge-to-land system with extremely high leaching-loss risk but apparently compliant under the One Plan.

[4] N-inhibitors where later identified as being unsuitable for this property due to high drainage potential (~1300 mm). Alternative mitigation options were proposed and evaluated, including optimising fertiliser use, expanding the effluent area, and reduced urea use through high energy supplementation (see Appendix 7.13). N-leaching reductions were estimated at 3 kg N/ha (sufficient to achieve compliance), and money saved from reduced fertiliser use could result in a net saving of $3,300 each year. Accordingly, the key conclusions and final cost estimates remain largely unchanged.



Map 4: Property map for Case Study #3

Case study #3: Rain-fed corporate dairy and drystock farm

Description: Rain-fed corporate sand-country dairy farm with support block (611 ha) located near Parewanui with lower rainfall (900 mm). Dairy platform running 3.2 cows/ha and producing ~350 kg MS/cow (above local average). Extensive alluvial flats with high land capability.

Contaminant assessment: Current N-leaching is calculated at a modest 18 kg N/ha/yr. Relatively low N-loss is explained by the inclusion of large areas of redundant land, low producing land, and the support block, all of which average dairy N-loss across a greater area (N-loss for the dairy platform would be 32 kg N/ha/yr if these areas were excluded). P-loss risk to water assessed as LOW.

One Plan N-loss limits: Calculated at 24 kg N/ha/yr for 2014, and gradually decreasing to 19 kg N/ha over twenty-years. The farm is currently operating well within its N-loss limits, and no N-reductions or special mitigation practices are required. Indeed, the farm has a comfortable buffer extending out for the full 20 years of consideration.

Mitigation options: While no N-reductions are required, several mitigations were evaluated either for future reference, or because they are a requirement under a different part of the FARM Strategy workbook. Five options specific to this farm were evaluated.

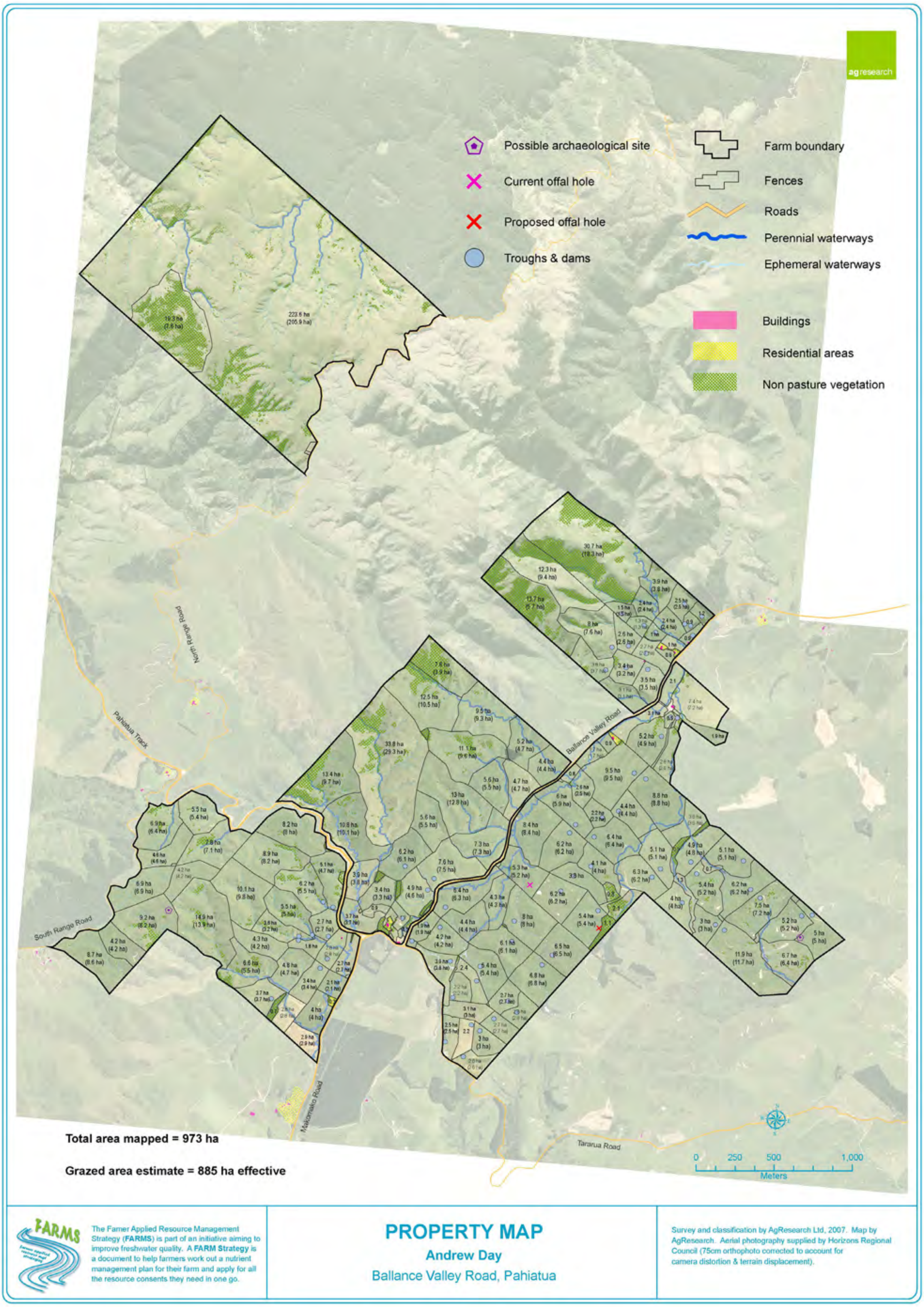
Option	Potential effectiveness	Economic implications	Practicality
N-inhibitors	N-loss ↓ **2.7 kg N/ha/yr**	Only 6.5% yield response needed to break even; potentially considerably more profitable	N-inhibitors
Stop use of urea in winter	N-loss ↓ **5 kg N/ha/yr**	Estimated $48,000 reduction in gross margin	Stop use of urea in winter
Install effluent holding pond	No impact with a small pond. Potentially N-loss ↓ **1 kg N/ha/yr** with a large pond	Small sealed pond recommended at a cost of $1,500	Install effluent holding pond (required)
Fence water bodies	Bug risk↓ & N-loss risk↓ & P-loss risk↓	$2,375 cost and $1,060/yr lost revenue (gross)	Fence water bodies (required)
New silage bunkers	N-loss potentially ↓ **0 - 3 kg N/ha/yr** (very tentative)	$180,000	New silage bunkers (required?)

Compliance requirements: Fence lakes, install effluent holding pond, and cease ford use by switching to alternative access to gravel block area. These are requirements under both the Clean Streams Accord and the One Plan. New silage bunkers may also be a requirement, depending on further clarification of both One Plan and the FARMS workbook specifications from the Council.

Compliance cost estimate: Assuming that two new silage bunkers are required, initial cost of One Plan compliance is estimated at $183,880. This reduces to $3,880 if having many smaller silage stacks (<500m^2) are permissible under the One Plan. Remaining cost is for waterway protection and effluent system improvement, both of which are Clean Streams obligations. Accordingly, compliance requirements under the One Plan may incur no cost whatsoever.

Conclusion: Not only is this property operating well within its One Plan N-limits, but it has a comfortable buffer and several mitigation options to easily keep N-leaching within N-limits out to 2034 (assuming no radical changes). The farm has land with high capability, and dairy N-loss is being averaged across less intensively used areas. It is conceivable that One Plan compliance will incur no financial cost, but only if Clean Streams obligations are fulfilled, and switching to smaller silage stacks is clarified as being a permissible option under the One Plan.

FARMS development: Key issues identified with Case Study 3 include: a) Leachate losses from large-volume silage stacks not accounted for in OVERSEER®, b) Silage stack requirements are not clear in the One Plan, c) Required two separate OVERSEER® models (drystock and dairy), and d) A conceptual issue arose regarding the inclusion of runoffs or support blocks in the calculation of N-leaching losses (major averaging effect).



Map 5: Property map for Case Study #4

Case study #4: Rain-fed sheep and beef farm near Pahiatua

Description: Rain-fed sheep and beef farm (973 ha) near Pahiatua under moderate rainfall (1470 mm) and low to medium stocking rates (whole farm = 9.5 su/ha). Mostly low capability steepland, moderate capability hill country, and a small area of higher capability flats. The farm is not targeted as 'intensive' under the One Plan, and is therefore considered as an extreme example for achieving compliance.

Contaminant assessment: Current N-leaching is calculated at a 10 kg N/ha/yr. P-loss risk to water assessed as HIGH. Sediment loss was estimated by Landcare Research at 3,400 tn/yr.

One Plan N-loss limits: Calculated at 11 kg N/ha/yr for the first year, and gradually decreasing to 10 kg N/ha over twenty-years. The farm is currently operating within its N-loss limits, and no N-reductions or special mitigation practices would be required (if the farm qualified as being 'intensive').

Mitigation options: Several mitigations evaluated either for future reference, or because they are required by a different part of the FARM Strategy workbook. Eight options specific to this farm were evaluated.

Option	Potential effectiveness	Economic implications	Practicality
Urease-urea replacement	N-loss ↓ **1 kg N/ha/yr**	Cost of $8,000 but potentially offset by at least +$8,000 production gains	High
Wetland for yard runoff	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$2,700 cost for fencing & planting	Medium (required)
Fence waterways	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$400,000 for 40 km sheep-proof fencing	Low (required)
Planted riparian buffers	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$405,200-$407,800 cost and $10,400 to $31,250/yr lost revenue	Extremely low
Install 28 new culverts	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$15,000 cost	Low (required)
Install 45 new troughs	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$19,475 cost	Low (required)
Construct 18 new dams	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$18,000 cost	Low (required)
New bridge?	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$20,000	?

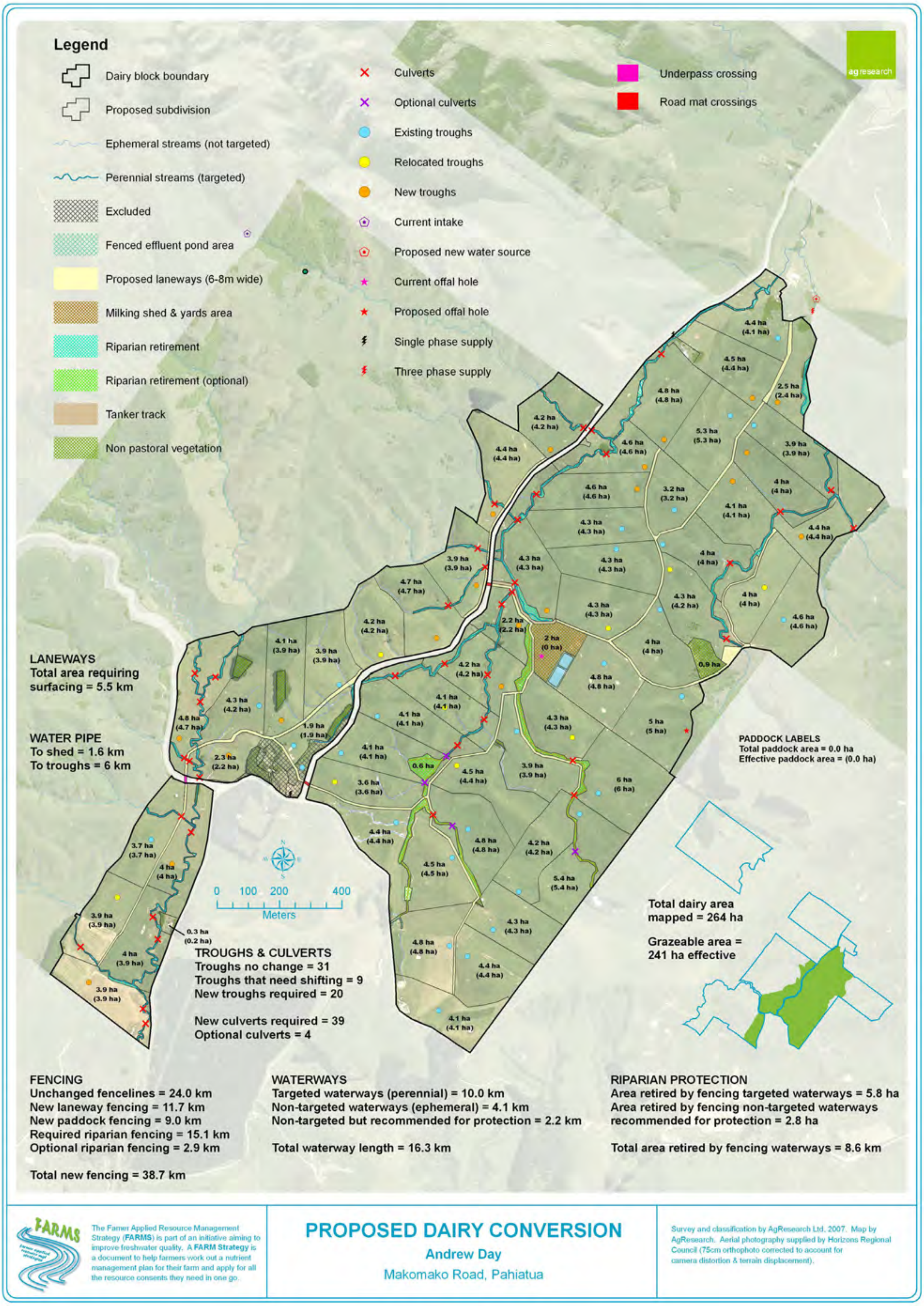
Compliance requirements: Includes 40 km of riparian fencing, controlling sheep yard effluent discharge, relocate offal hole, 28 new culverts, 18 dams, 45 troughs, and retire 3 ha isolated by stream fencing or construct a bridge. None of these requirements can be considered as Clean Streams Accord obligations.

Compliance cost estimate: Cost of full One Plan compliance is estimated at $455,000 or $475,000 if a new bridge is installed. The greatest cost arises from the waterway protection programme (including new fencing, culverts, dams, and troughs). This reflects the dissected landscape and related high incidence of waterways found in hill country, and in the Tararua District.

Reinterpretation of One Plan requirements: This case study is considered an extreme application of FARMS in being an 'extensive' rather than 'intensive' farm. An 'intensive' example would be expected to have greater existing development (more fencing, troughs, dams, etc), thereby lessening compliance requirements. Because of this, the case study was re-evaluated using a practical interpretation of workbook specifications, whereby only the 'intensive' areas of the farm were considered (Appendix 7.10). Harder hill areas were excluded, resulting in fewer troughs, culverts, dams and fencing requirements. Total compliance cost estimate reduced to $50,700. This is still substantial, but represents a valid reflection of development stages that can be expected between 'intensive' and 'extensive' farms.

Conclusion: Achieving One Plan N-targets would not be difficult for this property, primarily because it represents an 'extensive' operation with low N-losses. However, extensiveness means the property is less developed in terms of fencing, troughs, dams and culverts, and will therefore find One Plan requirements more challenging. A literal interpretation of these requirements could result in extreme compliance costs (~$475,000), but a more pragmatic interpretation that only includes the 'intensive' portion of the farm would result in considerable lower compliance costs (~$50,700). Financial outlay is still high, but this represents an extreme case and lower requirements/costs would be expected for more developed sheep and beef properties that do actually qualify as being 'intensive' under the One Plan.

FARMS development: Key issues identified include: a) Potentially high compliance costs for sheep/beef operations, b) Correctness of LUC classifications were challenged, and c) Comparatively fewer N-mitigation options available to low intensity sheep and beef farmers.



Map 6: Property map for Case Study #5

Case study #5: Proposed dairy conversion

Description: Proposed dairy conversion (264 ha) from sheep/beef under moderate rainfall (1470 mm) near Pahiatua. Aiming to run 2.7 cows/ha and produce 330 kg MS/cow, while retaining the balance of the farm in sheep and beef. Proposed dairying area is rolling to flat with a high capability for sheep and beef, but a moderate to low capability for more intensive uses.

Contaminant assessment: Predicted N-leaching is calculated at a 30 kg N/ha/yr for the dairy platform, which averages down to 15 kg N/ha/yr when calculated for the entire farm. P-loss risk to water assessed as HIGH (EXTREME for dairy, MEDIUM for sheep/beef).

One Plan N-loss limits: Calculated at 11 kg N/ha/yr for the first year, and gradually decreasing to 10 kg N/ha over 20-years. Dairy N-limit is 13 kg N/ha and sheep & beef is 10 kg N/ha. Dairy N-limit is low because only 30% of the conversion area is represented by land commonly associated with dairy farms. The conversion would need to reduce N-loss by 4 kg N/ha/yr to be compliant. This also depends on the coexistence of the sheep and beef enterprise to average dairy N-loss down to an achievable level.

Mitigation options: Five promising options were identified and evaluated.

Option	Potential effectiveness	Economic implications	Practicality
N-inhibitors	N-loss ↓ **1.9 kg N/ha/yr**	$71,200 net cost but only a 7.5% yield increase to break even; scope for higher increases	High
Off-farm winter grazing + reduced supplements	N-loss ↓ **1 kg N/ha/yr**, bug risk↓ & P-loss↓	$61,430 cost but potentially offset by utilising winter pasture ($20,000 - $40,000 revenue)	Low
Increase effluent area + feeding pad time	N-loss risk↓ & P-loss risk↓ & bug risk↓ (modelled N-loss reduction is minor)	$2,000 per year for spreading effluent solids across whole farm	Low
Wintering barn or herd home	N-loss ↓ **2 kg N/ha/yr**, bug risk↓ & P-loss↓	$240,000 cost for wintering barn and $411,000 cost for herd home	Medium
Alternative to Triticale crop	N-loss ↓ **2.7 kg N/ha/yr**	$27,700 cost of purchasing equivalent silage	High

Compliance requirements: In being a new conversion, One Plan and Clean Streams Accord compliance is assumed by default. The only exception is having to reduce N-loss by 4 kg N/ha/yr. Adopting N-inhibitors, plus purchasing Triticale silage (or equivalent) rather than growing it on-farm, both promise to reduce N-loss to targeted levels. Longer term targets would be more challenging, and an investment into a wintering barn or herd home may be required.

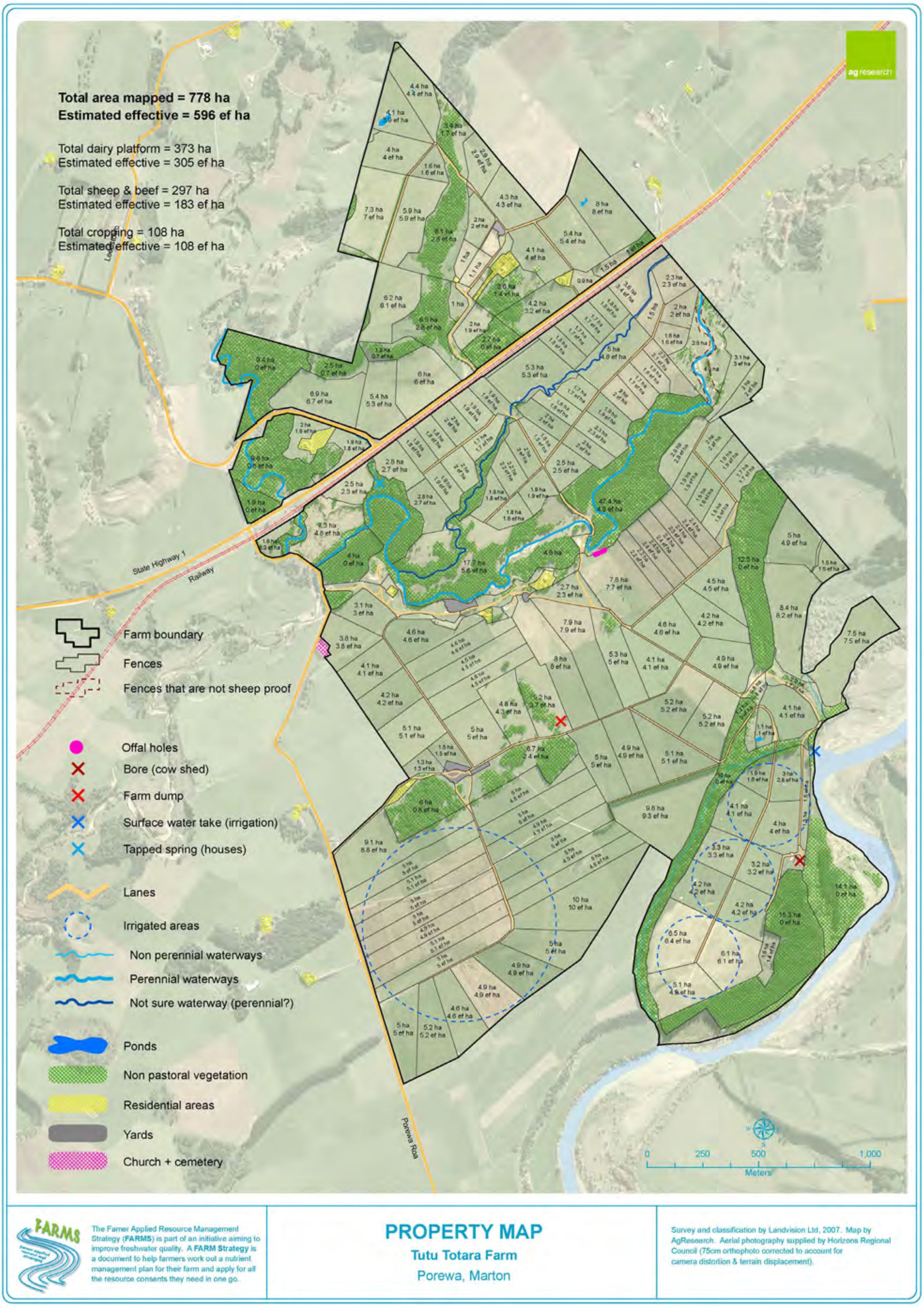
Compliance cost estimate: Cost of full One Plan compliance is estimated at $27,700. This represents the cost of purchasing Triticale silage (or equivalent) over and above the cost of growing it on-farm. Inhibitor use is predicted to pay for itself through increased pasture yields. Investing in a wintering barn would increase total cost by an estimated $240,000 (or $411,000 for a herd home).

Implications for conversion viability: The conversion would require an investment of ~$5.8 million. At a conservative payout ($5.40/kg MS), net surplus is estimated at ~$168,000 in year three, which is only ~$16,300 above what is currently achieved under sheep and beef. However, capital gain is a significant consideration (~$557,000), and the conversion would be an attractive investment under a higher payout (i.e. at $6.90/kg MS). Viability is jeopardised at a $5.40 payout, particularly if a wintering barn or herd home were included. As a tentative statement, compliance costs under higher payouts would not make the dairy conversion unviable.

Conclusion: Achieving initial One Plan N-targets would be readily achievable by adopting inhibitors and purchasing silage. Longer term targets may require additional options such as constructing a wintering pad or herd home. Compliance costs may jeopardise conversion feasibility at low payouts, but not at the high payouts currently being predicted. Even so, compliance costs are but one of many factors that need consideration before deciding to invest in a dairy conversion, and a more comprehensive analysis is recommended outside of this research exercise.

FARMS development: Key issues identified include: a) N-loss compliance implications for converting marginal land, and b) Implications for farms that straddle multiple Water Management Zones.

Note: Full dairy conversion analysis by Sheppard Agriculture provided as Appendix 7.14.



Map 2: Property map for Case Study #1

Case study #6: Irrigated mixed enterprise agribusiness

Description: Mixed sheep/beef/dairy/cropping agribusiness (778 ha) under a low to moderate rainfall (1141 mm) supplemented with irrigation, near Marton. Dairy platform running 800 cows/ha and yielding 434 kg MS/cow. Mix of terraces and alluvial flats with high capability.

Contaminant assessment: Whole farm N-loss at a low 16 kg N/ha/yr (17 kg, 12 kg and 24 kg for dairy, sheep/beef and cropping respectively), attributable to generally low stocking rates, many N-reducing options are already practiced, and N-loss from intensive areas was 'diluted' by including less intensive and non-pastoral areas. P-loss risk was LOW for the farm (MEDIUM for dairy and cropping).

One Plan N-loss limits: High at 25 kg N/ha for 2014, decreasing to 20 kg N/ha over 20-years (87% of the farm is high capability LUC class 1 to 4 land). The farm is operating well-within its N-loss limits, and no N-reductions or special mitigations are required. There is a comfortable margin extending out for the full 20 years of consideration, such that the property would still remain compliant even under an intensification scenario of 1100 cows.

Mitigation options: While N-reductions are not required, several mitigations were evaluated either for future reference, or because they are a requirement under a different part of the FARM Strategy workbook.

Option	Potential effectiveness	Economic implications	Recommendation
N-inhibitors	N-loss ↓ **1.4 kg N/ha/yr**	Only 5.4% yield response needed to break even; potentially more profitable	✓
Control sheep-yard runoff	Bug risk↓ & N-loss risk↓ & P-loss risk↓	$5,000 - $10,000 for effluent storage system	?
Fence waterways	Bug risk↓ & N-loss risk↓ & P-loss risk↓	$12,300 - $17,000 cost. Production losses negligible	✓
Decommission stock fords	Bug risk↓ & N-loss risk↓ & P-loss risk↓	Fencing costs built into fencing waterways. Alternative options already available (bridges)	✓
Improved dairy effluent system	N-loss ↓ **<1 kg N/ha/yr** for whole farm (↓ **37 kg N/ha/yr** for the Effluent Block)	Capital investment of $16,680 but offset by nutrient efficiencies worth +$12,000 per year	✓
Stop use of urea in winter	N-loss ↓ **1 kg N/ha/yr**	Estimated $69,000 lost revenue	×

Compliance requirements & costs: The sheep and beef unit was assessed as 'intensive' resulting in the identification of several non-compliant items. Total estimated cost ($36,000 – $45,900) includes Clean Streams obligations ($16,680), and would reduce substantially if the Regional Council exempts sheepyard effluent discharge requirements, the 'suspect' stream remains unfenced, and nutrient-use improvements are included (+$12,000/yr). One Plan costs could be as low as $14,400.

Requirement	To comply with…	Recommendation	Cost estimate
Operate within N-loss limits	One Plan	No N-reductions or special mitigations necessary	-
No stormwater discharge to yards	One Plan	Install guttering & pipe to direct stormwater to land	$500
Exclude stock from waterways	One Plan (& Accord)	Sheep-proof 1.2 km existing fence; erect 1.6 km new fence; consider 0.9 km fence around 'suspect' stream	$12,200-$14,600
No stock fords or crossings	One Plan (& Accord)	Decommission stock fords	-
No offal hole <100m from river	One Plan	Relocate offal holes	$1,700
No direct discharge of effluent to water from the sheep yards	One Plan	Install effluent catchment & storage if sheepyard effluent requires special management (?)	$5,000 - $10,000
No dump <1m from water-table	One Plan	Decommission farm dump	-
Max effluent rate @ 35m^3/day & must have 2 days effluent storage	Accord (existing consent) & One Plan	Enlarge effluent area (62 ha), improve wash-down practices & install 420m^3 holding pond	$16,680 offset by ~$12,000/yr saving

Conclusion: Farming within One plan N-limits will not be a challenge for this farm, even if herd size is increased to 1100 cows. Of greater concern is compliance issues identified for the sheep/beef unit, and the inefficiencies associated with the dairy effluent system. Compliance costs could be substantial ($36,000 – $45,900), but nutrient-use improvements (+$12,000/yr) have the potential to balance capital costs over a longer period of economic consideration.

FARMS development: Key issues identified include: a) Nutrient modelling for complex enterprise mixes, b) Inconsistencies with One Plan catchment zoning, c) Farm straddled two Water Management Subzones, one targeted and the other was not, and d) Identifying a 'representative year' for OVERSEER® modelling when enterprise mixes are changing from year to year.

Discussion of case study results

Current N-leaching losses: Despite some of the case studies representing intensive operations, predicted N-leaching losses for all the case studies were consistently low (Table 2) relative to industry averages reported by OVERSEER® and Clothier et al. (2007)[5]. In part this reflects provincial differences in farming intensity and productivity for the OVERSEER® averages (e.g. much higher N-losses would be expected in provinces such as the Waikato). In the main, however, low N-leaching losses are attributable to five key reasons:

- To achieve consistency with how One Plan N-limits are calculated, total farm area rather than effective was used for nutrient modelling. This is not always standard industry practice. All of the case studies had significant areas of non-grazed land (trees, ponds, sheds, residential, etc.) that effectively 'diluted' whole farm N-loss (i.e. N-loss was averaged across a larger area). Modelling using effective area only, generally pushed N-losses for the dairy cases well into the 30-40 kg N/ha N-loss range.
- Land use intensity was not uniform across all paddocks, and some of the case studies included a mix of intensive/extensive land uses (e.g. mixed operations with support blocks, or sheep and beef blocks). High N-losses from intensive blocks were effectively averaged across the less intensive blocks, thereby diluting the reported whole farm N-loss.
- Several case studies already had significant N-mitigation practices in place. For example, Case Study 1 regularly uses N-inhibitors, with an estimated effect of reducing whole farm N-loss by 20%.
- Farm-scale mapping provided the opportunity to establish correct drainage status of case study soils. When the appropriate modifications were made to OVERSEER®, the effect was up to a 2-3 kg N leaching reduction on a whole farm basis (oxygen reducing conditions of poorly drained soils result in lower leaching losses but higher greenhouse gas losses).
- In the main, case study farmers were managing their N-inputs efficiently, particularly with N-fertilisers (low to modest rates and use of split dressings).

Table 2: Average N-loss values for different land use categories

	Case study whole farm ranges	*Case study enterprise ranges*	*Average ranges reported in OVERSEER®*	*Ranges reported in Clothier et al., 2007[2]*
Cropping	-	24	-	10-140 kg N/ha
Dairying	15-26	15-26	30-50 kg N/ha	15-115 kg N/ha
Sheep and beef	10	10-11	5-20 kg N/ha	6-60 kg N/ha

Current P-loss risks: OVERSEER® rated most of the case studies with an overall LOW P-loss risk, although high fertility blocks within farms often scored HIGH or EXTREME (mainly effluent blocks). Further, case studies 4 (hill country sheep and beef) and 5 (dairy conversion) rated as HIGH and EXTREME respectively. Slope and soil fertility appear to be the key reasons for these ratings.

Faecal microbes: Stock voiding directly to unfenced streams and crossings was the only faecal microbe contamination source identified in this project. Gaps in research understanding currently limit methods available for confidently assessing other sources.

One Plan N-loss limits: N-loss limits were calculated using farm-scale LUC classifications on the basis that they are more accurate than regional classifications (however, see the comparisons in Part 3). Results indicate that the intensive cases (dairy, mixed enterprise) have accommodating N-loss limits that range between 20-25 kg N/ha for the first year, and gradually declining down to 16-20 kg N/ha over 20 years (Table 3). All these particular farms had a predominance of high class land, with between 80-90% of total farm area made up of LUC classes 1-4. A quick analysis of farms in the Manawatu-Wanganui Region[6] suggests that 71% of intensive farms are dominated by high capability land (i.e. >80% total farm area is LUC class 1-4), and are therefore likely to have similarly accommodating N-loss limits.

[5] Clothier B, Mackay A, Carran A, Gray R, Parfitt R, Francis G, Manning M, Duerer M, Green S (2007). Farm Strategies for Contaminant Management. A report by SLURI, the Sustainable Land Use Research Initiative, for Horizons Regional Council. AgResearch, Palmerston North

[6] Intensive farms from AgriBase supplied by Horizons. Includes arable, dairy, flowers, fruit, vegetables and viticulture (1198 farms). Analysis is for the whole region rather than just intensive farms that fall within priority targeted catchments.

Table 3: Case study summaries											
		N Cap (kg N/ha/yr)						Financial implications [e]			
	N leaching (kg N/ha/yr)	Year 1	Year 5	Year 10	Year 20	Required reduction (Year 1)	Recommendations and requirements to achieve compliance [a]	Clean Streams Accord costs [a]	One Plan non-negotiable costs [a]	Additional costs to achieve N-targets [a]	Revenue implications [a]
Case study 1 (Dannevirke dairy farm)	**25**	24	21	19	18	1 kg N/ha reduction required	- Enlarge effluent area - Fence waterways (3.2 km) - Install 2 culverts - Control pond overflow (redirect storm water) - Install two troughs - *Construct bridge* [b] - Move dump site	$24,600	*$74,500*[b]	$0	$2,860 loss from land retired by fencing waterways
Case study 2 (Hukanui dairy farm)	**26**	20	19	17	16	6 kg N/ha reduction required	- Larger effluent area + improved fertiliser + less urea + more supplement [z] - Upgrade effluent system - Fence waterways (3.1 km) - Install three culverts - Divert shed roof storm-water to land	$61,610	$500	$0	Net saving of $3,300/yr [z] $6,400 loss from land retired by fencing waterways
Case study 3 (Sand country sheep, beef, & dairy)	**18**	24	21	20	19	Nil (+6 kg N/ha in credit)	- Install effluent holding pond for existing consent compliance - Fence lakes (1 km) - Deactivate use of stock ford - *Construct two silage bunkers* [c]	$3875	*$180,000*[g]	$0	$1,060 loss from land retired by fencing lakes
Case study 4 [i] (Pahiatua sheep & beef)	**10**	11	11	10	10	Nil (+1 kg N/ha in credit)	- *Control yard discharge (wetland)* [h] - Fence waterways (*40 km* or 11 km) [d] - New troughs (*45* or 35 units) [d] - New culverts (*28* or 21 units) [d] - Dams (*18* or 2) [d] - Move offal hole site	na	*$455,175*[d] ($50,710)	$0	$6,000 loss from land retired by fencing waterways
Case study 5 (Dairy conversion)	**15**	11	11	10	10	4 kg N/ha reduction required	As a new conversion, both Accord and One Plan compliance is assumed by default for all requirements other than farming within N-limits - Adopt N-inhibitors - Purchasing Triticale silage rather than growing it on-farm	$0	$0	$98,200[f]	Plus $71,200 gain. 7.5% inhibitor response to break even [f]
Case study 6 (Marton sheep, beef, dairy, & cropping)	**16**	25	22	20	20	Nil (+9 kg N/ha in credit)	- Control storm-water - Fence waterways [g] (*3.7 km* or 2.8 km) - Cease use of stock fords - Relocate offal hole - Decommission dump - *Manage sheepyard effluent* [h] - Enlarge dairy effluent area; improve washdown practice; install effluent holding pond	$16,680	*$19,400 - $29,080*	$0	$370/yr loss from land retired by riparian fencing Plus $12,000/yr gain from improved nutrient use

[a] Blue = Clean Streams Accord obligation, Red = One Plan non-negotiable requirement, Green = Additional recommendations to achieve Year 1 N-target. *Items and costs in italics are contestable. Either One Plan specifications were not fully clear (e.g. silage stack requirements), or it is marginal as to whether the item qualifies as a Clean Streams or One Plan requirement (e.g. bridges).*

[b] Marginal as to whether the bridge ($73,000 cost) is a Clean Streams obligation or a One Plan requirement

[c] One Plan specifications need clarification. Under a literal interpretation the farm can shift to smaller silage stacks and remain compliant without having to construct new bunkers. However, this could be considered a loophole because total silage leachate will probably remain unchanged.

[d] Number of units dependent on whether the whole farm, or just the intensive proportion, qualifies for compliance considerations.

[e] Owing to volatility in payouts and input prices, estimated costs are only relevant to when each particular case study was prepared.

[f] In all cases where N-inhibitors were recommended for achieving N-targets, the cost of inhibitor is likely to be offset by production gains (otherwise, why would people use it?). Only modest pasture responses were required to break even (generally around 6% to 7.5%), and research developments are suggesting that much higher response rates can be expected in certain environments.

[g] Includes optional recommendation to fence a 'suspect' stream (0.9 km @ $4,680), which has all the bed characteristics of a sizeable stream but when examined (early winter 2008) the stream was effectively dry (i.e. technically it does not qualify as a targeted stream).

[h] Requires clarification from the council regarding the intended applicability of effluent discharge requirements to sheep yards.

[i] Represents a worst case application of FARMS. The property does not actually qualify as 'intensive' under the One Plan.

[z] This mitigation combination is an alternative to N-inhibitors. See Appendix 7.13.

In practice the number of intensive farms dominated by high capability land is likely to be greater than 71%, because the analysis did not separate out mixed dairy/sheep/beef enterprises (where the sheep and beef component is more likely to involve lower capability land).

Case studies 4 and 5 (sheep/beef, and the dairy conversion) had particularly low N-loss limits (11 kg N/ha yr 1). This is expected for the sheep and beef farm because it is a hypothetical 'One Plan intensive farm' (i.e. it does not qualify as intensive). A predominance of LUC class 6 & 7 land (81% of total farm area) makes it more suitable for extensive rather than 'One Plan intensive' pastoral grazing. Accordingly, results for this particular farm can be considered as a worst case scenario.

A low N-loss limit for the dairy conversion also reflects lower capability land. Despite representing the better land on the sheep and beef farm (Case Study 4), only 29% of the proposed conversion is classed as LUC 1-4. Relative to other farms in the Region, less than 4% of all intensive farms are classified as being in a similar situation (<4% of intensive farms have <30% of total farm area as LUC 1-4). The percentage may be even lower if database errors were considered. In short, the land is only marginally suitable for a dairy conversion, and it is therefore unsurprising that it attracts a low N-loss limit.

N-loss limits for one of the withdrawn case studies is also relevant. While this farm withdrew partway through the project, it represents a highly intensive system on what has traditionally been considered lower capability land (sand country). Year 1 N-loss limits were calculated at 18 kg N/ha from farm-scale LUC, and 14 kg N/ha using regional-scale LUC (see Part 3), both of which are low given the level of land use intensity. On a regional basis only 12% of intensive farms are implicated (i.e. intensive farms that have >50% sand country). It is suspected that these farms will incur less generous N-loss limits relative to their counterparts in alluvial and loess dominant landscapes (please note that Case Study 3 is located within the sand country adjacent to the Rangatikei River, and over 50% of the property is represented by alluvial soils).

Achievability of One Plan N-loss limits: Results were variable, ranging from N-losses being 6 kg N/ha over a farm's permitted limit (Case Study 2), through to being 9 kg N/ha within the limit (Case Study 6). This simply reflects the many possible combinations of land type, management practices (including existing mitigations) and land use intensities.

Operating within N-limits would be achievable for all of the case studies. None would need to resort to major changes to their farming systems for the initial implementation period, such as land use diversification or reduced stock numbers. Generally N-limits could be achieved by fulfilling other requirements such as existing consent conditions, Clean Streams Accord obligations, other One Plan specifications, or by adopting supplementary practices such as N-inhibitors in some cases (Table 3). Even the dairy conversion would be achievable (largely because of a low initial stocking rate).

In general, we would expect similar results for most of the Region's pastoral livestock farms, particularly those in traditionally intensive areas, and those operating within average to above-average levels of production. Possible exceptions may include ultra-intensive operations, new intensive land uses venturing into traditionally marginal landscapes, and farms with particular high-risk landuse/environment combinations (e.g. high rainfall + coarse shallow soils + low capability land + few trees/redundant areas + high stocking rates). Identifying high risk combinations across the region are discussed further in Part 4.

20-year N-targets: First year N-loss limits for all case studies would decrease between 9% to 25% over the One Plan's 20-year implementation period. Decreases are proportionally small if Yr 1 N-limits are small, which favours those farms with initially low N-loss limits. For example, N-loss limits for Case Study 4 (sheep/beef) will only decrease 1 kg/ha over the twenty years, while limits for Case Study 1 (Dannevirke dairy) will decrease by 6 kg N/ha. The second case will therefore find N-loss limits more challenging over the long term.

Assuming that current N-loss remains unchanged over the next twenty years[7], then three of the case studies would need to adopt additional N-reducing practices to remain compliant. Again, even at these slightly more challenging levels, N-loss limits are still likely to be achievable without having to make major farming adjustments or sacrifice stocking rates.

The assumption that current N-loss will not change is perhaps optimistic given current intensification trends. Case Study 5 (dairy conversion) is effectively an intensification scenario, but long-term N-loss targets are still considered achievable (only an extra 1 kg N/ha added to the limit). Likewise, a herd expansion option was examined for Case Study 6 (Marton mixed-enterprise), whereby a shift from 800 to 1100 cows would result in

[7] Assumes that advances in N-mitigation technology and practice keeps pace with intensification trends

increased N-leaching losses. In this particular case the farm would still be operating comfortably within its N-loss limits.

An additional two intensification scenarios were constructed for Case Studies 1 & 2 for interest (example provided as Appendix 7.6). The predicted differences were substantial. Case Study 1 would need to decrease N-leaching by 25 kg N, and Case Study 2 by 21 kg N/ha. If no new N-mitigation advances become available over the next twenty years, then achieving compliance under these two scenarios would likely require major changes to each farming system. However, many developments are possible over the next 20 years, and reliable predictions cannot be made over such long timeframes.

Contaminant minimisation options: All case studies had a range of options available, which were tailored to each case study's situation and magnitude of N-loss. There was significant overlap between non-negotiable requirements (Clean Streams obligations, other Rule 13.1 requirements) and options to minimise N-loss and freshwater contamination. Indeed, in most cases the non-negotiable requirements went a long-way towards achieving N-loss targets. The few options recommended for achieving N-targets alone included N-inhibitors (1 case), larger effluent disposal areas (3 cases), and purchasing supplement (2 cases). Generally, most of the region's intensive farms could expect a similar situation – many contaminant minimisation options to choose from, and significant N-loss reductions simply by fulfilling Clean Streams obligations and other Rule 13.1 requirements.

Lower intensity farms may be an exception. Fewer contaminant minimisation options were available for the sheep and beef farm (Case Study 4) relative to the dairy cases, and the uptake of any given option had comparatively less impact on N-reduction (e.g. a 20% reduction in N-leaching has less impact for a sheep/beef farm at 11 kg N/ha, relative to a 20% reduction for dairy farm that is leaching 30 kg N/ha).

Clean Streams Accord: All dairy case studies (4) required further work before becoming Accord-compliant (excluding the dairy conversion which was considered fully compliant). Three of the four had issues regarding effluent storage and application to land, and 2 of the 4 had issues around stock exclusion from surface water. If all Accord obligations had been achieved before this project, then FARM Strategy requirements and costs would have been reduced by a substantial degree (refer to blue text in Table 3).

Other Rule 13.1 compliance requirements: When all other compliance considerations are removed (i.e. Clean Streams, existing consent conditions, One Plan N-loss limits), then the remaining Rule 13.1 requirements were generally small for dairy farms, but comparatively large for non-dairy farms. However, in regards to dairy, a single compliance issue could translate into a major cost (e.g. bridges or silage bunkers – see Table 3).

Case study extensive land-uses resulted in the identification of a disproportionate number of compliance requirements (Case Studies 3, 4, 6). These farms are either sheep and beef, or include a proportion of the farm dedicated to less intensive uses (support blocks, sheep and beef enterprise). Compliance was assessed on a 'whole of farm basis' rather than focusing solely on the 'One Plan intensive' portion of the farm, because One Plan N-loss limits are calculated on a 'whole of farm basis' also. However, in one particular case the cost of compliance would have been extreme (sheep and beef farm), so the case was reassessed on an intensive/extensive block basis. Results suggest that compliance would still be demanding for the farm, but not unachievable. This issue and related issues (e.g. inclusion of farm runoffs) are discussed further in Part 4, and recommendations are made on how it can be managed. From a regional perspective, the key implication is that less developed farms, or farms that include less developed areas, will possibly incur higher compliance requirements than their more developed counterparts.

Several discrepancies and interpretation difficulties were also encountered with FARMS and One Plan specifications, which are also addressed in Part 4.

Financial implications: All the case study farms would need to spend money to implement their FARM Strategies. Estimated costs were variable between farms, and often a single compliance item would incur a major and disproportionate cost relative to other costs (e.g. Case Study 1 costs were estimated at $73,000 to install a bridge relative to $1,500 for other One Plan costs). Large item costs also tended to be contestable because of One Plan interpretation ambiguities (e.g. silage bunkers for Case Study 3, and sheep yard effluent system for Case Study 6), or because a requirement overlaps between the One Plan and Clean Streams Accord (e.g. bridge in Case Study 1). It is recommended that FARMS specifications that are likely to implicate expensive capital investments be clarified or reviewed, if the costs reported here are deemed excessive. However, also note that farms that had already invested in expensive capital items as a normal part of farm development tended to incur lower compliance costs.

Clean Streams obligations represented a significant cost for all established dairy farms, ranging between ~$4,000 to ~$62,000 (cases 3 and 2 respectively). These costs associated with effluent storage and disposal issues, and to a lesser extent excluding stock from waterways. None were considered contestable, although what constitutes a 'Clean Stream stream' was often debated, and there may be lower-cost solutions other than those recommended and used to estimate costs.

As noted previously, fulfilling Accord obligations and other Rule 13.1 requirements went a long-way towards achieving N-loss targets. In some cases N-inhibitors were recommended as additional mitigations. Outlay costs could be high, but associated pasture responses inferred from recent research findings suggest that performance gains would at least balance the initial outlay, if not add to farm profitability. Accordingly, adopting the use of N-inhibitors was considered an investment that paid for itself, which taken together with the N-loss reductions of fulfilling other obligations, results in the net cost of the One Plan's N-loss limits being a minor consideration. It also suggests that farms currently achieving compliance with existing consents and Clean Streams obligations, will incur fewer costs than farms currently at low levels of compliance.

Improved nutrient-use efficiencies associated with larger or optimal sized effluent-application areas also has the potential to reduce costs associated with fertiliser costs. For Case Study 6 (Marton mixed enterprise), shifting from 14 ha to 62 ha could reduce fertiliser costs by $12,000 per year. Conversely, land retired by fencing waterways can represent a substantial loss of production, estimated to range between $370 up to $6,000/yr for the case studies. Adopting wide riparian margins has even greater implications. For Case Study 1 (Dannevirke dairy), riparian widths of 10, 20 and 30m would retire 5, 9.9 and 14.7 hectares of grazed land, with the corresponding loss of gross income estimated at $28 600, $57 200 and $85 800 each year. While there are many good reasons to establish riparian margins, and they can be highly effective in most cases, no recommendation was made to adopt wide riparian margins for any of the case studies. They may, however, be suitable for other farms in the Region. Likewise, these wider-type margins may become a more defendable proposition should water quality continue to decline.

Case study results do not provide a clear answer to the question 'what is the absolute cost of Rule 13.1 to farmers?'. This requires a dedicated economic analysis beyond the scope of this project, and one that covers longer term implications (e.g. capital cost spread over the life of the item) and current financial situations on a case-by-case basis. However, results from the case studies provide a degree of insight into the variables that are likely to impact on potential costs (Figure 2). It is also suggested that proactive and more environmentally aware farmers that have well developed farm infrastructure are least likely to incur high FARM Strategy implementation costs. Preparation costs are discussed in Part 2.

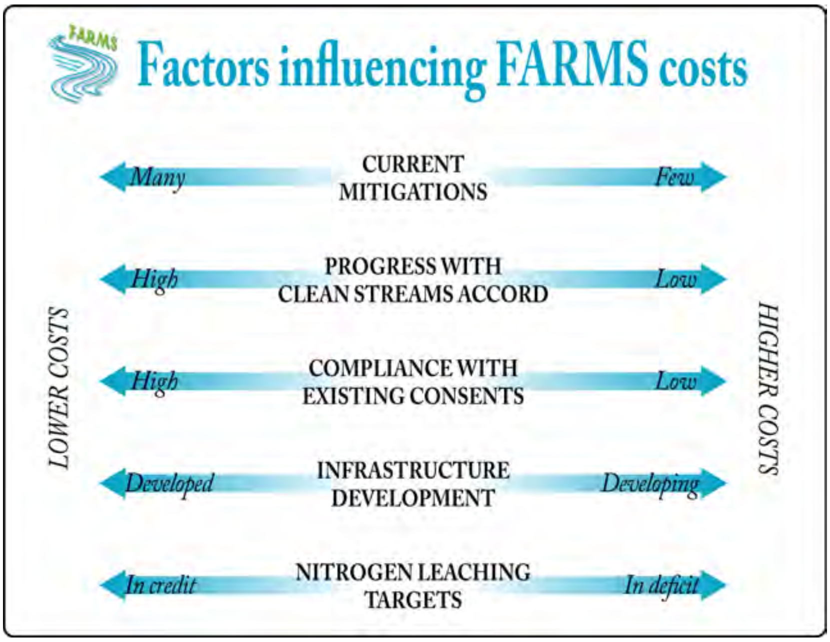


Figure 2: Variables that are likely to impact on the cost of implementing a FARM Strategy

Summary and key conclusions

Lower than expected N-leaching losses were explained mostly by the type and quality of information used to build an OVERSEER® model, which has implications for the consistent region-wide application of FARMS. Suggestions to achieve consistency are discussed in Part 2.

Case study farms with higher capability land had more generous N-loss limits. The majority of intensive farms in the Manawatu-Wanganui (>70%) appear to have a similar predominance of high class land, and are therefore likely to attract similarly generous N-loss limits. Conversely, hill country farms with low capability land are likely to attract less generous N-limits.

Farming within N-limits would be achievable for all the case studies. Half the cases would need to decrease their farm's N-leaching losses by 1-6 kg N/ha, while the other half were in credit by 1-9 kg N/ha. None required major changes to their farming systems to achieve N-targets. Generally the targets were readily accommodated by fulfilling other requirements such as existing consent conditions, Clean Streams Accord obligations, other Rule 13.1 requirements, or by adopting supplementary mitigation practices such as N-inhibitors. Fewer mitigation practices are available for lower intensity land uses such as sheep and beef.

Similar results are expected for most pastoral livestock farms in the Region, particularly those in traditionally intensive areas, and those operating at average to above-average levels of production. Possible exceptions may include ultra-intensive operations, new intensive uses venturing into traditionally marginal landscapes, and areas with particularly high-risk combinations of land use and environment. Identifying these areas is discussed in Part 4.

Twenty-year N-targets would also be achievable for the case studies, albeit slightly more challenging because of reductions in N-loss limits. Farms with generous Year 1 N-loss targets will need to make greater reductions over the 20 years relative to farms with not so generous Year 1 targets. However, the degree of achievability will be dependent on long-term rates of intensification relative to the advancement of N-mitigation practices, both of which are difficult to foresee over 20 years.

Farming within N-targets has only minor financial implications for the case studies. Most would achieve their targets by fulfilling Clean Streams Accord obligations and 'other' Rule 13.1 requirements. However, costs associated with these other obligations and requirements were high, often disproportionately, particularly for cases failing to meet existing consent conditions (mainly around effluent disposal), and those with lower levels of infrastructure development. Properties that had already invested in expensive capital items as a normal part of farm development tended to incur lower compliance costs. It is suggested that proactive and more environmentally aware farmers that have well developed farms are least likely to incur higher costs.

Other Rule 13.1 requirements represent the single largest cost, although there is much uncertainty regarding expensive capital items (e.g. bridges, extensive riparian fencing, sealed silage storage) because of inconsistency or ambiguity regarding the interpretation of both One Plan and FARMS Workbook specifications, particularly as they apply to less intensive farms and farm blocks. If case study implementation costs are higher than those deemed acceptable for controlling freshwater contamination, then it is recommended that the Council seek to clarify or review those FARMS requirements that may involve expensive capital investments.

In summary, the FARM Strategy approach appears to be a workable solution to an otherwise difficult problem. Application difficulties were encountered, but they were not overly challenging and potential improvements are discussed and recommended (Part 4). Farming within N-limits would definitely be achievable for all of the cases examined, and it is expected that this finding will be transferrable to most of the Region's intensive pastoral farms. Exceptions should be closely scrutinised as they potentially represent high risk farms. Similarly, major farming changes, such as reduced stocking rates, would not be envisaged for most farms. Many lower-impact contaminant minimisation options are available. As such, the cost of farming within N-limits is most likely to be a minor consideration. However, costs to achieve compliance with other Rule 13.1 requirements could represent significant capital investments, particularly on less developed farms.

PART 2. REPORTING FORMATS AND PREPARATION GUIDELINES

Introduction

This project required each case study report to align with the design and formatting of SLUI Whole Farm Plans. These are comprehensive designs, which are well suited as a foundation for investigation purposes. However, a comprehensive design is less suitable for the regular preparation of FARM Strategies.

Guidelines and recommendations are provided for the design of three levels of FARM Strategy, including a *minimum design*, a *medium design*, and the *comprehensive design* used in the case studies. Important specifications are included to promote a fair and consistent reporting approach. Also, please refer to Appendix 7.1 for additional FARMS preparation insights and considerations.

Case study reports vs. SLUI whole farm plan designs

Case study reports were prepared with a similar design structure to SLUI Whole Farm Plan prototypes. This required extensive use of maps to convey a lot of information succinctly, which in turn pre-necessitated the generation of digital inventories for use in a GIS (Geographic Information System) environment. Graphic design was undertaken to promote reader understanding and interest. Digital size of each report was minimised by linking and compiling maps, graphics and text in dedicated publishing software. GIS databases and graphics used for each case study are available to the Regional Council if required.

Content dissimilarities between FARMS and SLUI reports reflect the nature of the issues examined, and an exact match between the two could not be achieved (e.g. different headings and slightly different sections). However, general content adhered to a structure of description → issue assessment → evaluation of options to address issues → recommendation and strategic planning.

Recommended industry guidelines for preparing FARM Strategies

Three approaches are recommended for the preparation of FARM Strategies. This is based on the idea that most farms will be able to prepare a FARM Strategy quickly and easily, but recognises that some will have an interest in undertaking more detailed assessments.

Note that FARM Strategies are first and foremost a report prepared for the regional council. While guidelines are adaptable, FARM Strategies presented as part of a resource consent application should not contain information that is erroneous to the consent itself. Farmers pay for their consents to be processed, and having a consent planner study, for example, a fertiliser recommendation, could be considered as an unnecessary expense. It is therefore recommended that information that is extra to FARM Strategy requirements either be appended or produced as a section that can be removed, or conversely, that the Strategy is included as an extractable appendix as part of a different farm report (e.g. a fertiliser recommendation).

'Minimum' level FARM Strategies

Minimum level FARM Strategies are recommended in most cases. An example is provided as Appendix 7.11, which has been built around reporting styles similar to those used in some fertiliser-recommendation reports. Suggested components (Figure 3) include:

1. **Concise summary**: Provided at the start of the report. A short overview is important, as the intended audience will include people who are unlikely to know anything about the farm in question. Likewise, the summary should be written as a standalone document because not everyone will read the full report. Critical questions to answer include:
   - When does Rule 13.1 come into effect for the farm?
   - What are the 20-year One Plan N-leaching limits for the farm? From what source were the LUC classifications obtained to calculate N-leaching limits?
   - What is the predicted N-leaching loss from OVERSEER®? Is it high or low? Is a reduction needed for compliance?
   - What is the P-loss risk?
   - How can contaminant risks/losses be reduced? What contaminant-mitigation practices are applicable, and what degree of N-loss mitigation can be expected? What are your recommendations to achieve One Plan compliance for Year 1 permissible N-limits? Would longer term N-targets be a challenge for the farm?

- Are there any other FARMS Workbook items that are non-compliant? If yes, what needs to be done? What are your recommendations?

2. **Introduction**: General overview of why the report has been prepared, including purpose.
3. **Clean Streams Accord status (dairy only)**: An assessment of progress towards achieving Clean Streams Accord requirements[8].
4. **Farm description**: Rich description of the farm system. Provides an opportunity for the farm owner or manager to check the correctness of base information. Also gives readers who may be unfamiliar with the farm a degree of context regarding environment, management, land use, performance, intensity and problems. The farm description should include:

   a) Legal description: Legal description of property parcels, including legal areas, both for resource consent purposes, and a check of farm areas used for OVERSEER® modelling.

   b) Property map: Locates all features relevant to FARMS Workbook specifications, including the farm boundary, waterways, water-bodies, active offal holes, active farm dumps, public roads, residences, public buildings, recreation areas, bores, and water takes (see the Workbook for full specifications). Feature identification should extend ~200m from the farm boundary.

   c) Annual rainfall average supplied from Horizons Regional Council.

   d) Nutrient management blocks: Different parts of the farm categorised into blocks for OVERSEER® modelling[9]. Minimum blocks include all non-pastoral land, pastoral land, and effluent spreading areas (if dairy). Nutrient management blocks can be depicted on the Property Map (see example Appendix 7.11).

5. **Contaminant status and OVERSEER® modelling**: A report on OVERSEER® nutrient budgeting and comparison of current N-leaching losses against permissible N-leaching losses. Should include:

   a) OVERSEER® modelling results for N-leaching and P-runoff risk.

   b) Brief discussion on other contaminant risks, particularly faecal bugs and sediment.

   c) Map showing regional Land Use Capability classification for the property (and measured areas of each LUC classification). This can be extracted from the NZ Land Resource Inventory (NZLRI) database[10].

   d) One Plan permissible N-leaching limits for the farm (calculated from LUC classes and One Plan class N-loss limits).

   e) Comparison and discussion of current vs. permitted N-leaching losses for Year 1. Discussion of longer-term implications (20 years).

6. **Contaminant minimisation strategies**: Identification of N-minimisation options relevant to the farm in question, and recommendation of a suite of options to achieve Year 1 N-

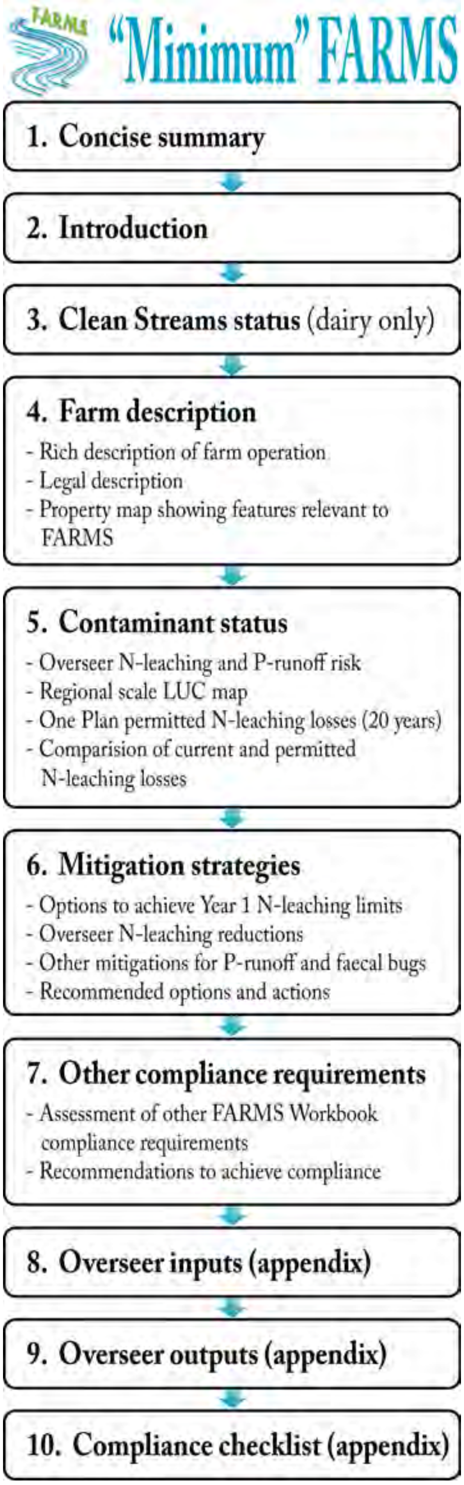


Figure 3: Suggested components of a "Minimum" level FARMS Strategy

[8] See www.mfe.govt.nz/issues/land/rural/dairying.html for Clean Streams Accord requirements and specifications.
[9] Creating farm nutrient management blocks is described in the Code of Practice for Nutrient Management (www.fertresearch.org.nz).
[10] NZLRI database can be sourced from Landcare Research Ltd.

leaching limits as modelled through OVERSEER®. Discussion on mitigation options for other priority contaminants.

7. **Other One Plan compliance requirements**: Identification of other Workbook compliance requirements (offal holes, water takes, etc.), highlighting non-compliant items, and providing recommendations on how compliance can be achieved. A checklist approach was particularly useful during the case studies (see Appendix 7.11 for example).
8. **OVERSEER® inputs appendix**: Summary of all input information and assumptions used for OVERSEER® modelling. Should include explanations if OVERSEER® defaults have been altered. The summary will permit the exact reconstruction of the OVERSEER® model built for the farm.
9. **OVERSEER® outputs appendix**: OVERSEER® generated reports for checking. Should include Nutrient Budget tables (for all blocks, and the whole farm), Nitrogen Report, Effluent Report (if dairy), and the Block Nitrogen Report.
10. **Compliance checklist appendix**: Recommended that a checklist be included so property owners have a summary of One Plan compliance requirements for future reference.

The suggested 'minimum' level structure can be adapted, provided the key questions are answered (see 'Concise Summary' above). Information quality should be paramount throughout, and the following standards are recommended:

- ⇨ Total farmed area should be used for both OVERSEER® modelling and the calculation of permitted N-leaching limits (see Appendix 7.7).
- ⇨ All maps should be 'true to scale', and created electronically in dedicated mapping software (e.g. GIS, farm mapping software). Precise measurement is important for OVERSEER® modelling (particularly effluent areas and non-pastoral land area), calculation of N-leaching limits from LUC areas, calculation of One Plan separation distances, and the measurement of fenced and unfenced waterways.
- ⇨ Presenting a Land Use Capability map is suggested as a requirement aimed at discouraging LUC being reported by nutrient management blocks.
- ⇨ Only rainfall averages supplied by Horizons Regional Council should be used for OVERSEER® modelling. Rainfall can have a marked influence on modelled N-loss, so it is therefore important that the rainfall input parameter comes from one consistent source.
- ⇨ Nutrient budgeting using OVERSEER® software should only be undertaken by approved operators. 'Approval' can be obtained as post-graduate certification[11], or via special approval by Horizons Regional Council (in recognition that some experienced nutrient management experts already have equivalent qualifications and credentials).
- ⇨ All OVERSEER® input parameters and assumptions, plus any parameter changes from OVERSEER® default settings, should be reported in an appendix and signed off by the consultant and farmer as being true and correct at the time of modelling. Changes to default settings should be justified with an explanation. This requirement is intended as a quality-assurance protocol to discourage the intentional provision of misinformation, or the manipulation of OVERSEER® to return distorted N-leaching loss results.
- ⇨ All relevant OVERSEER® output tables should be appended, particularly the inclusion of nutrient budgets for each block. This provides the Council with an opportunity to quickly check the validity of the nutrient budgeting. However, it also requires Council staff to understand the nutrient budget reports.

Issues behind these recommendations are discussed further in Part 4.

[11] For example, Massey University offers Intermediate and Advanced Sustainable Nutrient Management post-graduate courses that specialise in the use of OVERSEER. See http://flrc.massey.ac.nz/

Medium level FARM Strategies

Medium level FARM Strategies are recommended when increased confidence is required. The same general structure of the 'Minimum' level strategy is used (Figure 3), with the following provisions:

- ⇨ Either regional LUC is verified, or a new farm-scale LUC classification is undertaken. Regional LUC were largely classified using remote techniques, and may not therefore be fully correct for farm-scale applications (scale effects – see Part 3). Verification entails a site visit to check regional classification correctness and make amendments if necessary, while a farm-scale classification requires a new field survey according to updated mapping and classification techniques[12]. LUC classification and verification should only be accepted from qualified and experienced surveyors.
- ⇨ LUC classifications can be 'adjusted' one class for irrigated land. Again, these adjustments should only be undertaken by a qualified and experienced LUC surveyor.
- ⇨ The inclusion of a basic budget (cost estimates) regarding investment in capital works (e.g. fencing, culverts) and adoption of straightforward mitigation practices (e.g. switching to urease-treated urea). More in-depth production and economic assessments should be reserved for comprehensive level strategies (see below).
- ⇨ A works map and five-year planning schedule should be required. Works maps show where recommended FARM Strategy activities are to be undertaken, while a planning schedule details what activities are required and when they should be implemented.

Comprehensive level FARM Strategies

Comprehensive level FARM Strategies are only recommended in certain circumstances, such as dairy conversions, complicated enterprise mixes, or for ultra-intensive farms where achieving One Plan N-loss limits may be challenging. For examples the reader is referred to the Case Study Reports. The key difference is the depth of investigation, and a greater emphasis on whole farm sustainability through integration of economic, production, environment and farmer circumstance considerations. There is no set recipe for a comprehensive level strategy. Differences could include:

- ⇨ The use of auxiliary models and calculations to further assess contaminant risk and potential mitigation effectiveness, particularly in relation to P-runoff risk in certain landscapes, sediment losses, and certain nutrient processes not yet fully accounted for in OVERSEER® under certain land uses.
- ⇨ Production and economic evaluation by a qualified farm business consultant to design new or modified farming systems when N-limits are particularly challenging or new land uses are proposed.
- ⇨ Evaluation and integration of new or novel contaminant mitigation technologies if and when they arise.

Preparation cost estimates

Preparation costs for comprehensive level strategies can be estimated with confidence (because the case-study reports represent comprehensive strategies). Estimates for other levels are more difficult because there are few examples to work from, and it is not yet clear what type of services will be made available from the regional council (e.g. information supply) and industry (e.g. fertiliser companies).

Cost estimates have been aggregated under general headings for reporting purposes. In part this protects commercial sensitivity requested by service providers who provided cost estimate quotes.

[12] GB Douglas, GR Harmsworth, IH Lynn, A Mackay, A Manderson, PFJ Newsome, MJ Page, A Burton, D Cameron, B Cathcart, G Cooper, T Crippen, J Cuff, G Eyles, P Fantham, D Hicks, J Loveridge, N Ngapo, D Shearman, S Stokes, M Todd, and R Van de Weteringh, (2008). Updating the Land Use Capability Survey Handbook. Envirolink Tools AGRX0604, project for Horizons Regional Council.

Minimum level preparation costs

Cost estimates presented in Table 4 assume that Horizons provides information concerning legal descriptions, aerial photography, and regional LUC map with pre-calculated permitted N-loss. The remainder is undertaken by a service provider. Cost to prepare a minimum level FARM Strategy is estimated at approximately $1,500.

An alternative scenario where a fertiliser company undertakes nutrient budgeting and mitigation assessment as an added value service, and the farmer undertakes their own farm mapping and report writing, could result in zero expenditure (i.e. without factoring in farmer's time).

Table 4: Preparation cost-estimate for minimum level FARMS

Base information (aerial photo, legal descriptions, etc.)[a]	$	0
Information collection via farm visits and farmer interview[b]	$	500
OVERSEER® modelling (base model + mitigation scenarios)[c]	$	200
Compliance assessment (Workbook specifications)[d]	$	200
Farm mapping and map preparation[d]	$	150
Report preparation[d]	$	500
Total	$	1,550

[a] Assumed supplied gratis by Horizons
[b] Dependent on travel costs
[c] Conceivably this would incur no cost as part of an added value service provided by fertiliser companies
[d] Nil financial outlay if these activities undertaken by farmer

Medium level preparation costs

The only significant change from minimum level costs would be the addition of regional LUC verification (~$500/farm) or farm-scale survey ($1,500 to $3,000 depending on the property), and extra time for budgeting, map preparation, and scheduling of activities (combined total of an extra $300 to $500). Cost to prepare a medium level FARM Strategy is estimated at approximately $2,300 to $5,000.

Comprehensive level preparation costs

Costs for preparing a comprehensive level FARM Strategy have been estimated from the case-studies (less research specific costs) at approximately $10,600 (Table 5). Depending on character of the farm (area, complexity, location) and the reason for preparing a comprehensive level strategy, cost could be expected to vary by approximately +/-10%.

Table 5: Preparation cost-estimate for comprehensive FARM Strategies

Base information (aerial photo, legal descriptions, etc.)	$	850
Information collection via farm visits and farmer interview[a]	$	1,500
Farm-scale LUC classification[b]	$	1,750
OVERSEER® modelling (base model + mitigation scenarios)	$	200
Compliance assessment (Workbook specifications)	$	450
Economic implications assessment	$	1,000
Auxiliary assessments	$	1,500
GIS/farm mapping and map preparation	$	2,875
Report preparation	$	500
Total	$	10,625

[a] Dependent on travel costs
[b] Dependent on farm size and landscape complexity. For an average dairy farm survey cost may vary between $1,500 to $3,000.

Summary and conclusions

Suggested guidelines have been presented for the preparation of FARM Strategies according to three levels of minimum, medium and comprehensive. Minimum level strategies are likely to suffice in most cases, with medium and comprehensive levels retained for complicated and/or challenging farm operations.

Preparation costs are estimated at approximately $1,500 for minimum level FARM Strategies, between $2,300 to $5,000 for medium level strategies depending on the nature of the farm, and over $10,000 for comprehensive strategies that require deeper investigations and expert input.

Depending on services made available by the regional council and fertiliser companies, it is conceivable that a minimal level FARM Strategy could incur no direct financial cost to the farmer (other than the farmer's time).

PART 3. COMPARISON OF N-LOSS LIMITS CALCULATED AT TWO SCALES OF LAND USE CAPABILITY CLASSIFICATION

Introduction

The FARMS workbook specifies the calculation of N-loss limits using the Land Use Capability (LUC) system of land classification. This ranks the capability of land to sustain productive agricultural uses into one of eight classes, with Class 1 representing elite land suitable for arable and other intensive uses, through to Class 8 for land that is completely unsuitable for agriculture (mountains, bluffs, etc.).

Regional scale LUC classifications are readily available (1:50,000 scale) as the NZ Land Resource Inventory (NZLRI) Worksheets and Database. At this scale LUC is generalised, and is not usually considered appropriate for application at the property scale level. In contrast, property-scale LUC provides a higher quality and more representative classification for individual farms, and should therefore be the preferred choice of LUC when calculating One Plan N-loss limits. However, property-scale LUC classifications are less common, especially for flatter intensely farmed areas, and new surveys can be expensive to undertake (see Part 2 for cost estimates).

Study purpose is to evaluate implications of calculating One Plan N-loss limits using regional and property-scale Land Use Capability classifications.

Method

Regional-scale LUC extracted from the NZLRI database according to the extent of each case-study farm. Full LUC units were categorised back to the LUC Class level, and a 1:1 relational join was used to link One Plan N-loss limits (Table 6). Total permitted N-loss was calculated for each polygon, and then averaged according to total farm area for reporting.

Table 6: One Plan N-loss targets for LUC classes

	Permitted N-leaching losses (kg N ha^{-1} yr^{-1})							
	LUC 1	LUC 2	LUC 3	LUC 4	LUC 5	LUC 6	LUC 7	LUC 8
Year 1 (when Rule 13.1 comes into effect)	32	29	22	16	13	10	6	2
Year 5	27	25	21	16	13	10	6	2
Year 10	26	22	19	14	13	10	6	2
Year 20	25	21	18	13	12	10	6	2

Property-scale LUC necessitated field survey to collect new information according to standards for soil survey[13] and LRI/LUC survey[14]. A strong soil survey emphasis was required in most cases because soil properties are often the single greatest determining factor for flat land LUC classification. Two case studies were surveyed by the author, and the remainder by LandVision Ltd. Results were digitised into a GIS to calculate whole farm N-loss limits.

Owing to the limited number of samples for comparison, a desktop study was undertaken to compare N-loss limits calculated using SLUI whole farm plan LUC classifications (Year 1 plans) and regional equivalents. While these particular property-scale classifications are bias towards extensive land uses (namely hill country sheep and beef), they represent an alternative comparison for consideration.

Farms with irrigation were subjected to one further evaluation. Irrigation spread patterns were calculated and used to improve LUC classifications by an entire class on the basis that irrigation overcomes a key limitation, thereby improving the capability of land. Implications are discussed.

[13] Taylor, N.H. Pohlen, I.J 1979: Soil Survey Method. New Zealand Soil Bureau Bulletin 25.
[13] Milne, J.D.G.; Clayden, B.; Singleton, P.L.; Wilson, A.D. 1995: Soil description handbook. Lincoln, Manaaki. Whenua Press. 156 p.
[14] Soil Conservation and Rivers Control Council 1971: Land use capability survey handbook. 2nd Edn. Wellington, Water and Soil Division, Ministry of Works and Development. 138 p.

Results and discussion

Case study results

Maps to show differences in detail between the two scales of LUC classification are presented on the following pages (Maps 2 to 8). Opportunity was taken with the first case study to include an intensive survey (1:3,000 scale) to more fully evaluate implications.

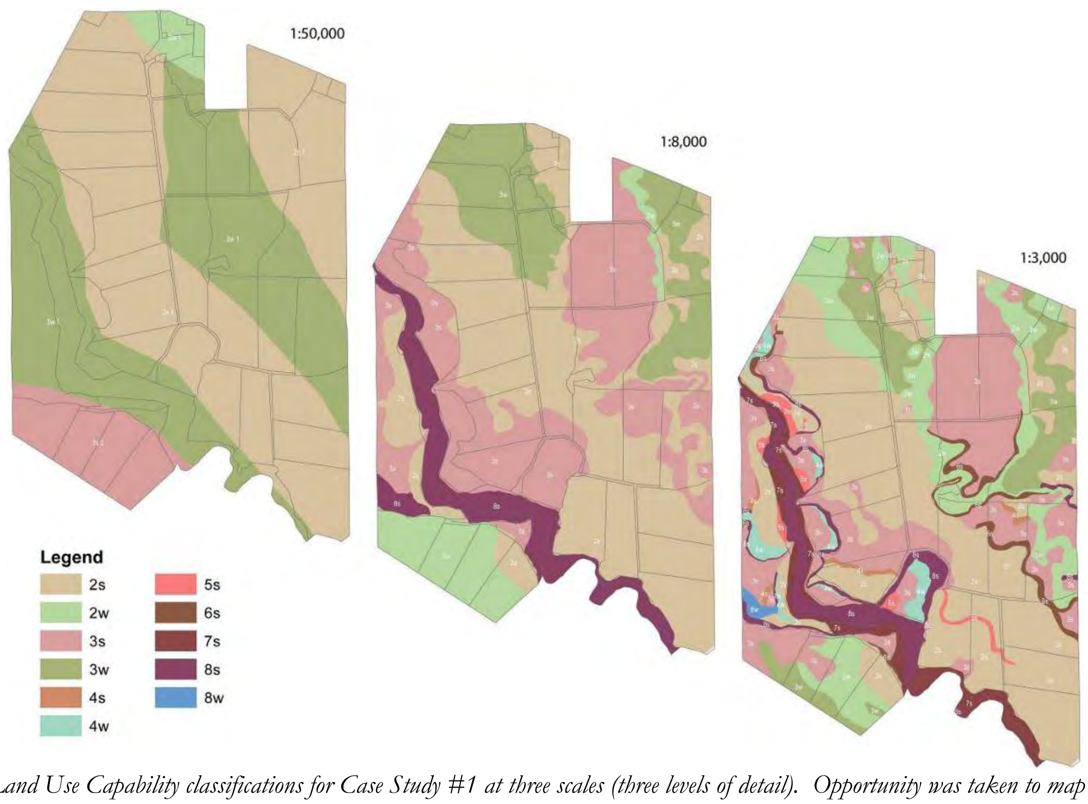
There are marked visual differences between the two scales of mapping. Regional scale classifications tend to be more generalised, less precise regarding boundary placement, and outright misclassified in many cases. The effect on calculated One Plan N-loss limits is shown in Table 7. Values are for year-1 N-limits, rounded to the nearest whole number to be consistent with the level of precision used by OVERSEER®.

Table 7: One Plan N-loss limits calculated for each case study at two scales

	One Plan N-loss limits for each farm (kg N/ha/yr)			
	Regional scale	Property scale	Difference**	% Difference
Case study #1: Irrigated Dannevirke dairy farm*	26	24	-2	-8%
Case study #2: Rain-fed Hukanui dairy farm	23	20	-3	-13%
Case study #3: Rain-fed corporate sand-country dairy and drystock farm	25	24	-1	-4%
Case study #4: Rain-fed Pahiatua sheep and beef farm	10	11	+1	10%
Case study #5: Proposed Pahiatua dairy conversion	12	13	+1	8%
Case study #6: Irrigated mixed enterprise agribusiness near Marton	25	25	0	0
Auxiliary example	14	18	+4	29%

** One Plan N-loss limited calculated from 1:3,000 scale was 23 kg N/ha/yr*
*** A positive difference indicates when it would be advantageous to use property-scale mapping, and negative values indicate when regional mapping would be more advantageous.*

Differences are mostly significant, although variable. For case study 1, it would be in the farmer's best interest to opt for regional-scale mapping, because this would permit an N-loss leaching allowance that is 8% more generous than that calculated using property-scale classifications. The main reason why this particular farm has different N-limits is that property-scale mapping identified a large area of low class river land, which was not picked up in the regional classification (Map 2).



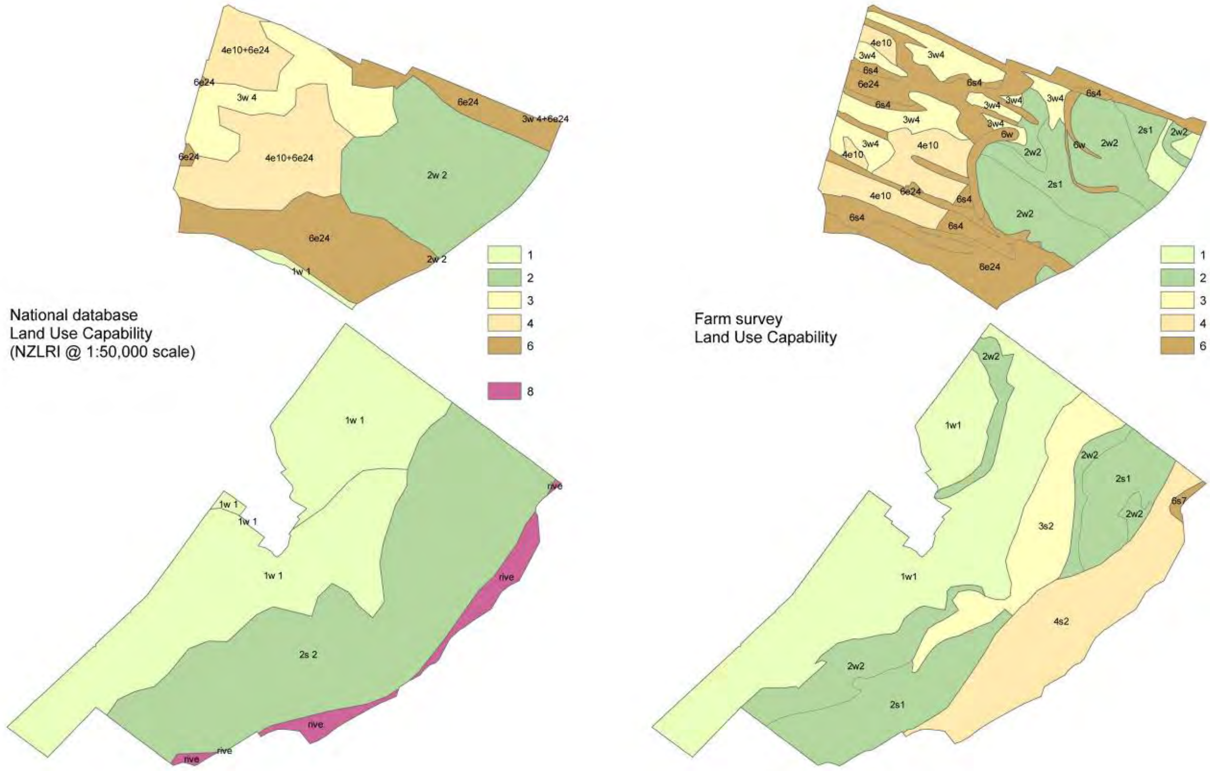
Map 2: Land Use Capability classifications for Case Study #1 at three scales (three levels of detail). Opportunity was taken to map at a highly intensive scale (1:3,000) for a more full assessment of scale implications.

Also shown in Map 2 is LUC classes at an intensive scale (1:3,000). This level of detail required an extra two days in the field. While it presents a much improved representation of farm LUC (and soils), the effect on One Plan N-limits was a minor (1 kg N/ha/yr difference relative to 1:8,000 the classification) and did not fully justify the extra survey effort. In this case, 1:8,000 scale is more than adequate for property scale mapping and N-limit calculation.

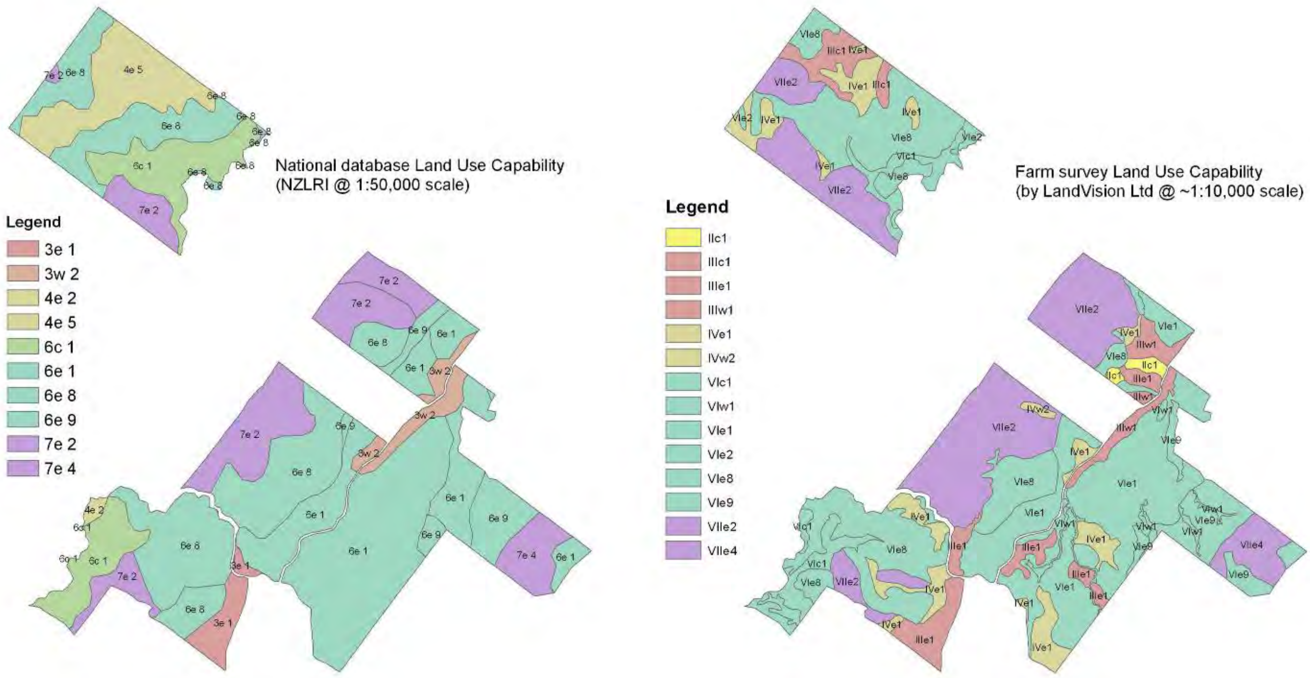
Similar relationships are evident for the remainder of the case studies (Maps 3 – 8). Property-scale mapping produced a much improved representation of farm LUC, but the effect on One Plan N-limits was variable. Where inclusions of better land were identified, N-limits were improved in favour of the farmer, while the identification of small areas of lower class land (e.g. patches of poorly drained, stony, gullied areas) made N-limits less permissible.

Regional classifications vary in detail and quality, as do property-scale classifications (dependent on terrain, surveyor capability, resourcing and time). It cannot be stated categorically, that having a property-scale classification prepared for N-limit calculation purposes, will be more advantageous in terms of allowing a more permissible N-loss limit. Results suggest it could be better or worse and dependent on the farm in question.

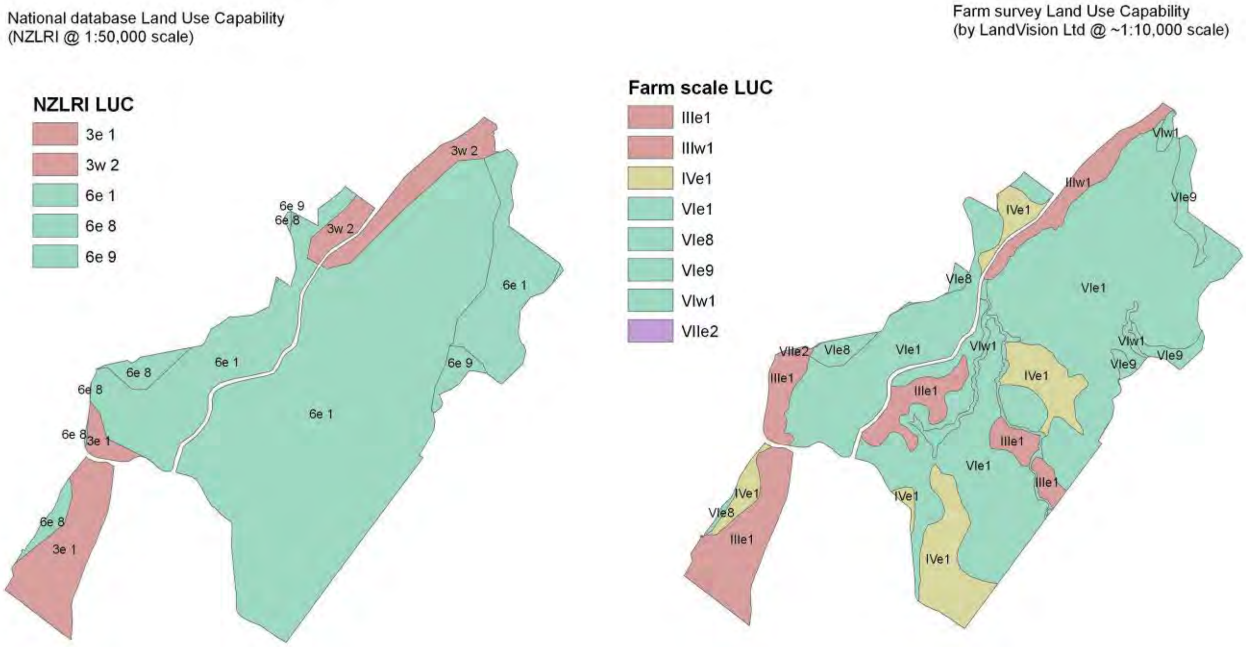
Map 3: Land Use Capability classifications for Case Study #2.



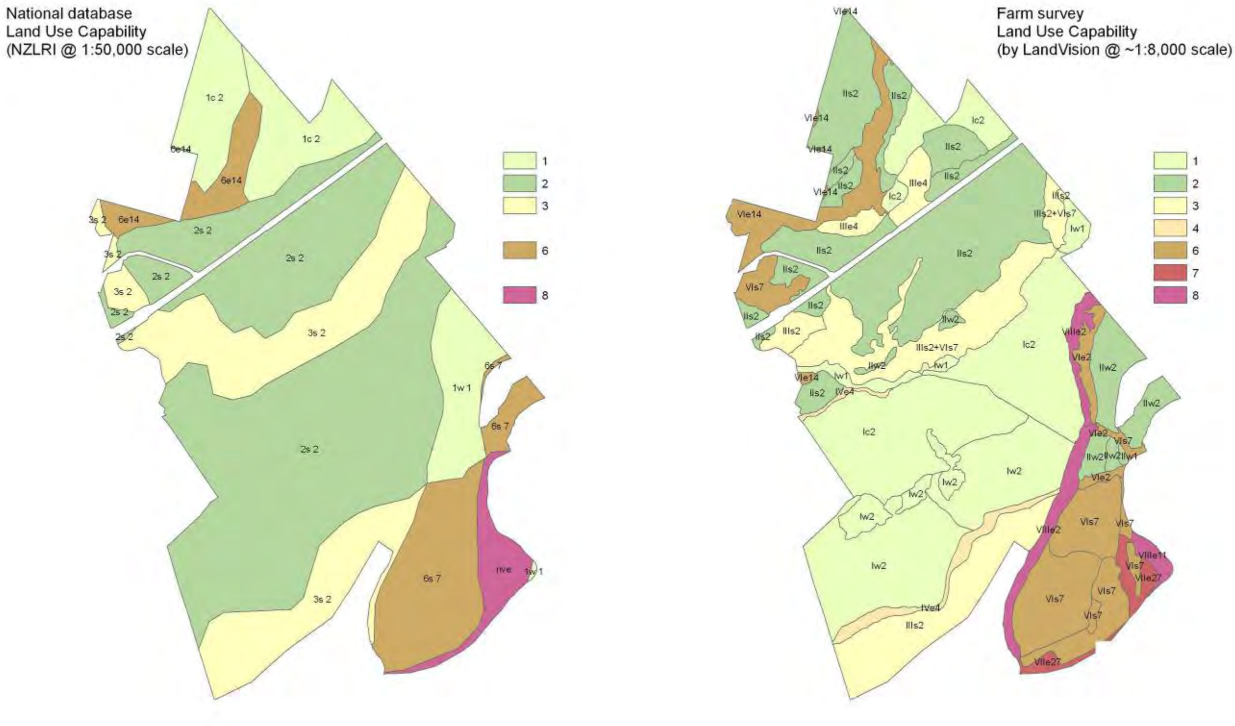
Map 4: Land Use Capability classifications for Case Study #3.



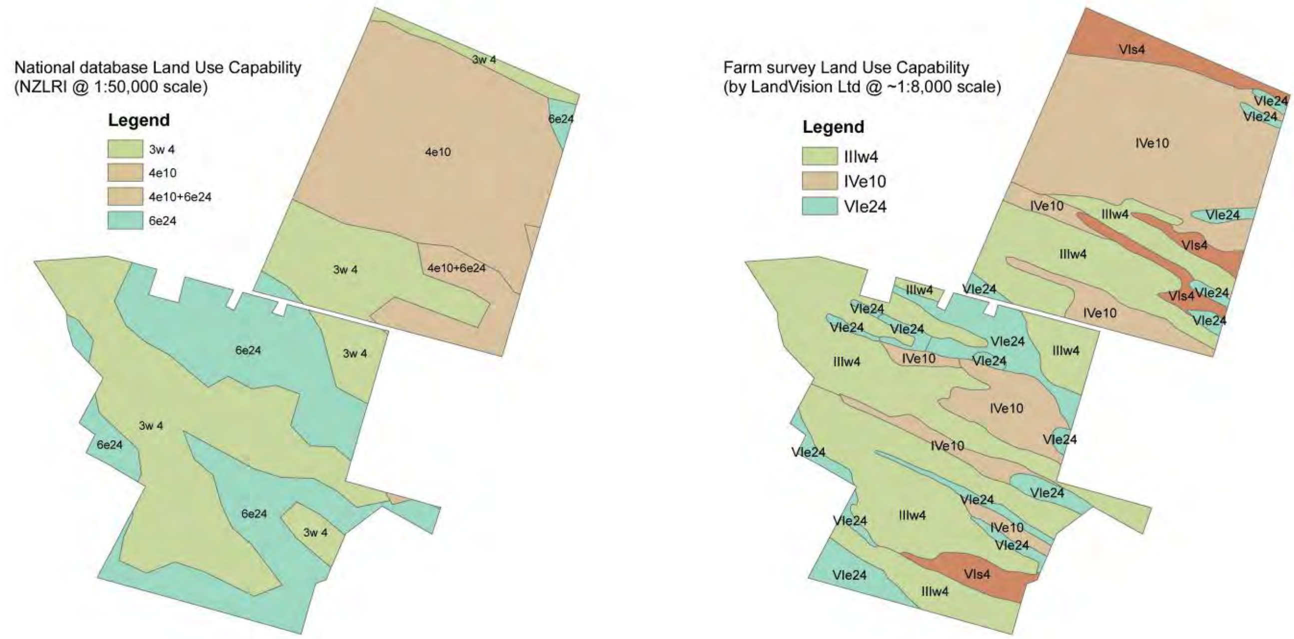
Map 5: Land Use Capability classifications for Case Study #4.



Map 6: Land Use Capability classifications for Case Study #5.



Map 7: Land Use Capability classifications for Case Study #6.



Map 8: Land Use Capability classifications for one of the farms that withdrew from the project.

Overcoming permanent limitations

Under the Land Use Capability system, land with few limitations for agricultural use will have high capability, while land with many limitations, or difficult to manage limitations, will have lower capability. Limitations such as stoniness, droughtiness, climate, flooding, drainage, and erosion are explicitly recognised, and surveyors are encouraged to consider other limitations when classifying LUC.

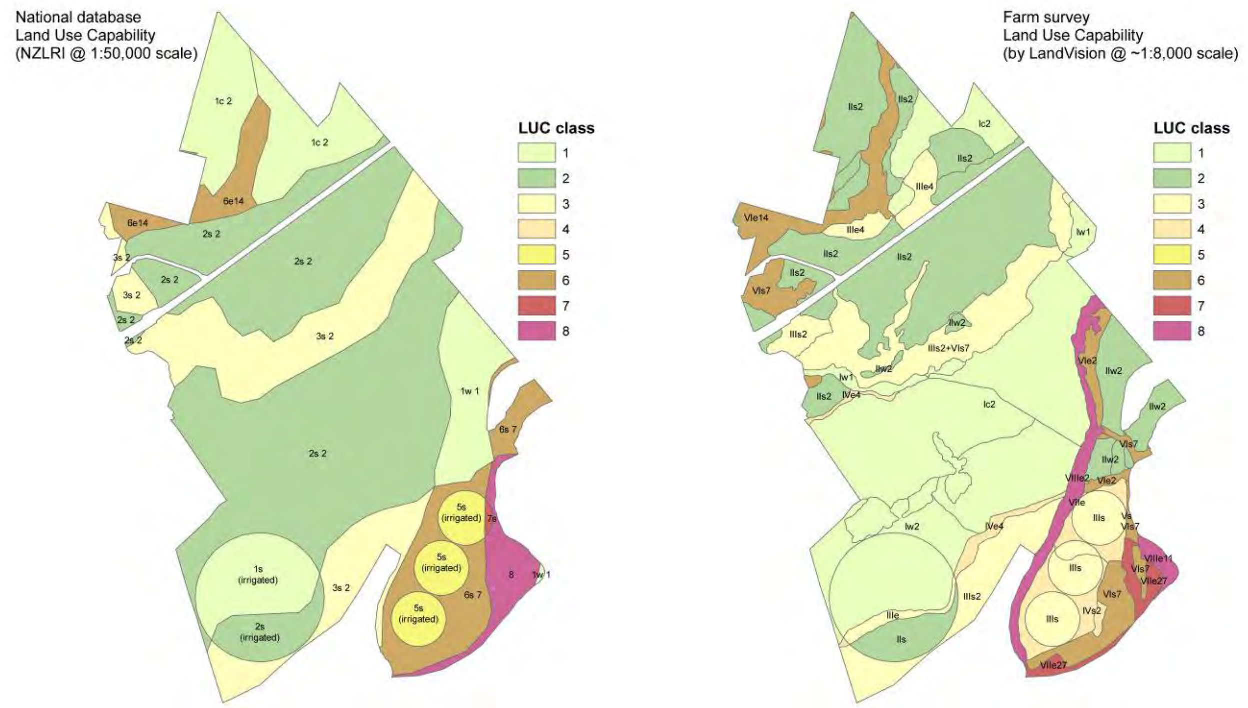
The principle becomes vague and difficult to apply when the limitation can be removed or overcome. For example, land can be artificially drained, irrigated, stone picked, protected from flooding, and so on. It can be argued that removing a limitation increases the productive capability of land, and the associated LUC classification should therefore be improved. However, some counter by stating that LUC should only change if the limitation is permanently removed. This is rarely a concern when major physical changes are made (stone picking, drainage networks). However, it does become a problem when deciding if localised irrigation (e.g. farm irrigation) represents the permanent removal of the droughtiness limitation.

Adjusting LUC by one class (e.g. from LUC class 4 to class 3) has implications for calculating N-loss limits, particularly when irrigated land represents a significant area of the property (Table 8 and Maps 9-10). In effect, each farm would be permitted a higher N-loss limit (although the difference does not show for regional scale classification of case study #6 because of the precision level). Differences are minor when only a small proportion of the farm is irrigated (Case study #6), but major when a large proportion of the farm is irrigated (the auxiliary example would be permitted to leach up to 26% more nitrogen using N-limits calculated from regional LUC).

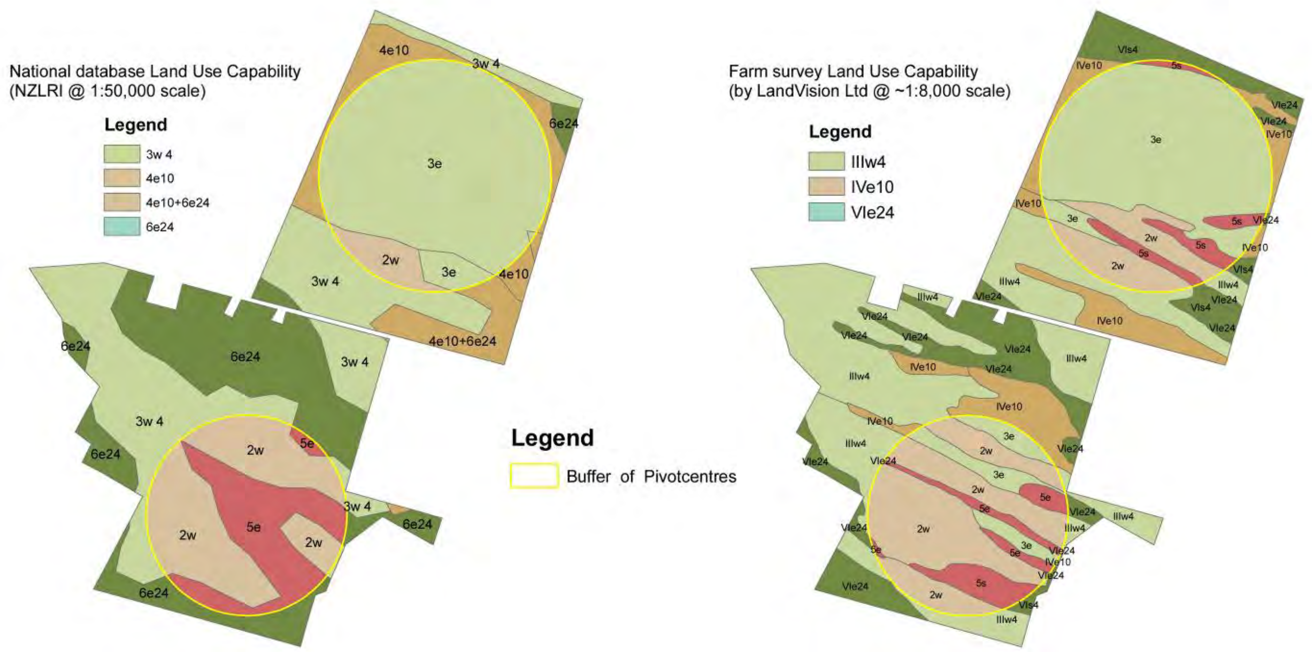
Table 8: Effect on N-limit targets by increasing land capability under irrigation

	One Plan N-loss limits (kg N/ha/yr)	
	Regional scale	**Property scale**
Case study #6 unadjusted	25	25
Case study #6: 12% of total farm area irrigated	25	26
Percent difference	0	4%
Auxiliary example unadjusted	14	18
Auxiliary example: 47% of total farm area irrigated	19	20
Percent difference	26%	10%

Horizons may wish to consider allowing for the adjustment of LUC for land under irrigation as part of FARM Strategy protocols. Results presented here should be considered against new standards and guidelines for classifying LUC currently being prepared as the LUC Handbook update[15], and how these changes may affect application of the FARM Strategy approach[16]. Presumably the concept of permanent limitations as they relate to localised irrigation will be clarified.



Map 9: Land Use Capability classifications for Case Study #6 adjusted for irrigation.



Map 10: Land Use Capability classifications for one of the farms that withdrew from the project (adjusted for irrigation).

15 Updating the Land Use Capability survey Handbook, Envirolink Tools contract AGRX0604.

16 Mackay, Clothier, B., Gray, R., Green, S. 2008. Implementation of FARM strategies for Contaminant Management. Further questions. A report by SLURI for Horizons Regional Council, May 2008 pp 108.

One Plan N-Loss Limits for SLUI whole farm plans

A desktop study was undertaken to compare N-loss limits calculated using a number of SLUI whole farm plan LUC classifications (34 separate farm-scale classifications) and regional equivalents (Appendix 7.12).

Results suggest that there is little advantage in opting for farm-scale LUC classification for calculating One Plan N-loss limits <u>for hill country farms</u>. Differences on average are almost insignificant (well less than 1 kg N/ha on average), and do not therefore justify the extra cost of commissioning farm-scale surveys on a wholesale basis. However, occasionally large differences (between +3 and -5 kg N/ha) suggest that farm-scale LUC may have important implications for the calculation of N-loss limits for some hill country farms.

SLUI whole farm plans are generally prepared for extensive hill-country properties, so results are not applicable to the intensive farms targeted under Rule 13.1.

While there is variation between LUC percentages for each SLUI farm, it can be expected that regional-scale hill-country LUC will be more similar to farm-scale hill-country LUC simply because landforms are the defining criteria for hill-country LUC classification, and landforms are easy to recognise at both scales. In contrast, soils are often the most defining criteria for intensive-farm LUC classification. Regional LUC is more likely to be misclassified for intensive land because soils are less easy to recognise (cf. landforms), and few areas in the Manawatu-Wanganui Region have farm-scale soil surveys[17]. In short, we would expect a higher degree of difference between N-loss limits calculated using regional and farm-scale LUC classifications for a similar sized sample of intensive farms.

Conclusions

For most of the cases it appears that property-scale mapping will have an effect on the calculation of N-loss limits.

Whether the effect is positive or negative is dependent on the farm in question. Opting for property-scale mapping may result in N-loss limits that are either more permissible or more constrictive.

Regional-scale LUC classifications appear to be adequate for calculating N-loss limits for hill country farms. However, as with the case study farms, differences for some farms can be considerable.

Assigning higher capability classes for irrigated land is rational, and will make N-loss limits more permissible particularly when irrigation is practiced across a large area of land.

Recommendations

That Horizons retain the current option available to farmers for calculating One Plan N-loss limits; namely that initial limits be calculated using regional scale LUC, but with the option for farmers to have property-scale LUC prepared if they wish to do so. It should be at the farmer's discretion to choose which N-limits are used for FARM Strategy purposes.

That any decision regarding LUC adjustment for irrigated land be deferred until the experts have addressed the issue in the LUC Handbook update. If it is not adequately addressed, then the recommendation is to allow LUC adjustment at Council discretion, and such adjustments should only be made by a qualified surveyor (effectively requiring a property-scale LUC classification).

[17] Horizons have commissioned an Envirolink-funded review of soil and land information resources available in the Manawatu-Wanganui Region, and an evaluation of how useful this information may be for SLUI and FARMS initiatives.

[17] Hewitt, A., Manderson, A., Willoughby, J., Wilde, H., & Hammam, Y. 2008. Assessment of available soil and resource information for the Manawatu Wanganui Region. Landcare Research and AgResearch.

PART 4. RECOMMENDATIONS FOR FARMS DEVELOPMENT

This section summarises all the discrepancies and challenges encountered while endeavouring to apply FARMS Workbook and One Plan specifications to each case study. As part of the project, when disruptive problems were encountered, effort was directed at auxiliary studies to identify solutions (auxiliary studies included in the appendices). Discrepancies and challenges are discussed, and recommendations are made on how the FARM Strategy approach can be improved for fair and widespread application.

FARMS Workbook

Progressively working through the FARMS Workbook for the first two case-studies highlighted several difficulties, many of which were later echoed by consultants and some case-study participants. The Workbook was considered too lengthy, and a considerable amount of time is required to work through each successive module. Further, constantly having to reference back and forth between specifications and recommended responses was tedious and less than efficient.

The process was adapted for the case studies by developing a checklist of compliance requirements (see example at the end of Appendix 7.11). The key advantage being that all requirements could be quickly assessed to identify non-compliant items. Non-compliant items could then be focused on in greater detail. The Workbook effectively became a reference document to help identify potential responses, and to clarify definitions for specific applications.

It is recommended that the current design of the FARM Strategy Workbook be reconsidered. The checklist, reference guide, and report combination proved useful for the case studies.

Interpreting specifications (FARMS Workbook, One Plan, Clean Streams Accord)

Requirements specified in the FARMS Workbook, One Plan, and the Clean Streams Accord were sometimes difficult to apply in practice. Likewise, there were discrepancies encountered between Workbook and One Plan specifications.

- ⇨ Sheppard Agriculture and Landvision Ltd pointed out that separation distances for effluent application contained in the Workbook are different from those contained in the One Plan. Both were calculated to evaluate implications (see Appendix 7.8). Workbook separation distances severely decreased the amount of land available for the disposal of effluent. It is therefore recommended that the more realistic One Plan separation distances be used.
- ⇨ Regarding dump and offal hole separation distances: Specifying "10 m from the first flood plain terrace of rivers" can be interpreted that it is permissible to install a dump or offal hole on the floodplain itself. This is a small technical point, but lawyers find technicalities useful.
- ⇨ The term 'water bodies' is used in reference to separation distances, and implies all types of surface water (rivers, streams, lakes, ponds, etc.). It also implies all streams that are smaller than the 'wider than a stride and deeper than a redband' definition. Is this specification too broad?
- ⇨ Following from the above, 'waterways' rather than 'water bodies' are used in reference to faecal bug contaminant specifications. Waterways are defined (albeit loosely according to the clean streams definition), but this does not include other water bodies such as lakes. There is an implicit assumption that 'waterways' should include lakes, although this is confused by reference to waterbodies in the separation distance specifications.
- ⇨ The Accord's 'wider than a stride, deeper than a redband' dimensions for qualifying waterways proved difficult to apply in practice (see Table 1, Part 1). By default, the Workbook 'definition' was also difficult to apply. It is recommended that perenniallity be used as a deciding criteria when the dimension criteria fail (e.g. stream flows all year, most years). Likewise, the Accord supplies no definition of lakes, which became problematic when deciding the difference between a pond and a lake (encountered in sand country with systems of 'many small lakes'). It is recommended that waterways and water bodies be clearly defined as a glossary entry.
- ⇨ Under the One Plan, silage stacks that cover an area larger than 500m² need to have a sealed base. However, the FARMS Workbook makes no reference to a 500m² trigger, implying that all silage stacks irrespective of size require a sealed base. Firstly, there is a conflict between definitions. Secondly, under the One Plan the work-around solution is to have many small stacks (<500m²), but this is unlikely to lessen the

environmental impact that the associated Rule is intended to address. Thirdly, under the Workbook specification, sealing the base of all silage stacks irrespective of size would be impractical.

- "Stock feed storage" includes hay-barns, and therefore all hay-barns that cover an area larger than 500m^2 require sealed bases. Given that hay-barns are covered structures and hay does not generally produce leachate, this requirement appears to have no environmental benefit whatsoever, and therefore represents an unnecessary specification (and an unnecessary cost to farmers).
- Workbook maximum permeability of "1 x 10-9 metres per second" for sealing feed storage bases is confusing. Presumably it is supposed to read 1 x 10^{-9} m/s. This also appears to be a generous permeability. A constant 1 x 10^{-9} m/s flux is equivalent to 31.5 mm/yr. Over the 3332 m^2 area used for silage storage in Case Study # 3, this would equate to 105 m^3 of permitted leachate per annum, which at a concentration of 1-5 g N/L would represent a permitted 105-525 kg N/yr loss (35-175 kg N/ha).
- Table 13.1 in the One Plan lists priority Water Management Zones. For Coastal Rangitikei (Rang_4), the entire Zone is targeted. However, in maps and GIS data supplied by HRC, the Porewa Water Management sub Zone is omitted (see the Farm Strategy Information Sheet available from www.horizons.govt.nz/default.aspx?pageid=322).
- The effluent disposal to land system used on the Case Study #2 farm (Hukanui dairy farm) effectively represents a point-source to land discharge (a siphon pipe). Under One Plan specifications this system is compliant, even though it was estimated to contribute large N-losses via leaching and drainage. It is recommended that a maximum 50 kg N/ha loading (per application) specification be considered for the effluent disposal rule.
- Separation distances specified in the Workbook require the identification of 'residences', but the term is not defined. The area that the 'residence' covers can have a large influence on the calculation of separation distances. Initially it was interpreted to mean just residential houses, but this interpretation expanded to include sections (lawns, gardens, etc.) because residential activities undertaken on sections are an important consideration with fertiliser/effluent drift and various odours (e.g. hanging out laundry, children playing). However, sections also include gardens, and some sections can have extensive gardens (up to several hectares). Further, the interpretation becomes more vague when having to decide between a large section and an intensely developed lifestyle block. It is recommended that Horizons put forward a concise definition of 'residences'.
- Farm dumps and offal holes must not be within the 'seasonally highest groundwater level'. Except for surface dumps, this implicates all dumps and offal holes in soils that are not classified as 'well drained' (i.e. all soils that are moderately well drained, imperfectly drained, poorly & very poorly drained, which are defined by redox-morphic features caused by fluctuating water tables). Only farms with well drained soils can therefore have an offal hole, or to a lesser extent, a farm dump (dependent on dump depth).
- Limiting dumps to 'only dead animal matter and organic waste' questions the very definition of a 'dump'. Also, does the current specification imply that <u>any organic material stored or stacked for disposal purposes</u> thereby qualifies as being a 'dump'? This could include the stacking of refuse silage, effluent solids (e.g. feedpads), bedding material (e.g. used sawdust), tree trimming/felling waste, scrub clearance material, etc.

Other implementation difficulties

- Property boundaries straddling two or more Water Management sub Zones were encountered with three of the case studies (#4, 5 & 6). This is an issue if part of a farm falls within a priority sub-zone, but the remainder of the farm does not. With Case Study #6 (irrigated mixed enterprise agribusiness near Marton) 31% of the farm area falls within a non-priority catchment (which just happens to be the most intensive part of the farm). In principle, this portion of the farm does not need to be included in the FARM Strategy. However, a Strategy is intended for a whole farm, and the OVERSEER® model is designed for whole farm applications. Further, One Plan catchment zoning has been created using regional-scale data, which is far too coarse for representative zoning at the farm scale (+/- 22m horizontal accuracy; error for vertical accuracy likely to be much higher; plus additional errors created by interpolation). Given the type of landscape, the precise high points that define the actual catchment boundary would be extremely difficult to locate in practice. Fortunately, for Case Study #6 the farmer willingly opted to include the non-targeted portion of his farm.

Table 9: Estimate of farms that straddle One Plan targeted catchments sorted by stocking intensity

Stocking intensity	*Number of farms*
High (>18 su/ha)	97
Medium (10.5 - 18 su/ha)	216
Low (<10.5 su/ha)	453

A quick analysis by HRC of AgriBase farms that intersect priority catchment boundaries suggests a high proportion of farms may straddle priority catchments (Table 9). To avoid future problems, it is recommended that Horizons specify how the problem of straddled catchments will be managed. Some suggestions include:

- If any part of the legal property boundary falls within a priority catchment (as defined by regional-scale data), then a FARM Strategy is required.
- If a pre-specified percentage of the legal farm boundary falls within a regional priority catchment (e.g. 25%, 50%, 85%) then a FARM Strategy is required.
- Horizons reserves discretion as to whether a FARM Strategy is required.

⇨ Compliance status of some requirements could not be fully assessed. Examples include:

- Leaking effluent ponds were suspected in two cases. In one case, patches of particularly wet soils were noted to the side of a pond, suggesting wall seepage. However, landscape position of the pond could mean that these seepages were natural outflows associated with a water table from the adjacent higher terrace. In the second case, seasonally fluctuating pond levels suggested winter recharge from a rising water table, and deep drainage during summer as the water table drops. In both cases it would require considerable investigation and monitoring to prove or disprove that the ponds were compliant (i.e. not leaking).
- Seasonal or occasional activities with a compliance requirement could not be fully assessed (e.g. must not spray effluent when wind drift may be a problem, no fertiliser application directly to water bodies, fertiliser applied according to industry code of practice, etc.).

⇨ Faecal contaminant risks could not be quantified for any of the case studies. While there is a body of developing research, particularly around the effectiveness of mitigation practices, the preliminary methods and models of quantifying faecal bug risks are still in an early stage of development.

⇨ Including 'extensively farmed' blocks (e.g. runoffs, support blocks) within a FARM Strategy requires further consideration. The following situations were encountered:

- Dairy farm in a priority catchment, but the runoff is located in a non-priority catchment (Case Study #2). Including the runoff would likely decrease current N-leaching (losses averaged across a larger area), decrease permissible N-loss limits (runoff is lower class land), and qualify the runoff for consideration of all 'intensive farm' compliance requirements (higher compliance requirements). For the case study in question, the runoff was omitted from the FARM Strategy.
- Dairy farm with a neighbouring drystock support block (Case Study #3), with both blocks located within a priority catchment. This effectively represents a runoff adjacent to the main farm. In this case the support block was included in the FARM Strategy, mostly because the support block had nil extra compliance requirements (all streams fenced, etc.).
- Mixed enterprise farm (Case Study #6) where most of the intensive enterprises fell within a non-priority catchment, while the extensive operation was located within a priority catchment. In this case the farmer opted to include all land for consideration, even though this incurred higher costs.
- Sheep and beef farm (Case Study #4) where most of the operation is extensive. A rigid application of One Plan requirements would result in compliance costs nearing half-a-million dollars. In this case, the farm was revaluated as an intensive and an extensive blocks, resulting in a 90% reduction in likely compliance costs.

There is unlikely to be one absolute specification that can encompass all possible farming configurations. Worse configurations are possible, particularly with agribusinesses that span farms, catchments, regional boundaries, and even ownership structures. The following approach is recommended:

1. First and foremost, a FARM Strategy is for the main farm, where a 'farm' is defined as one spatially contiguous block.
2. Support and satellite blocks located within priority catchments should be included in the FARM Strategy, but the final choice should be at the farmer's discretion. Inclusion would mean all Workbook compliance requirements must be observed. If not included, then each support/satellite block will require its own FARM Strategy.
3. Support and satellite blocks that are not located within priority catchments should be excluded from the FARM Strategy.
4. Properties with extensive enterprises practiced across a large portion of the farm (e.g. >20% of farm area), should be afforded the discretion to choose if the extensive block is subject to full compliance requirements. The block would be included in OVERSEER® modelling and permissible N-loss limits calculations, but excluded from consideration against other compliance requirements.

OVERSEER® modelling

- The OVERSEER® release used in this project (v. 5.2.6.0) does not accommodate the effects of N-inhibitor use. A 10-20% reduction on N-leaching losses was assumed (depending on farm location and type of inhibitors used). This is a coarse estimate, and improved inhibitor effect estimates are available with the most recent release of OVERSEER®.
- OVERSEER® does not yet accommodate all sources of nutrient loss, particularly direct stock contributions to unfenced waterways and during waterway crossings. If these sources are not quantified, then it is difficult to evaluate potential effectiveness of fencing streams, installing culverts, constructing bridges, etc. Auxiliary calculations were used to estimate contributions from these sources for the case study farm (see Appendix 7.9). While important for this project, these methods of estimating nutrient loss are not necessary, nor are they recommended, for inclusion in FARM Strategy protocols. More research is necessary.
- OVERSEER® has the facility to model N-application through fertigation. Fertigation using urea is currently practiced with the Case Study #1 farm (Dannevirke dairy farm). OVERSEER® modelling suggested this practice reduced N-leaching losses by 2 kg N/ha/yr. However, the reasons for this reduction cannot be fully justified from a research perspective, so urea fertigation was dropped as a possible N-mitigation practice.
- Situations were encountered that could not be fully modelled in OVERSEER®
    - For Case Study #1 (Dannevirke dairy farm), a floodplain area adjacent to the river (sandy shallow soils on gravel) was described as an "on-farm runoff" meaning cows are mobbed intensively across a small area (essentially a standing/feed pad). N-loss risk would be extremely high given stocking density, soil permeability, depth to the water-table, and winter conditions. Conceivably this practice could be contributing a disproportionate amount of N to catchment water contamination.
    - A similar scenario was encountered with Case Study #2 (Hukanui dairy farm). Approximately 43% of the farm is located within the former Mangahao River bed, with shallow soils on top of coarse gravels and stones, and a high water table (which could be considered as a subsurface river flowing through the gravels). The risk of leaching and contamination of water is suspected to be higher that what was modelled in OVERSEER®.
- An OVERSEER® set-up that mirrored current farm practice could not be constructed for all case studies. In part this is because certain input parameters rely on information from the previous year (production, fertiliser use). One of the cases had a particularly bad preceding year, and the model had to be built from longer-term farm information to ensure representativeness. In another case, the enterprise mix and flow of inputs was tightly linked to market conditions, and the farm design was therefore dynamic. A long-term 'average farm' had to be designed for modelling purposes.

  Representativeness should not be a problem once the farming community are regularly preparing nutrient budgets each year. However, there is an initial risk that some operators could use the 'average farm' argument as an excuse to construct low N-loss models. Two suggestions are made to limit this problem.

Firstly, nutrient budgeting for FARMS purposes should only be undertaken only by qualified operators (who should be familiar and experienced with how to build representatives model). Secondly, in cases where there is a problem, David Wheeler suggested building models for several preceding years, and then averaging the results. This would give much improved representation.

- Case studies with multiple enterprises required two or three different OVERSEER® models (e.g. cropping + dairy + drystock as separate models for Case Study #6). Nutrient inputs and outputs were aggregated to report a whole farm nutrient budget. Aggregating N-leaching losses from several enterprises also had the effect of diluting whole farm N-loss. While there is an argument that N-losses from each enterprise should be treated independently, the whole farm aggregation approach is recommended to keep the FARMS approach as uncomplicated as possible. Further, a multiple enterprise configuration is currently being considered by the OVERSEER® development team.
- Horizons rainfall records indicate that the Case Study #2 farm (Hukanui dairy farm) spans a steep rainfall gradient (435mm difference in annual mean rainfall between top and bottom of the farm). N-leaching modelled by OVERSEER® is particularly sensitive to rainfall, so the gradient effect was evaluated by comparing 'rainfall by farm', 'rainfall by nutrient management block', and 'rainfall by isohyet/block configurations' (Appendix 7.5). In this particular case there appeared to be little change in modelled whole-farm N-loss, suggesting that using one 'rainfall by farm' value is adequate.
- The current release of OVERSEER® is not calibrated for annual rainfall exceeding 1650 mm/yr. Extrapolation has been used to predict modelling effects above this limit. Reliability of model predictions may therefore decay at successively higher rainfall inputs (i.e. >1650mm/yr). Future OVERSEER® releases may be calibrated to higher rainfall levels. For the interim, one option is to cap the rainfall input parameter at 1650 mm/yr, but this may create consistency problems particularly with backwards compatibility of OVERSEER® files. The alternative is to continue to recommend the use of OVERSEER® without a rainfall cap, on the basis that OVERSEER® represents the current scope of our science understanding of nutrient processes.
- Area is another variable that has a large determining effect on predicted N-leaching losses. All the case studies used total farm area for OVERSEER® modelling (on the basis that N-limits are calculated on total farm area), with non-pastoral areas grouped as a 'tree block' (assigns a uniform 2 kg N/ha/yr input). The effect was to dilute reported whole-farm N-loss (see Part 1 discussion, and Appendix 7.7 for a comparison using total vs. effective area). It is therefore important that total farm area and non-effective area are accurately established (e.g. GIS-based measurement), and that total farm area is consistently used when using OVERSEER® and calculating permitted N-loss limits (to ensure 'apples are compared to apples'). Amongst other things, this practice would reduce one potential source of calculation error.
- The preceding comments are not a critique of OVERSEER®; rather just situations encountered during this project. OVERSEER® is definitely still the most suitable and robust model for the requirements of FARMS. Most difficulties encountered were readily accommodated by liaising with the OVERSEER® development team. Further, several considerations raised in this document have already been addressed in the most recent OVERSEER® release, or they are currently being considered or developed for future releases. With this in mind it is important to emphasize that if new situations or requirements are encountered by the application of OVERSEER® for FARMS purposes, then these should be passed onto the development team for consideration.
- A fundamental tenet of the OVERSEER® model is that it assumes best management practice. For example, the model assumes that effluent is applied according to recommended best practices such as those found in the Dairy and Environment Committee manual. Pond, silage and raceways fall into the same category. In some of the cases best management was not always practiced (as identified by field visits), and auxiliary calculations and adjustments were made where possible. However, recognising similar situations outside of a research setting may be more challenging, as it requires farmers to be fully versed in what the best practices are for a given activity, and being upfront and honest when best management is not being practiced. Failing to identify where best management is not practiced may result in distorted modelling, and the overlooking of potential contaminant sources.

Quality control and assurance

- Effective use of OVERSEER® is partly dependent on the quality of information provided by farmers. There is a risk that misinformation may be inadvertently supplied (e.g. farmer doesn't keep records of when or how much N-fertiliser or effluent is applied. Farm owner and sharemilker may not share information), or dishonest individuals may supply incorrect information intentionally to distort OVERSEER® modelling in their favour.

OVERSEER® may compensate in some cases. For example, from production data alone OVERSEER® will capture some of the effect of increasing supplements and fertiliser even though these may not be declared. Not declaring full supplement use would typically lead to overestimation of N leaching, while failing to declare N-fertiliser use would result in underestimation. These balances are mediated through the effect of N concentration in the diet.

Effective modelling is also dependent on the quality of operator. Without a qualified understanding of nutrient cycling and processes, there is a risk that OVERSEER® modelling will result in inaccurate results. Likewise, there is considerable opportunity to intentionally manipulate OVERSEER® inappropriately to return a low N-leaching result.

In regard to information quality, one option is to require farmers to supply accounts and receipts that confirm production, fertiliser and supplementary feed particulars. However, this could be considered invasive and somewhat draconian, and would represent yet another compliance cost for the farming community (e.g. accountant fees). It may therefore create additional resistance to the uptake of FARMS.

An alternative is adopting a suite of assurance protocols. These could include:

- Standardising OVERSEER® inputs where possible. Rainfall is a key example, where Horizons supply the rainfall input parameter from one consistent source, rather than independent operators using their own variable sources or estimates.
- Only qualified OVERSEER® operators are permitted to undertake nutrient budgeting for FARMS purposes.
- Encouraging 'no change' to default OVERSEER® settings where possible. Not everyone is a nutrient scientist, and some adjustments in OVERSEER® require a deep understanding of nutrient processes before those adjustments are made. If defaults are changed, then the operator is required to note and justify why these changes were made in the Information Check (see below).
- Every FARM Strategy is required to submit an Information Check as an appendix (see example Appendix 7.11). This records all OVERSEER® input information, any assumptions made (e.g. when specific information is not available), and any changes to default settings are justified. Requiring both the farmer and the OVERSEER® operator to sign that the information is 'true and correct' would help discourage intentional misinformation and misuse of OVERSEER® modelling.
- Including key OVERSEER® output tables as an appendix is also required (e.g. nutrient budget reports for each block). This provides the opportunity for quickly checking any modelling inconsistencies. However, this requires the regional council to have the capacity and expertise to interpret nutrient budgets.
- Encourage or require monitoring of certain activities, particularly the when and how much of N-fertiliser and effluent application. Compliance would be difficult to monitor.
- If tighter standards are required, a random audit system can be introduced to check OVERSEER® modelling.

Other issues and considerations

- ⇨ One case study farmer challenged the correctness of LUC classifications assigned to his property. The company who undertook the classifications returned to the farm and checked their classifications, but the farmer still had misgivings. It is recommended that protocol be put in place if or when such circumstances arise in the future. This could include engaging the services of a second LUC classifier, or a council-internal classifier, to check and validate the first classification.
- ⇨ Assessing compliance status. In principle this should only be done by resource planning professionals who have studied FARMS Workbook and One Plan requirements. In practice, the assessments will be undertaken by farmers and whoever they engage to prepare their Strategy. However, this may be offset by consultants up-skilling to ensure that quality assessments are undertaken to offset any liability risk (e.g. failing to identify a compliance issue that later results in the farmer being penalised or prosecuted). Likewise, simplification and clarification of the FARMS Workbook would facilitate improved assessments.

- ⇨ During the project, an opportunity was taken to attend a dairy discussion group to talk about FARM Strategies. Several issues arose that may be of interest to Horizons:

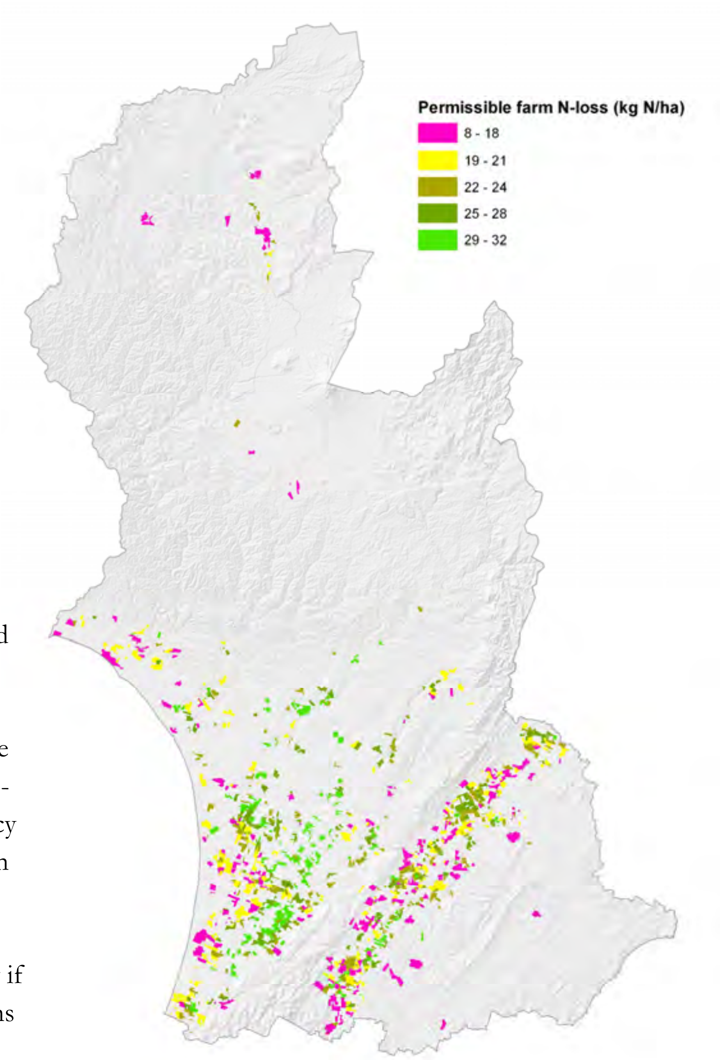
  - Few of the discussion group participants were aware of the full implications of Rule 13.1, and what it may mean to their future farming operation.
  - In particular, none of the participants knew if they required a FARM Strategy (i.e. did not know if their properties were located in targeted catchments). It may be worth noting that Horizons have not made available a map of sufficient detail that allows the location of specific properties (the map in the FARMS information is too coarse, and the maps in the One Plan have insufficient location references, and priority catchments are only identified in tables).
  - A comment was made that proposed N-limits finally provided context to nutrient budgets – all participants had nutrient budgets prepared for Clean Streams obligations, but budgets quickly found their way 'to the bottom of the drawer' because they conveyed little practical meaning (permitted N-loss limits were calculated for each farmer prior to the meeting, using regional LUC).
  - None had heard of Land Use Capability classification. Interest was expressed in finding out more, because LUC will define what their farm's permitted N-loss will be.

  Feedback from the group suggests there may be opportunity to promote greater awareness and understanding. Calculating permissible N-loss targets for the Region's intensive farms would not be particularly challenging (Map 11).

- ⇨ There is a risk that consultants may endeavour to generalise LUC into nutrient management blocks for calculating permissible N-loss, rather than using the original LUC boundaries. This would be quicker, and would negate the need for any measurement using GIS or farm mapping software. It also aligns with the OVERSEER® concept for soil distribution, which explicitly requires the simplification of soil types to fit nutrient management blocks. To avoid this, it is recommended that permissible N-loss must be calculated from the original LUC polygons, and that a map of LUC be included with each FARM Strategy.

Research gaps and opportunities

- ➪ There are fewer opportunities for N-loss reductions in hill country. In part this reflects the type of land use (comparatively more N-loss mitigation options are available for dairy and cropping), and the magnitude of N-loss exhibited by sheep and beef operations (e.g. at 10 kg N leaching/ha a 4% reduction will have no impact on OVERSEER® N-loss, as compared to a 4% reduction for a dairy operation running at 50 kg N-leaching/ha). Review and supplementary research is recommended to help develop a suite of N-mitigation options suitable for intensive hill-country farms.



Map 11: One Plan permissible N-loss limits for most of the Region's dairy farms calculated using farm parcels supplied by HRC and regional-scale Land Use Capability classifications (from the NZLRI database)

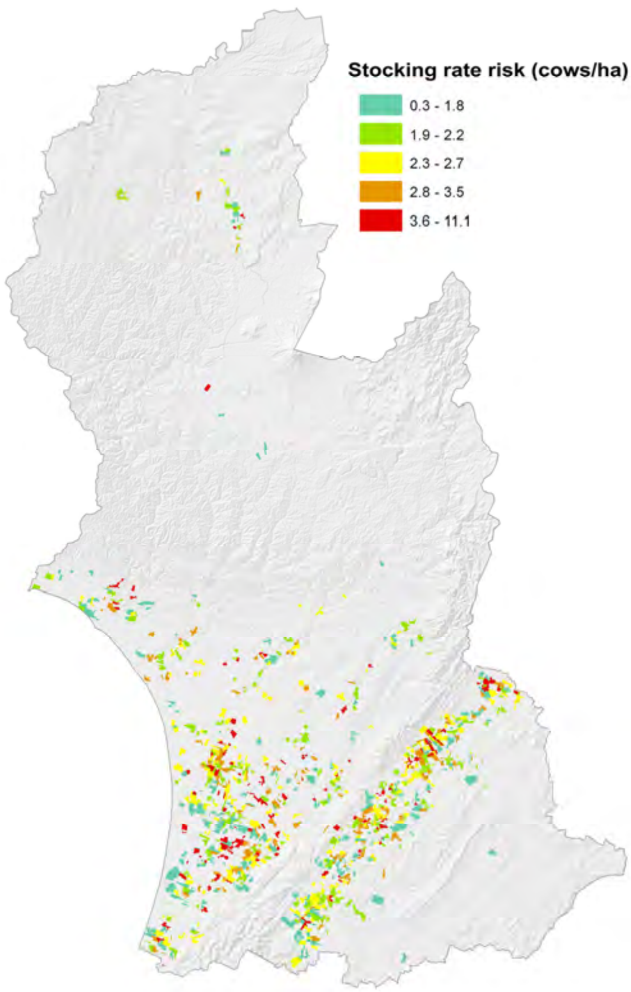
- ➪ Fertigation of urea was initially recommended as an N-mitigation for Case Study #1, but was later withdrawn when Ants Roberts highlighted a Ravensdown commissioned review that discredited fertigation of pasture as a practice that decreases N-leaching losses. However, the review was not conclusive, and there are yet-to-be-disproved arguments regarding the efficiency and effectiveness of pastoral fertigation. Given the scope of irrigation in the Manawatu-Wanganui Region and the related opportunity for N-fertigation, then it is important to clarify if N-fertigation has the potential to help Horizons achieve catchment N-loss reductions.

- ➪ In two cases there was evidence that effluent ponds may have been leaking, but this could not be confirmed within project limits. Conventional knowledge asserts that organic debris will eventually seal any risk of leaching from effluent ponds, even with coarse soils. However, if this is not always true, then potentially many effluent ponds within the Region could be contributing to elevated catchment N-losses. If there is no easy way to confirm pond leakage, then it is unlikely the FARMS approach will help control these sources. Investigation is recommended to determine if there is a problem, particularly in the gravel-dominant Tararua lowlands (the colloquial 'forty-mile bush').

- ➪ Similarly, there is limited research concerning the fate of N and leachate generated from unsealed silage stacks. Research using effluent mostly collected from silage bunkers suggests leachate is a toxic soil contaminant, and levels of potential N-leaching could influence whole-farm N-leaching losses (see Part 1: Case Study #3). There is an opportunity to further clarify the dynamics and fate of nitrogen under silage stacks.

- ➪ Three of the four dairy enterprise case studies had non-compliant effluent treatment and disposal systems. Either the volume of effluent was different than that stated in the consent (higher because of generally more cows), or the system was poorly designed or maintained. If this is the case for such a small sample of farms, then is the problem more widespread, and what is the implication of reducing N-water contamination if all dairy farms were actually achieving their consent conditions?

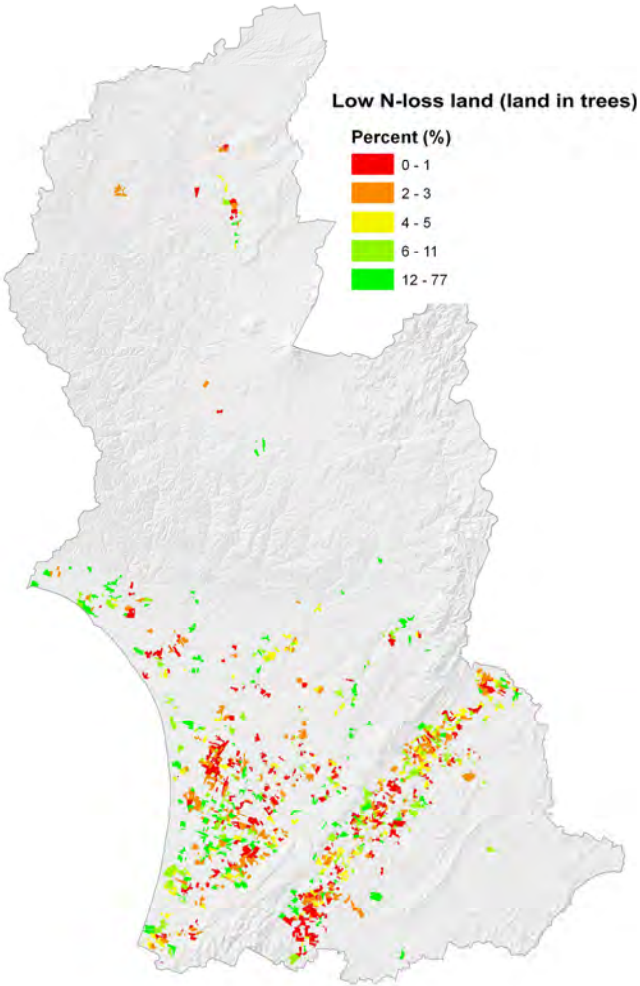
- Slow flowing waterways, particularly larger drains, are likely to reduce N-losses through water-weed uptake (and subsequent grazing by stock), and reducing conditions associated with slow moving and almost stagnant water. It is not clear how much research has been done regarding in-water attenuation for smaller streams, and whether or not the reductions are of a significant magnitude to affect whole-farm N-losses.
- Several of the case studies that bordered rivers had dense stands of lupins growing on the gravel wash. Likewise, the hill country case study had sizeable areas of gorse. As legumes, lupins and gorse (and broome) could be fixing and releasing substantial quantities of nitrogen. Studies measuring N-leaching losses under weedy legumes have reported upwards of 50 kg N/ha being lost via leaching in some environments. Currently, weedy legumes are not accommodated by OVERSEER®. Further, N-loss contributions from weedy legumes are not known for priority catchments. In some catchments weedy legumes could potentially make substantial N-contributions to water quality decline.
- Basic research regarding the dynamics of faecal microbes is underdeveloped, and risks associated with the contamination of water cannot yet be robustly quantified.
- One particularly important situation not covered in the case study examples is mole and tile drainage of Pallic Soils. At least 300 intensive farms in the Manawatu-Wanganui Region include Pallic Soils, a high proportion of which are likely to have artificial drainage (these particular soils are very difficult to manage intensively without drainage). More investigation is required to effectively model N-leaching behaviour with these drained Pallic Soils, possibly beginning with a review of recent research around Palmerston North and Dunedin.
- While outside the scope of this report, several conceptual difficulties were encountered regarding the use of Land Use Capability for distributing N-caps. Clarification would be useful through critical review and debate amongst those qualified in LUC classification.

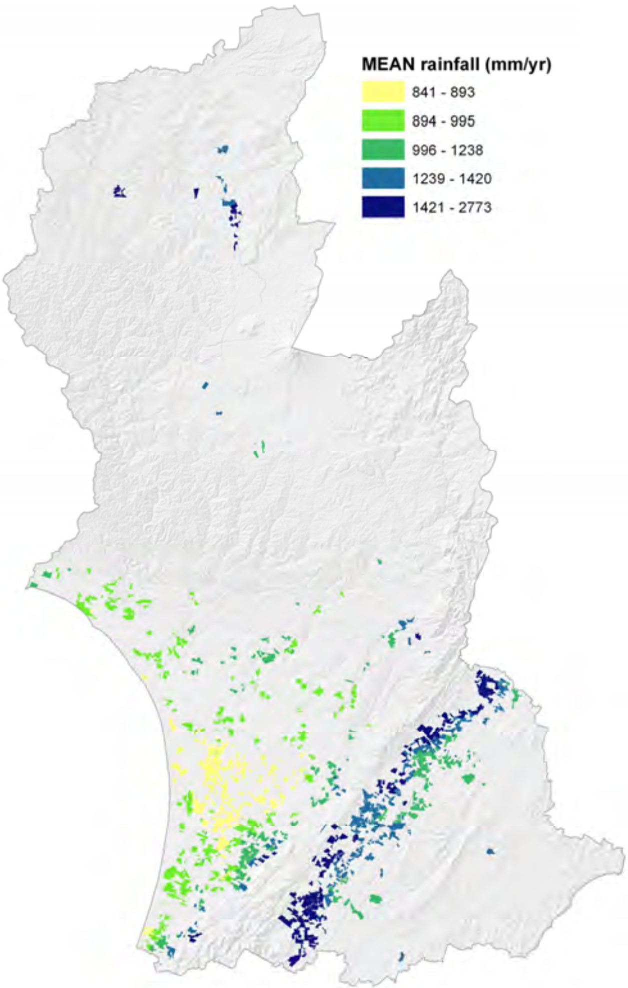


- Longer term implications could be explored further, particularly the financial implications of intensification trends vs. more constrictive N-caps, and the potential longer term cost to farmers if investments and actions are delayed.
- A region-wide investigation of all intensive farms that examines the achievability of complying with One Plan N-loss limits is feasible, and would be useful for identifying properties that are more likely to encounter difficulties. A brief scoping study has already been undertaken to identify various risk factors by farm (examples as Maps 12-14), but further work is required to define and weight cut-off classes using OVERSEER®.

Map 12: Stocking rate risk for dairy farms. The higher the stocking rate, the greater the probability of high N-losses due more urine patches

Map 13: Dairy farms ranked by percentage of low N-loss land (% of farm in trees and other non-pastoral vegetation). Whole farm risk is reduced for farms with a high percentage of trees (N-leaching averaged over a greater area).





Map 14: Rainfall risk for dairy farms, whereby higher rainfall conveys a higher risk of deep drainage and therefore N-leaching.

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7.1 PROCESS USED TO PREPARE CASE STUDY STRATEGIES

1. **Locating farms**: Project supplied with list of nominated farmers with phone contacts. Time taken to locate farms and legal farm boundaries was considerable. Most located by using property databases, although ownership structures were not always clear. Suggestion – FARM Strategies contain a legal description. Suggestion: That HRC provide farmers with legal boundaries as part of the FARM Strategy process. Each legal boundary later confirmed by case study participants as part of the first farm visit.
2. **Orthophotos**: High resolution orthophotos (0.75m) where obtained from HRC for use as a reference and a mapping base. Orthophotos are geometrically corrected aerial photos that have had distortions removed (camera distortion, terrain distortion). They provide an accurate snapshot of land cover useful for locating and mapping features of importance, and represent an economical option for obtaining accurate and precise spatial measures (length and area).
3. **Farm boundary re-mapping**: Two stages – remote interpretation and checking by land owner/manager. Re-interpretation of more precise property boundaries in a GIS using legal farm boundaries as a guide, and the orthophoto base for precise positioning. Re-interpreted farm boundaries subsequently checked by case study participant and modified where appropriate. New boundaries were often considerably different than legal property boundaries, both in terms of precision, and in terms of 'land that is actually farmed'. The latter often extended into land that was not legally owned (e.g. recent land reclaimation caused by river channel changes, and 'land tradeoffs' between neighbouring farms where terrain limited the practical ability to fence off legal boundaries). Suggestion: That the definition of 'total farm area' used in FARM Strategies be worded to include both 'legal area' and 'farmed area'. Suggestion: That legal farm boundaries be used for 'minimum' level Strategies if no alternative is available, and the use of 'actual farm boundaries' (legal + all farmed) be used at the 'medium' level.
4. **Paddock mapping**: Paddock maps prepared for each case study. Used for reference, identifying nutrient management blocks, and in some of the subsequent analyses. Fence lines interpreted off orthophotos. In some cases farmers were able to provide existing paddock maps in paper form (these were scanned, georeferenced and warped to match farm boundaries, and vectorised to be used as a reference layer for orthophoto interpretation), or in electronic form either as a directly useable GPS-derived vector file (supplied in CAD georeferenced .dxf format) or from farm mapping software (converted to CAD .dxf by Wheresmycows.com for importing and georeferencing for use in a GIS). Draft paddock maps were checked and adjusted during farm visits (several iterations were necessary for some farms). Suggestion: While paddock maps proved important for the comprehensive case studies, they are more of a 'medium' level than a 'minimum' level requirement.
5. **Feature mapping**: Features include tracks, lanes, buildings, residences, public buildings, public roads, sheds, irrigation takes and application coverages, offal holes, waterways, etc. Most were used in the calculation of effective area (see below), while others were important for calculating separation distances for evaluating compliance requirements. This involved mapping certain public features outside the farm boundary. Features were either interpreted of orthophotos or Quickbird imagery (via Google Earth where available); located from existing databases (e.g. resource consent irrigation take locations); or located by the farmer onto a map during the first visit. Suggestion: Locating some features are critical for evaluating certain compliance requirements, and should therefore be required even with 'minimum' level Strategies.
6. **Effective area**: Important for identifying area of grazed land; all other land that is not grazed can be modelled differently in OVERSEER®. All non-pastoral features (yards, residential, tracks, sheds, waste land, etc.) erased from the paddock map. All non-pastoral vegetation mapped out using a combination of spectral classification (limited to Red, Green, Blue) and manual digitisation. Dense vegetation cover types erased from the paddock map. Less dense covers (e.g. scattered scrub, space planted trees) were assigned an estimate cofactor representing 'percent of pasture growing beneath trees'. Paddocks that were not used as part of the grazing rotation were indicated by the farmer. Ungrazed paddocks, non-erased, and co-factored areas used to estimate effective area. Effective area calculated using this method was often different to that reported by farmers (often based on removing whole paddocks or dense covers alone). Difference was particularly large for one farm, because they did not include two sizeable paddocks 'that don't really grow much grass' in their estimate of effective area. Similar, it is known that some dairy farms will exclude steeper parts of their farms for the same reason. While this may be an effective way of more positively reporting production on a per hectare basis, it is unsuitable for nutrient budgeting purposes. All farmed land should be entered into OVERSEER®, where lower producing pastoral areas can be assigned a lower relative yield to ensure fair representation. Suggestion: The best possible estimate of effective area

should be an important consideration for all farming, irrespective of FARM Strategies. However, the method described here is perhaps excessive. For a 'minimum' level Strategy, any estimate of effective area should be sufficient and in tone with the suggested standard. For the 'medium' level, a map-based estimate of all pastoral land that is grazed should be included, even if it includes very low producing pasture. Relative yields from different blocks can be assigned later for OVERSEER® modelling.

7. **Land resource survey:** Regional Land Use Capability (LUC) extracted from the NZ Land Resource Inventory (NZLRI) database at a 1:50,000 scale. Farm-scale soil survey, Land Resource Inventory, and LUC classification undertaken by professional surveyors at 1:5,000 to 1:8,000 scales. Used to calculate One Plan N-loss limits at two scales for comparison (see below). General survey method involved stereographic interpretation of landforms using stereo- pair aerial photos sourced from the regional council, followed by several days of field survey to map soils and other land characteristics. Farm LUC classified using national guidelines, and correlated to regional equivalents to obtain additional information. An extended legend was prepared for each case study. Representative soils were described, but the only particularly useful considerations for OVERSEER® modelling is the identification of soil type and drainage class.

   Data collected at 1:50,000 scales are generally too coarse for farm management purposes. However, while desirable, farm scale surveys are presently too expensive to be a standard requirement for FARM Strategies. Suggestion: That NZLRI data be used for 'minimum' standard Strategies. Suggestion: That farm-scale survey information be optional and at the discretion of the farmer at minimum and medium levels (meaning they choose if farm or regional surveys are used for calculating N-loss limits). Suggestion: That it be made clear that N-loss limits be calculated using LUC map units rather than nutrient blocks.

8. **Collecting other physical information:** 'Distance from coast' (in the direction of the prevailing wind) is used in OVERSEER® to calculate atmospheric contributions of certain nutrients (including nitrogen). Distance to coast was measured for each farm using GIS to a +/-50m precision. While this is excessive precision relative to the significance of atmospheric contributions, reasonably precise measures using GIS or maps should be encouraged. Suggestion: that actually measuring 'distance to coast' be a recommendation for professional use of OVERSEER®.

   Rainfall isohyets for the Region were supplied by the Council, representing rainfall averages from NIWA and regional council monitoring stations interpolated spatially using triangulation and orographic rainfall modelling. Isohyets were interpolated back into a continuous grid at a 5m resolution (excessive). Farm rainfall was calculated from the average value of all grid cells encompassed by a farm boundary (zonal statistics).

   Rainfall has a large effected on predicted leaching losses from the OVERSEER® model. While several farms had local rainfall averages they were keen to use, they were discarded in favour of using the averages calculated from regional council isohyets. This provided a uniform standard across all farms. Suggestion: Rainfall is an important modelling variable. To ensure consistent modelling, and to discourage misuse of OVERSEER®, farm rainfall should be provided from one consistent source.

   One case study straddled a steep rainfall gradient, and was assessed using rainfall for individual blocks (See Appendix 7.5). Likewise, recommendations about capping rainfall at 1650mm (the upper limit of OVERSEER® calibration) are made elsewhere.

9. **Assessment of Clean Streams Accord status**: Opportunity was taken during field work to assess physical compliance with Clean Streams obligations. This was added to later through evaluation of 'effluent disposal to land' compliance (see below). Assessment focused on protection of significant waterways and waterbodies from stock, stock crossings, and compliance regarding effluent disposal to land. Cost associated with addressing non-compliant items was later separated from costs associated with One Plan compliance; some of these costs were significant. Difficulties were experienced with definitions, particularly in regard to what is a 'clean streams stream', and the frequency of ford crossings that would necessitate a bridge. Several marginal calls had to be made, always in favour of the farmer (on the basis that the farmer should receive benefit of the doubt, until proven otherwise). An alternative definition for targeted streams was used in favour of the Accord's vague definition. Suggestion: That the 'medium' FARM Strategy standard include an assessment of Clean Streams status. Suggestion: That the existing Clean Streams definition for streams be amended to include 'waterways that flow all year round, most years" (i.e. perennial waterways that flow all year around except in summer droughts).

10. **Farm consultants:** Independent farm consultants were engaged at different levels to help evaluate economic implications. Primary roles included:

- ⇨ Collecting farm information from a business and production perspective to assist with the farm description component (see below).
- ⇨ Benchmarking farm performance to add context, and provide a basis for comparison against similar farms. This proved to be surprisingly difficult for the dairy farms, particular as the promise of DairyBase could not be realised because of limited representation of local farms. Where possible, consultants used their own benchmarking systems.
- ⇨ Farm production modelling where it was deemed necessary (e.g. using Udder). Only farms with a high N-loss were considered, as several of the mitigation options had implications for whole farm production (e.g. stopping urea use, changing supplement types and ratios). Farms with comparatively lower N-loss were not modelled (not required and difficult to justify the added expense).
- ⇨ Provide local cost estimates for mitigation options, production changes, and any compliance costs.

11. **Pasture production:** An assessment of current and potential pasture yield was made to help identify relative yield categories for OVERSEER® modelling, but mostly simply because it is something that was included in the original SLUI whole farm plan prototypes (i.e. trying to maintain a similar template). Farm LUC units were correlated with regional equivalents to identify recommended stock carrying capacities for Top Farmer and Potential Farmer. Non-effective land was excluded from the analysis. Top Farmer stocking rates were converted to pasture yield estimates (stocking rate x 550 kg DM/yr/su divided by utilisation rate – e.g. 80% for dairy), and normalised to total farm pasture yield reported when the farm was modelled in OVERSEER®. This was further normalised if local production information was available, as an estimate of current pasture production. Yields were also adjusted spatially if irrigation was used. Potential yields calculated directly from Potential Farmer stocking rates. Suggestion: While some farmers found it to be interesting information, it is not considered a core component of a FARM Strategy. The suggestion is to include pasture yield gaps as a requirement for combined SLUI Whole Farm Plans and FARM Strategies (e.g. Case Study #4), but to keep it optional for other types of FARM Strategy (i.e. inclusion depends on whether the farmer would like this sort of information).

12. **Designing nutrient management blocks:** Preliminary nutrient management blocks were designed using physical information obtained during survey. These were presented and corrected by case study participants during the farm visit.

13. **Information interview for OVERSEER® inputs:** Each case study participant was interviewed to extract information to be used as input variables for OVERSEER® modelling, involving a farm visit. In most cases a crude model could be set up before even visiting the farm, which made working through the required inputs considerably more easy. Some of the required information was also provided through the consultant (see above). Key inputs include soil test reports, fertiliser use, feed and mineral supplement use, stock policies, effluent management, etc.

    Much of the information required for OVERSEER® – whether it be production, management or input related – can only be obtained from or through the farmer. This has several implications:

    - ⇨ Forgotten information: Certain management practices required by OVERSEER® are rarely recorded by farmers in general, and therefore depend on farmer recollection. Recollection is not always perfect, particularly with the timing of certain activities (e.g. urea application) and specific quantities (e.g. urea and supplements can vary in response to season). In certain cases, the 'best information' that could be provided was a guess.
    - ⇨ Misinformation: While not evident with any of the case study farms, a high reliance on people-supplied information creates an opportunity for providing misinformation if it is advantageous towards lower N-loss modelling. Likewise, there are certain 'hidden' adjustments in OVERSEER® that can be used to lower reported N-loss (discussed elsewhere).
    - ⇨ May have to deal with several people: Occasionally the farm consultant or fertiliser rep had to be contacted to supply sufficiently detailed information. Further, in one case both the farm manager and farm owner had to be engaged separately because neither could provide the full information requirements individually (50:50 sharemilking agreement – neither fully shared the information they held with each other).
    - ⇨ Demanding: A complicated farm that is being set up as a detailed model can be demanding on time required from the farmer, the amount of information required, and the level of detail. Several farmers found the process wearisome.

- ⇨ Information assurance: It is conceivable that high quality information can be obtained from farmers by specifying the following as obligations: a) All fertiliser receipts must be sighted. b) All production records must be confirmed (stock numbers, average live weight, milk yield). c) All relevant management activities must be monitored and recorded (where, when, how much) including urea and other fertiliser applications, mineral supplements, water use for irrigation, and effluent applications. However, this is likely to be distasteful to farmers in general, and may possibly create resistance to the initial uptake of FARM Strategies.

Problems regarding information quality were partly offset by the comprehensive approach. This involved several return visits or contacts with each manager over an extended period, which provided interim time to ruminate on initial recollections, and to correct information that may not have been correct the first time around. Involvement of consultants also improved information quality, either through prompting farmer recollection, or through having direct access to farm records and receipts. Finally, an assurance 'information check' was requested for each case study, which listed all input information (and assumptions) used in OVERSEER® modelling, and a request to the information provider and modeller to sign off that the information was true and correct to the best of their knowledge. Suggestion: specifying tight regulatory requirements regarding the provision of information for OVERSEER® modelling is not recommended. This may create unnecessary resistance to FARM Strategies. Rather, signed assurance information checks should be used initially, perhaps backed by random audits to check information validity. Tighter requirements can be revisited if information quality is poor. Suggestion: An alternative is to require improved monitoring and recording of information by farmers (regarding inputs used in OVERSEER® e.g. N-fertiliser use, irrigation amounts and timings, effluent irrigation details). In principle, many farmers could be expected to do this anyway (because nutrient budgeting will become an annual requirement). However, this does not remove the risk of dishonest individuals intentionally providing incorrect information.

14. **Nutrient budgeting:** Each farm was modelled using OVERSEER® Nutrient Budgets version 5.2.6.0. To achieve consistency between farms, default settings were only changed if there was exceptional reason. These reasons, plus any assumptions made when information was imperfect, were listed in an assurance 'information check' sheet appended to each case study report. In principle, the exact same farm model can be rebuilt for property using these 'information check' sheets. Suggestion: Those undertaking nutrient budgeting for FARM Strategies use default settings unless there is good reason for making a change. Justification for deviating from the defaults should be included in an assurance 'information check' sheet. Nutrient budget set up for the first case study was checked by AgResearch internal review, and external review by James Hanley from Massey University. Models for subsequent case studies were checked internally only. Suggestion: There is considerable opportunity for inadvertent misuse of OVERSEER® by inexperienced operators. This risk can be offset by specifying that FARM Strategy nutrient budgets are only accepted from qualified operators. 'Qualified' could include certificated operators (e.g. Massey University nutrient management course), or operators endorsed or recognised by OVERSEER® developers. Suggestion: As a resource consent component, it is important that those processing consents are able to recognise suspicious nutrient budget results. Consent planners should therefore be required to achieve a basic understanding of OVERSEER® nutrient budgeting, possibly through special training.

    Problems were encountered setting OVERSEER® up for several farms (e.g. cannot have a purely drystock support block as part of a dairy model – always assumes that dairy cows must be grazed at some point. Also, cannot have more than one type of crop, or the total crop area is constrained, when trying to model a mixed-arable farm). Problems of this nature were overcome by setting up two, in one case three, separate enterprise models for each case study farm. Model outputs were aggregated to a whole farm basis for reporting. Suggestion: that those undertaking nutrient budgeting for FARMS purposes use more than one model for complicated farms with more than one type of land use.

15. **Nitrogen loss:** OVERSEER® provides an estimate of nitrogen lost from the farm system via leaching and runoff (mostly leaching). However, the model does not yet account for all potential sources, particularly stock crossings and unfenced waterways. Without knowing N-contributions to these sources, the effectiveness of certain mitigations (fencing, bridges, culverts) could not be fully evaluated. Special auxiliary projects were undertaken for two case studies (Dannevirke and Hukanui) to estimate N-contributions to water from these sources (see Appendix 7.9). In both cases the N-loss was significant enough to impact on whole-farm N-loss (even with the use of conservative estimates, and were therefore added to OVERSEER® modelled N-loss. Suggestion: While the calculation of N-loss from alternative sources is straightforward, it represents an added complication backed with incomplete science, and is not therefore recommended as a standard requirement of FARM Strategy nutrient budgeting.

One particular case study harvested large volumes of silage from a support block and stored it as stacks (unsealed bases) on the main dairy platform. Potential N-losses associated with silage effluent leachate were calculated/estimated, and were significant enough to influence whole-farm N-loss. However, reports in the literature conflict, and as far as could be determined within the limits of this project, N-losses from beneath silage stacks have not been measured in NZ.

16. **Faecal microbe risk:** Risks associated with faecal microbe contamination of freshwater resources could not fully evaluated. While there is a strong body of research on the effectiveness of mitigation practices, the methods and models of quantifying pathogen risk are still in an early stage of development. However, 'rule of thumb' estimates regarding direct deposition to waterways were provided in some cases for demonstration purposes (see individual case study reports).

17. **P-loss risk**: P-loss risk was estimated using OVERSEER®, which reports a calculated amount and a classification of risk. Other P-loss sources were also evaluated (stock crossings, direct deposition to unfenced waterways), but the amounts were negligible in most cases (see Appendix 7.9).

18. **Sediment loss:** While the project brief did not specify an assessment of contaminant risk, an opportunity was available to report on sediment loss risk for the sheep and beef case study. This was provided by John Dymond of Landcare Research using a region-wide sediment loss model.

19. **Effluent assessments:** Where resources permitted, and when there was reason to suspect a problem, dairy farm case studies had their effluent systems evaluated independently. This included a review and comparison of existing 'disposal to land' consents. Two studies were also undertaken by Dave Horne from Massey University to investigate environmental problems associated with existing systems (mainly focusing on N-loss contributions from inefficient systems), and the design of new compliant systems. This involved the periodic calculation of Farm Dairy Effluent, its storage, and when, where and how much of application using local rainfall and evaporation records. Reports have been appended.

    Two of the three dairy case studies had serious effluent disposal problems, sufficient to impact on the calculation of whole farm N-loss. The third had a suspected problem with leakage and groundwater recharge, but this could not be confirmed within the scope or resources of this project. Suggestion: If these farms are representative of effluent disposal systems throughout the region, then significant improvements in N-loss could be expected by more tightly monitoring associated resource consents. Likewise, there is scope for further research, particularly a 'what if all farms achieved deferred irrigation', and 'do effluent ponds leak in some landscapes'.

    Some discrepancies in specifications and rules were also identified.

20. **Calculating One Plan N-loss limits**: One Plan N-loss limits were linked to LUC classification layers in a GIS environment to calculate total permissible N-loss by unit (kg N/unit), and whole farm N-loss expressed on a per hectare basis (kg N/ha/yr).

21. **Intensification trend analysis and implication for N-loss limits:** Rule 13.1 permissible N-loss limits are calculated incrementally in 5-year periods out to twenty years. It is difficult to speculate how farm N-loss may change over such a long period, which therefore makes it difficult to fully evaluate implications of N-loss limits. Existing intensification trends were used to extrapolate how production may change over the next twenty years. Predicted changes in production and inputs were modelled through OVERSEER® to generate a future N-loss scenario for most case study farms. An auxiliary report was prepared for each (see Appendix 7.6). Suggestion: Not to include trend analysis in FARM Strategies – far too speculative. Suggestion: To consider reviewing FARM Strategies every five years. However, this adds a more frequent compliance cost, and it can be argued that existing compliance procedures are sufficient to allow longer review periods (i.e. farmer's responsibility to inform council of any breach of conditions or major deviation from the plan, backed with random audits to check compliance).

22. **Effect of scale on the calculation of One Plan N-loss limits**: N-loss limits were calculated using two scales of Land Use Capability classification, including 1:50,000 scale classifications derived by clipping an extract from the NZLRI database using farm boundaries, and the automatic allocation and calculation of N-limit by polygon. Special farm-scale survey was undertaken to classify land and a more detailed scale. N-limits calculated at both scales were compared. As a general statement, the results showed only small differences (1 or 2 kg N/yr difference) in most cases, despite some major differences in LUC classification. The only exception was a sand country farm were N-loss differences were substantial. It was decided that the number of examples were too few to draw meaningful conclusions. As a surrogate for a larger sample, all first-year SLUI whole farm plans were examined (having farm-scale LUC) and compared. This highlighted greater differences, but results can only be considered indicative because

most SLUI farms are non-intensive and hilly/steep. Few farm-scale LUC classifications for flatter farms are available. Suggestion: That HRC consider supplying all farmers with a farm map of NZLRI and calculated N-loss limits. Or provide it on request. Suggestion: that 'minimal' level Strategies use NZLRI derived limits.

23. **N-limit assessment using different farm areas for calculation**: One Plan N-loss limits are calculated on a' total catchment area' basis. N-loss limits should therefore be calculated using total farm area. Nutrient budgets, however, are often calculated on an effective area basis. A quick assessment was undertaken to evaluate N-limits and N-loss calculated using a) total farm area, and b) effective farm area (see appendices). It was concluded that 1) the exact same area used for OVERSEER® modelling should be used for calculating N-limits (otherwise comparing apples with oranges), and 2) total area should be used rather than effective area to keep in line with the way catchment N-loss targets were calculated. Suggestion: That total legal area plus total farmed area be used for calculating both OVERSEER® N-loss and One Plan N-loss limits.

24. **Recognising existing practice**: Many of the case studies had already implemented certain changes and activities that were contributing to reduced contaminant risks (riparian fencing, land retirement, deferred irrigation, etc.). It is important that these are recognised and documented, simply as an acknowledgement and record. Suggestion: that existing practices and works be recognised in the 'medium' level FARM Strategy.

25. **Identifying promising for minimising N, P and bug impacts (mitigations)**: Commonly recognised N, P and bug minimisation practices are listed and recommended in the FARM Strategy workbook. These were summarised together with other recognised practices into a rather extensive spreadsheet. Promising mitigation practices were selected for further evaluation depending on the case study in question (i.e. depended on farm situation, goals, magnitude of N-loss, likely effectiveness, etc.). For farms that were currently operating within their N-loss limits, several mitigations were also nominated for further evaluation (for demonstration purposes).

    The idea of identifying and evaluating several potential mitigation is to present the farmer with choices.

26. **Evaluating potential effectiveness of promising mitigations**: Evaluation of potential effectiveness centred around mitigations that would reduce N-loss. Where possible, modifications were made in OVERSEER® to reflect the mitigations, and the farm was remodelled to evaluate the effect on N-loss. For mitigations that OVERSEER® does not yet accommodate, studies were referenced and calculations were made to estimate potential N-loss reductions. Where no quantifiable estimate was possible (particularly for bugs, P-loss, and seasonal related N-mitigation practices), reference was made to studies that had demonstrated improvements. Production implications of compound mitigations, or mitigations with a direct implication for production yields (e.g. reducing urea use), were evaluated using farm modelling software (e.g./i.e. Udder), with results used to rerun OVERSEER®. Two farms required this level of analysis, one of which withdrew from the project.

27. **Evaluating potential costs of promising mitigations**: Most nominated mitigations carried a requirement for financial investment, or carried implications for production yields (positive and negative implications). Local cost estimates were provided by consultants. Most represent contractor rates at the time of the assessment, and may therefore have changed markedly given the volatility of farm input prices at present. However, it is conceivable that cost would be reduced in many cases if farmers undertook the activities themselves. Where there were large cost items that depended on site-specific details (e.g. bridging a particular stream), external experts were contracted to provide a cost estimate.

28. **Assessment of other FARM Strategy compliance requirements**: Full compliance requirements are listed in the FARMS workbook. There were discrepancies in places, particularly between the One Plan and the Workbook (discussed elsewhere). All compliance requirements were extracted from the workbook and summarised as a checklist. Compliance was assessed by 1) interviewing the farmer, and occasionally the farm worker, 2) site visits (generally in conjunction with other fieldwork, but several special visits were required for full confirmation), and 3) GIS analysis, particularly for the identification of separation distances.

    There were several compliance considerations that could not be examined within the project's scope, either because they were occasional activities (e.g. spray drift will not affect neighbours) or they involved a difficult assessment (e.g. effluent ponds not leaking). In such cases, full compliance was assumed until proven otherwise.

Costs were estimated for each compliance requirement (over and above those recommended for achieving N-loss targets).

29. **Designing a five-year strategy**: The most feasible, cost effective and N-reducing mitigation options were recommended for uptake. Each was worded as an objective, and a schedule of implemented was constructed spanning a five-year period. Extensive or demanding activities were broken down to achievable actions by year.

30. **Assurance 'information check'**: All OVERSEER® modelling inputs, assumptions, and setting changes (i.e. and deviation from default settings) were listed as an appendix for each case study report. There is sufficient detail to rebuild the OVERSEER® model if required. Farmers and the person who prepared the nutrient budget were asked to sign off 'to the best of our knowledge this information is true and correct'. Suggestion: that 'information check sheets' be required for all FARM Strategies. This adds a degree of assurance. Further, information and assumptions can be checked quickly, or used to rebuild models as part of a random audit monitoring programme.

31. **Spatial analysis, GIS and map cartography:** All spatial related aspects of the case study farms were captured for use in ArcGIS 9.2 suite mostly through manual digitising. Spatial data were used for certain analyses, precise measurement (e.g. stream lengths, fence lengths, etc.). Comprehensive datasets are available for each case study property. Maps were used extensively in case study reports because they can convey a lot of information efficiently and effectively ('picture worth a 1000 words'). Likewise, farming is an inherently spatial activity, so it makes sense to evaluate and report these activities in a spatial context. Map design aligned with SLUI whole farm plan maps.

32. **Graphics and report formatting:** Inclusion of many large maps in a standard MS Word document threatened to make each case study report unwieldy. In an effort to keep megabyte size to a manageable level, dedicated publishing software was used to retain less demanding data structures (i.e. vector rather than raster). Some graphics design work was also undertaken to keep the look and feel of each Strategy similar to that used in the SLUI whole farm plan prototypes. Software: Abobe CS2 Illustrator, Indesign, Acrobat, Photoshop.

7.2 EXTERNAL CHECK OF MODELLING AND METHOD FOR CASE STUDY #1

By James Hanly, Soil and Earth Sciences Group, Institute of Natural Resources, Massey University.

(August 2007)

Introduction

AgR has been contracted to evaluate the One Plan approach to contaminant management (the FARMS approach), developed by Horizons Regional Council, using seven intensive farming case-study farms in the Manawatu-Wanganui Region. Key result areas:

1. Scale sensitivity of N-loss targets
2. Farm nutrient loss vs. nutrient loss targets
3. Farmer 'acceptability'
4. Mitigation options and cost
5. Strategy design to mirror SLUI whole farm plan designs

This report provides a brief review on the use of OVERSEER® to model farm inputs for the Barrow farm, and on the methods and rationale used to calculate both N-loss targets and direct N-losses to waterways. This review is based on the following three draft documents provided:

1. Resource Management Strategy report (John & Debbie Barrow, Maharahara Road, Dannevirke (Dated 10/07/06).
2. Barrow Interim Report # 1 – Horizons N-leaching limits calculated at three scales of Land Use Capability (LUC) classification for John Barrow. (Dated 6/08/07)
3. Barrow Interim Report # 2 – N & P loss estimates for John Barrow. (Dated 6/08/07)

Overall, the use of OVERSEER® Nutrient Budgets to model farm inputs for the Barrow farm and the methods and rationale used to calculate both N-loss targets and direct N-losses to waterways are appropriate. Listed below are recommendations and comments that are mostly aimed at improving the consistency of the approach used or clarifying the information provided.

1. Resource Management Strategy report notes:

Page 4

- Rainfall value – It is important not only to have the source of the rainfall data (eg Horizons), but also how it was derived. For example, was the rainfall modelled or is it from weather station data and what is the proximity of the weather station to farm? Also, what is the period the data is averaged for? It is important that the farmer knows how this rainfall figure is derived because it can have a significant impact on N-loss estimated by OVERSEER® (eg. 100 mm lower average rainfall will reduce farm N-loss from 31 to 29 kg N ha^{-1} yr^{-1}.)
- MS and Stocking rate – Are these long-term average annual values? As productivity inputs also have an influence on N-loss, it is would be useful to know the number of years these are averaged over. Stocking rate used was derived from peak cow numbers. Need to check whether the OVERSEER® input requires peak stocking rate or average.

Page 6

- Irrigation – An estimated 350 mm is used for the period of January though to early March. This is a period of 10-11 weeks rather than 14 weeks. Interim Report 2 (page 12) uses 14 weeks but also includes December. The value of 350 mm annual irrigation was derived using 25 mm/week multiplied by the number of weeks requiring irrigation based on a gross soil water balance. The use of a monthly average water balance, while useful for demonstration purposes, is not very adequate for determining irrigation requirements. A soil water balance based on daily climatic information over a thirty year period, using the closest NIWA weather station to the Barrows farm, indicates that the annual irrigation requirement is 220 mm. If irrigation is 80% efficient, then the irrigation requirement would be 275 mm (11 weeks) (Pers. comm. with Dr Dave Horne). Also, the average annual rainfall in the gross soil water balance on page 12 equals 1057 mm, whereas, the rainfall used in OVERSEER® is 1200 mm. Best to remove this table and use long-term daily data to estimate irrigation requirements.
- Effluent management – The phrase "most opportune times" is used to describe when effluent is applied to land. Should explain whether "most opportune times" refers to soil moisture deficit, labour availability, effluent storage etc? Also, it would be useful to have some more detail about the irrigation system and how the farmer makes decisions about when to apply and what application depth to use. The issue with the pond possibly leaking needs to be clearly signalled as something that needs addressing.

Page 7

- Grazing rotations – should state that these are average grazing rotations.
- Supplement purchased – While the supplement purchased last season was used in OVERSEER®, is this typically of what they use or was this higher than usual? Again, this should be a long-term annual average value.

Page 8

- The following statement is used: *"Note that these high yield potentials are used to calculate N-loss targets. The higher the potentials for your farm, the greater the N-loss target you can operate under*". This statement may give farmers the false impression that the closer they get to their yield potentials the higher their N-loss target becomes. In fact, the more they attempt to operate closer to their yield potential, the more likely they will exceed the target that has been set for them based on their average LUC. This is because the targets are set at a percentage of the LUC-based yield potentials (eg. 75%). Best to remove this statement.

Page 10

- NZ dairy farm N-loss average – in OVERSEER® this range is listed as 30-50 kg N ha^{-1} yr^{-1} rather than 30-40.
- Nitrification inhibitors – How many seasons have these been used and does the farm intend to use them again next season? It would be useful to indicate whether this is likely to become an ongoing management practice.

Page 11

- The following statement is used: *"an almost insignificant 0.07 kg P ha^{-1} yr^{-1}"*. However, unlike with surface runoff and drainage, this P is not lost at times of high stream flow, but is mostly deposited outside the winter period and is deposited directly to stream. Therefore, the significance will depend on stream flow at the time of deposition. For example, a total of 7 kg P deposited to stream in dung requires ~ 212,000 m^3 of pure water to be diluted down to ~ 0.033g TP/m^3 (ANZECC guideline). Likewise, the pathogens deposited in dung directly to the stream during summer are likely to have a greater impact on its safety for swimming and drinking, compared to pathogen contaminants in surface runoff generated during winter.

Page 16

- The statement "only a small reduction of 2 kg ha^{-1} yr^{-1}" contradicts the statement on Interim report #1 (page 5), which states "The reduction was 2 kg N which is considerable".

2. Barrow Interim Report # 1

Page 4

- As shown in the report it is useful to know the impact of mapping scale on N-loss target. Likewise, it may also be useful to know the effect of soil mapping scale on the N-loss estimated by OVERSEER®.

Page 5

- The approach chosen, using the effective areas for determining both average LUC class and OVERSEER® N-loss estimates, is the most straightforward given OVERSEER® doesn't have an option for "redundant" land. However, if this approach is used, then to be consistent the N-loss targets set by Horizons for the different LUC classes (Appendix 6: Defining nutrient (nitrogen) loss limits within a water management zone on the basis of the natural capital of soil) should also be calculated using effective areas. If not then this will create an unfair comparison. The inclusion of redundant land in the setting of N-loss targets for each LUC class will lower the target, whereas the exclusion from OVERSEER® will increase the average N-loss value for the farm. If the effective areas are to be used then it is important to ensure that the LUC targets are also set using effective areas.

3. Barrow Interim Report # 2

Page 3

- Consider changing the following sentence: *"This is at the lower end of N-loss (NZ average for dairy is 30-40 kg N ha^{-1} yr^{-1})"* to *"This is at the lower end of average dairy farm N-loss (NZ average for dairy is 30-50 kg N ha^{-1} yr^{-1})"*
- For calculations of direct deposition of dung and urine to stream it would be more consistent to use average cow numbers milked rather than peak cows milked.

Page 5

- It may be worth noting that if watercress growing in the stream is grazed, as the farmer suggests, then direct deposition may be higher than the values based on crossings only.

Page 11

- The soil test values listed in the table for "No fertiliser block" are different from those used in OVERSEER®.
- A general comment on the effect of soil type and drainage characteristic - When a soil type is selected it would be helpful if OVERSEER® listed the default drainage characteristic along with the other soil characteristics (OVERSEER® Issue). Also, having two places to enter drainage information can create variations between users (eg. using poorly drained in the "Soil" window is 3 kg N^{-1} ha^{-1} year lower than using the default or imperfectly drained in the "Advanced soil setting window"). For example:

K-road (irrigated) block	Kg N ha^{-1} yr^{-1}
Default (no drainage selection made)	24
Poorly drained[1]	21
Mole-tile drained[1]	27
Poorly drained + Mole-tile drained[1]	24
Imperfect drainage[2]	24
Poor drainage[2]	22

1 - using the tick boxes in the "Soil" window.
2 - using the selection in the "Advanced soil setting window"

Also, the accuracy of information about the soil types and drainage characteristics for blocks on farms can significantly impact on N-loss values estimated by OVERSEER® (this is just something to be aware of for sensitivity).

Page 12

- Clover content – If the impact of recent factors (eg. ragwort spray, clover root weevil) are only short-term (eg. 1-2 seasons) then it is reasonable to use "Medium" rather than "Low". However, there are other factors (eg. N fertiliser use and ryegrass species) that may have caused more long-term suppression of clover and, therefore, "Low" clover content may be more appropriate. As shown in the report, this one choice can change N loss by 4 kg N ha^{-1} yr^{-1}, so there needs to be good justification for the clover content level selected. It will be import for the farm to have its clover content monitored from now on to determine whether the lower clover observed is a short or long-term effect.
- Does the farm grow forage crops or use cultivation for pasture renewal?

Page 14

- OVERSEER® doesn't seem to be taking into account that the use of holding ponds has reduced the N load to the effluent block in the Effluent report window. OVERSEER® says that 16.3 ha are required to get a rate of 150 kg N ha^{-1} yr^{-1}, but the effluent block is 15 ha and is only receiving 34 kg N ha^{-1} yr^{-1} as effluent (OVERSEER® bug!).

7.3 EFFLUENT DISPOSAL ASSESSMENT CASE STUDY #2, DAVE HORNE, MASSEY UNIVERSITY

Land Application of FDE to Billington's farm

Introduction

A soil water balance for the period 1994 to 2004 was used to investigate the management of land application of farm dairy effluent (FDE) to the Billington's property. It is important to note that this analysis addresses only the irrigation of liquid FDE and not the application of solid sludge from any of the ponds.

It will be important that 'deferred irrigation' is practised on the farm to minimise the risk of either surface runoff and/or the rapid drainage of FDE through the shallow soil to underling gravels.

Two irrigation systems were investigated- a standard travelling irrigator and the Larral system. The standard travelling irrigator is ordinarily the cheapest land application system to purchase although it has very high operating costs (mostly associated with labour inputs). In contrast, the Larral system is relatively expensive but has very low operating costs. More importantly, the Larral system is likely to facilitate the successful practise of deferred irrigation in this wet climate.

OVERSEER® suggests that an effluent block of 20 ha is required if the application of N in FDE is to equal 150 kg N ha^{-1}. Other assumptions and input parameters that are important to this analysis are given in Table 1.

Table 1. Input parameters in the analysis

Available water holding capacity of soil	30 mm
Irrigated area	20 ha
Effluent production associated with milking	53 l cow^{-1}
Area of shed roof	175.4 m^2
Area of yards	1241.7 m^2
Pond area	2664 m^2
Pond volume	3835 m^3

System 1 – Travelling irrigator

The smallest depth that travelling irrigators can apply is typically 8 mm. If deferred irrigation is to be successfully practised then a soil moisture deficit of 8 mm will be required. The soil water balance model was constructed so that on any day when the deficit was 8 mm or greater, two 'runs' of the irrigator (i.e. 2 shifts) would irrigate 100 m^3 to 1.25 ha.

Table 2 shows the effluent generated for each of the years between 1994 and 2004 and the number of 'unsafe' irrigation days for a travelling irrigator (i.e. days when the soil moisture deficit was less than 8 mm) during the lactation season. It also presents the volume of FDE that would have to be applied to wet soil because the pond was full (i.e. a breach of deferred irrigation).

This simple analysis suggests that, given the current infrastructure (e.g. pond dimensions), it will be extremely difficult to successfully achieve deferred irrigation on the Billington's farm with a travelling irrigator. In five of the ten years under consideration, there was a risk that approximately 25 to 30% of the annual FDE load would have exited the soil as runoff and/or rapid drainage (Table 2). To successfully practise deferred irrigation most years, the ponds would need approximately twice the current storage capacity i.e. 8000 m^3.

Table 2. The number of unsafe irrigation days in the lactation season and the volume of FDE applied when the ponds are full for the travelling irrigator case.

Year	Effluent generated per annum (m^3)	Unsafe irrigation days in lactation season	FDE that was applied to wet soil because the pond was full (m^3)
94-95	9306	175	1272
95-96	9088	174	5013
96-97	8997	172	2857
97-98	8627	159	192
98-99	8901	146	3754
99-00	8424	123	0
00-01	8889	133	1594
01-02	8575	146	0
02-03	8469	137	3033
03-04	9353	173	278

The single greatest advantage of the travelling irrigator option is that at $ $26,500 it is relatively inexpensive to purchase.

However, at 2 shifts of the irrigator per day it does have a high labour cost to operate.

Option 2 Larral system

The Larral system was chosen by way of contrast with the travelling irrigator because of its ease of operation and its low application rate and because a large area can be irrigated on any one day.

The application rate of the Larral system is typically 3.6. mm hr^{-1}. There are numerous ways to manage a Larral system but for the purposes of this simulation exercise it was assumed that the critical soil moisture deficit for deferred irrigation was 4 mm. For the Larral scenario, the soil water balance model was constructed so that on any day when the deficit was 4 mm or greater, 210 m^3 (at a depth of 3.6 mm) was irrigated onto 6 ha using 20 sprinklers. This would require that sprinklers are shifted three times each day but this should take approximately 15 minutes per shift.

In contrast to the travelling irrigator, the Larral system was able to achieve deferred irrigation in all but one of the ten years under consideration (Table 3). Even in this year it was probably possible to have perfected deferred irrigation if the Larral system had been managed appropriately.

Table 3. The number of unsafe irrigation days in the lactation season and the volume of FDE applied when the ponds are full for the Larral system.

Year	Effluent generated per annum (m^3)	Unsafe irrigation days in lactation season	FDE that was applied to wet soil because the pond was full (m^3)
94-95	9306	150	0
95-96	9088	137	854
96-97	8997	133	0
97-98	8627	122	0
98-99	8901	106	0
99-00	8424	89	0
00-01	8889	99	0
01-02	8575	106	0
02-03	8469	103	0
03-04	9353	139	0

The Larral system is expensive to purchase. It is estimated that a system with 20 sprinklers would cost the Billingtons approximately $53,500. However, the operating costs of a Larral system is much lower than that of a travelling irrigator because the labour requirements are much smaller.

N loss

It is difficult to quantify the N loss to waterways associated with current effluent treatment. OVERSEER® suggests that there are approximately 2805 kg of N in the effluent produced at the miking shed. If it is assumed that approximately one half of this quantity of N exists the pond in liquid form (due to gaseous emissions and retention of solids) then approximately 1402 kg N is currently discharged into the low spots in paddocks via the open-ended pipe. If, in turn, one half of this N then enters water bodies through runoff and drainage, the N loss from the current system is 701 kg. This gives a 'whole farm' loss of 3.7 kg ha^{-1} due to effluent treatment i.e. increases total farm loss form 23 to 26.7 kg ha^{-1}.

OVERSEER® suggests that if a Larral system is established on 20 ha of the farm and deferred irrigation is practised then total farm losses will be 23 kg N ha^{-1}. In other words, the Larral system and deferred irrigation will reduce N leaching by 3.7 kg N ha from the current value.

7.4 EFFLUENT DISPOSAL-SYSTEM CASE STUDY #6, DAVE HORNE, MASSEY UNIVERSITY

Introduction

A soil water balance for a ten year period (1994 to 2004) was used to investigate the management of land application of farm dairy effluent (FDE) to the Marshall's property. It is important to note that this analysis addresses only the irrigation of liquid FDE and not the application of any solid sludge.

Volume of FDE generated

The most interesting challenges to improved FDE management on this farm arise from the very large volume of effluent generated. On average, 28,493 m^3 $annum^{-1}$ (standard deviation of 614 m^3 $annum^{-1}$) of FDE is produced (Table 1). This is due to; the relatively large catchment area (4758 m^2), slightly higher rainfall (1141 mm) and the large quantity of water used in the washing of the yards (100 l cow^{-1}). There is limited opportunity to divert storm and runoff water away from the effluent sump. See Appendix 1 for input parameters to the model developed for simulating FDE production.

Drainage of FDE

Given the deep and relatively free draining nature of the Tokorangi sandy loam, preferential flow of FDE through this soil should not be a major problem *per se*, therefore, it may not be necessary to practise 'deferred irrigation', at least not in a strict fashion. Some storage will be useful if irrigation of FDE is to be deferred in periods of heavy rainfall.

There are two issues associated with the current management of FDE on this farm. In addition to the large volume of FDE generated, the annual application depth of FDE to the 'effluent block' is unacceptably large both in terms of the hydraulic and nutrient loads. Currently, FDE is applied to the effluent block, which is only 14 ha, at a rate of 204 mm per $annum^{-1}$ (Table 1). This should be compared with the water irrigation demand of this soil which is, on average, only 100 mm $year^{-1}$.

Irrigating 204 mm FDE is likely to increase the amount of drainage from the effluent block and concomitantly the risk of nutrient loss. The water balance suggests that on average 60 mm (i.e. 30% of the annual FDE irrigated to land) will drain rapidly through the soil profile. It is difficult to know to what extent this effluent will be refurbished as it travels through the soil: this drainage water is likely to be nutrient-rich but not to the extent encountered in soils where preferential flow dominates.

In addition, the water balance suggests that irrigating this quantity of FDE will result in 159 mm of extra drainage throughout the year (Table 1).

Table 1. FDE irrigated to the effluent block and drainage from this area

Available water holding capacity of soil	75 mm
Effluent generated per year	28,493 m^3
FDE irrigated to the effluent block	204 mm
FDE applied to wet soils that will drain rapidly	60 mm
Drainage with no FDE irrigation	390 mm
Drainage with FDE irrigation	549 mm

N leaching from the effluent block

OVERSEER® (version 5.2.6) was used to predict likely N losses in drainage water from the effluent block. OVERSEER® suggests that nitrogen, phosphorus and potassium are currently applied in FDE to the effluent block at rates of 800, 97 and 1059 kg ha^{-1}, respectively. These rates are clearly unsustainable.

If a drainage value of 390 mm, as predicted by the soil water balance with no FDE irrigation, is inserted into OVERSEER®, a leaching loss of 52 kg N ha^{-1} is calculated (Table 2). This is how FDE irrigation to the effluent block is usually inputed into OVERSEER® i.e. the volume of the effluent is ignored and it is assumed that it is not a significant contributor to drainage, at least not in the way that water irrigation is. This is ordinarily a reasonable assumption because the depth of FDE applied is small. However, as has been demonstrated above, very large volumes of FDE are irrigated to the effluent block on this farm (i.e. approximately twice the water irrigation requirement). If the increased drainage value of 549 mm as a result of applying FDE is inserted into OVERSEER®, the N loss increases to 57 kg ha^{-1}.

Table 2. N loss from the 'effluent block'

N leaching with 390 mm of drainage	52 kg ha^{-1}
N leaching with 549 mm of drainage	57 kg ha^{-1}

Need to expand the effluent block

OVERSEER® suggests that if the effluent block was increased to 60 ha in area, the application rates of N, P and K would be 185, 22 and 251 kg ha^{-1}. Importantly, N loss in drainage from this larger area would be 19 kg ha^{-1} (Table 3). This reduction in N loss should help the farm comply with its 'One Plan' N leaching allocation. The depth of FDE irrigated to this expanded area would be 47 mm of which only 13 mm is at risk to draining quickly through the profile.

Currently there is no storage for FDE on the farm: this should be rectified. However, the farm is fortunate in that given the Tokorangi sandy loam is not poorly drained and it does not have an artificial drainage system, large volumes of storage are not required. It is suggested that three or four days of storage - sufficient to avoid the need to irrigate in periods of heavy rain - may be adequate. Also, scheduling irrigation to the Tokorangi sandy loam should be more straightforward then is the case for soils with artificial drainage systems.

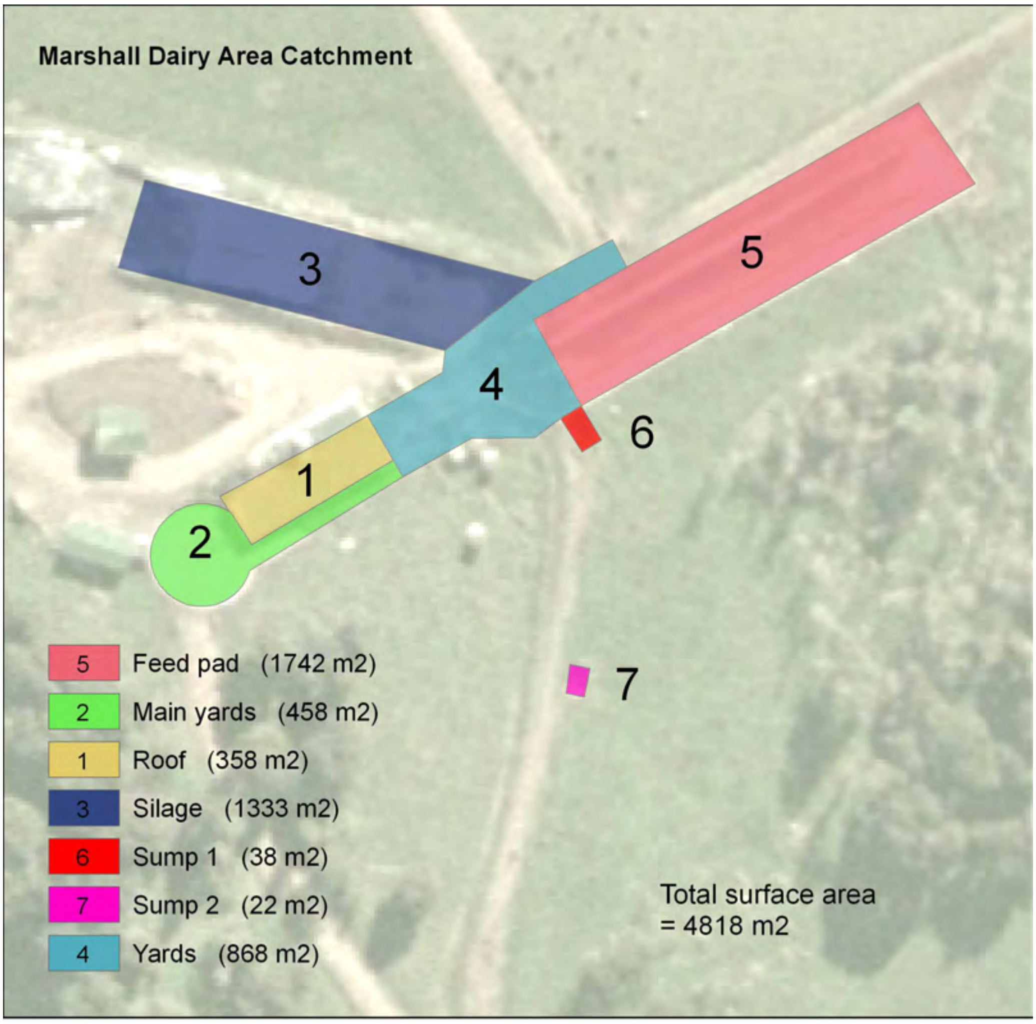
With an increase in the size of the effluent block to approximately 60 ha or greater and the construction of storage capacity, the farm should be able to continue to use its current travelling irrigator.

Table 3. Some suggested parameters of an expanded effluent block

Area of expanded effluent block	60 ha
FDE irrigated per year	47 mm
FDE at risk to rapid drainage	13 mm
N leaching	19 kg ha^{-1}

Input parameters in the model.

Available water holding capacity of soil	75 mm
Irrigated area	14 ha
Effluent production associated with milking	100 l cow^{-1}
Area of shed roof	358 m^2
Area of yards	1325 m^2
Feedpad	1742 m^2
Area of 'silage' yard	1333 m^2
Pond area	60 m^2
Pond volume	60 m^3
Effluent generated per year	28,493 m^3



7.5 EFFECT OF RAINFALL VARIATION AVERAGING ON OVERSEER® MODELLED N-LOSS FOR CASE STUDY #2

Introduction

N-loss modelled by OVERSEER® is sensitive to rainfall. As a generalisation, the higher the rainfall, the greater the loss of soil water by deep drainage, and thus the higher the N-loss risk by leaching.

The Billington Dairy Farm straddles a steep rainfall gradient. This may be due to its close proximity to the Tararua Ranges, and its location within a valley (that runs perpendicular to the Ranges). Average annual rainfall modelled by NIWA as isohyets (using NIWA and Horizons Regional Council meteorological stations) suggest a 435mm annual rainfall difference between the top and bottom of the Billington Dairy Farm (Figure 1). Given N-loss sensitivity to rainfall, this high level of variation may influence OVERSEER® N-loss, both for the whole farm, and for individual nutrient management blocks.

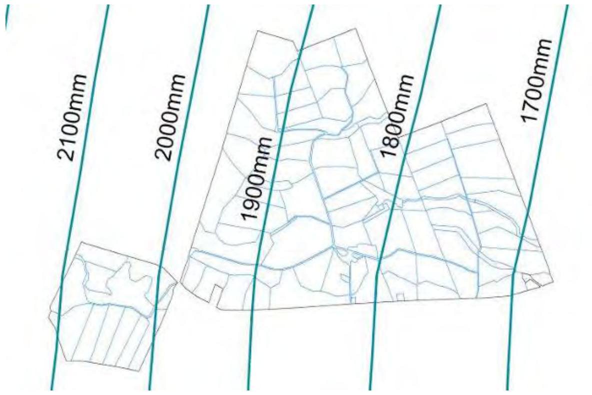


Figure 1: Rainfall isohyets across the Billington Dairy Farm.

Method

The Billington Dairy Farm was modelled through OVERSEER® using three levels of rainfall averaging. Rainfall was the only parameter changed during each of the three scenarios. Average rainfalls were calculated by interpolating the rainfall isohyets into a raster continuous surface, and then taking the spatial average of farm & block polygons (via zonal statistics). Each scenario was run at three rates of urea use (100kg, 200kg, & 300kg N/ha/yr).

Scenario 1: Uses six nutrient mgt blocks identified by the farmer, but rainfall average is calculated for each block (i.e. 2050mm for block 1, 1825mm for block 2, etc).

Scenario 2: Uses the six nutrient management blocks, and an annual rainfall average of 1865mm (i.e. the average for the whole farm).

Scenario 3: The six nutrient mgt blocks were intersected by 100mm rainfall bands to create 12 new blocks. Average rainfall was calculated for each new block. N-loss for each new sub-block was aggregated/summarised according to original blocks for comparison.

Result

Results suggest that OVERSEER® accommodates the effect of rainfall averaging. There was one or two discrepancies but these probably have more to do with rounding (particularly at the reporting end).

Generally there was little effect on whole farm N-loss totals. The exception is the 47kg using a uniform whole-farm rainfall average (cf. 46 kg), which may suggest a whole-farm average rainfall could produce a slightly higher N-loss value at high N use. While +1kg N may be a small value, particularly with high N use, it could be a critical amount for a dairy farmer trying to achieve her N-loss cap.

Understandably there was variation on a block-by-block basis, but this is generally in the order of +/- 1kg N/ha (but up to 2kg N in some cases). Not relevant to the Horizons project (interested in whole farm N-loss), but it would be important for studies looking within blocks to identify problems & mitigations.

Table: OVERSEER® results for different rainfall averaging techniques modelled at three levels of N use

1. Standard blocks + block rainfall			
	300kg	200kg	100kg
FARM	**46**	**31**	**21**
Stoney block	49	32	21
60 acres	54	35	23
Front Block	49	32	21
Top Flats	50	33	22
Front Block B	65	47	34
Non pastoral	2	2	2

2. Standard blocks + whole farm average rainfall (1865mm)			
	300kg	200kg	100kg
FARM	**47**	**31**	**21**
Stoney block	50	33	22
60 acres	50	33	22
Front Block	50	33	22
Top Flats	50	33	22
Front Block B	67	48	35
Non pastoral	2	2	2

3. New blocks + block rainfall			
	300kg	200kg	100kg
FARM	**46**	**31**	**21**
Stoney block 11	51	33	22
60 acres 1	54	35	23
Front Block 2	51	33	22
Top Flats	51	33	22
Front Block B5	64	46	34
Non pastoral	2	2	2
Front Block B6	65	47	34
Front Block 3	47	31	20
Front Block 4	49	32	21
Stoney block 12	47	31	20
Stoney block 13	49	32	21
Top Flats 15	50	32	21

4. New blocks + block rainfall summarised by original blocks (i.e. same as table 3 above)			
	300kg	200kg	100kg
FARM	**46**	**31**	**21**
Stoney block	49	32	21
60 acres	54	35	23
Front Block	49	32	21
Top Flats	51	33	22
Front Block B	65	47	34
Non pastoral	2	2	2

Conclusion

It appears that using block rainfall averages is not necessary when the purpose is the identification of whole-farm N-loss, even when a steep rainfall gradient is present.

Exceptions may be:

- High N use
- When there is an interest in N-loss from individual blocks
- Perhaps when there is a lot more variation regarding N-inputs and N-processes between blocks

7.6 TREND ANALYSIS UNDER AN INTENSIFICATION SCENARIO FOR CASE STUDY #2

Introduction

Intensive farms in select catchments of the Manawatu-Wanganui Region will need to farm according to N-loss limits proposed in Horizons One Plan. Increasingly tighter N-loss limits are to be implemented in f increments over a twenty year period. AgResearch has been contracted to evaluate current N-loss against N-loss limits for seven case study farms. While N-loss can be readily modelled for current farm practice, it is more difficult to predict how farm N-loss may change over the 20 year period. The objective is to extrapolate the Billington's current system 20 years hence according to production trends and industry objectives, and to use the results to model potential N-loss change out to 20 years.

N-loss limits

N-loss limits have been calculated for the Billington farm according to FARM Strategy specifications. These are based on an assessment of Land Use Capability, and they are unlikely to change over the 20 year period.

Table 1: Permissible N-loss limits (kg N/ha/yr)				
Year	*2010*	*2015*	*2020*	*2030*
Calculated from farm mapping	**20**	**19**	**17**	**16**

Existing N-loss

N-loss for the Billington farm has been modelled at 24 kg N/ha/yr using OVERSEER®. An additional 2 kg N/ha/yr has been calculated (contributions associated with unfenced waterways and the effluent system), which brings **existing N-loss to 26 kg N/ha/yr**.

Reduction required by 2010

The Billington farm is required to reduce farm N-loss by 6 kg N/ha/yr before 2010. If nitrogen losses remain constant, then a further reduction of 4 kg N/ha is required before the end of the 20 year period. So the farm needs to aim at reducing N-loss by 10 kg over twenty years.

However, it is likely that farm production will change significantly over the 20 year period, and this would have an impact on levels of N-loss and the ability/cost of achieving longer term N-loss limits.

Predicted production increase

The dairy industry has set a target of 4% growth in farm productivity per year. This is not unrealistic given that average milk solid production per cow has increased by 4% per year between 1994 and 2004 (source: Stats NZ). However, expecting a 4% increase per cow is perhaps unrealistic – over a twenty year period cow performance would need to lift to around 590 kg MS per cow. More realistic perhaps is a target of 500 kg MS/cow within twenty years, given that 400 kg MS/cow is being achieved by some of today's farmers. Accordingly, we propose the Billington farm operation could realistically target a 500 kg MS/cow level of performance for year 2025. This requires an increase of 3.3% MS/cow/yr or 8.8 kg MS/cow/yr. According to the LIC, a gain of 3.6 kg MS/cow/yr on average is currently being achieved through genetics alone.

Productivity is a measure of efficiency. This report uses total milk-solid production as a crude indicator of productivity, and the industry's target of 4% growth. Using a uniform yearly increase (cf. compound annual increase), the Billington farm would be looking to gain 5,200 kg MS each year (4% of 130,000 kg), and would be aiming to produce 228800 kg MS in year 2030 (~1380 kg MS/ha). This is not an unrealistic proposition.

While some productivity gains will be attained through genetics (currently 3.6 kg MS/cow/yr according to the LIC), most gains will likely follow existing trends of higher stocking rates and increased inputs. For example, between 1994 & 2004 dairy cow numbers increased by 34% and dairy farm urea use increased by 162% (PCE, 2004). These are quite dramatic changes over a short period. For the Billington farm, a more gradual and perhaps realistic future trend can be calculated from the industry's 4% gain/yr target and the potential of 500 kg MS/cow.

If the Billington farm aimed to increase productivity by 4% each year by both by lifting total MS production to 273890 kg MS and by lifting individual cow performance to 500 kg MS/cow, then we can predict how cow numbers may need to change over the 20 year period (Table 1). Assuming the management style doesn't change dramatically over the 20 year period, cow numbers can be used to estimate feed and fertiliser requirements per cow, and extrapolated according to the herd size increases. These can then be used as key inputs into the OVERSEER® model.

Change in production parameters						Change in key feed & fertiliser inputs[5]					
Year	Total MS @ 4% increase per yr (kg MS)[1]	MS kg/cow @ 500kg MS/cow 20yr target[2]	Change in cow numbers to achieve target	Change in pasture equivalents (kg DM/ha/yr)[3]	Change in stocking rate[4] (cows/ha)	Silage (kg)	Balage (kg)	Hay (kg)	Palm kernel (kg)	Urea (kg/ha)	30% K Super (kg/yr)
1	**130000**	**333**	**390**	**12760**	**2.35**	**26,000**	**35000**	**40000**	**75000**	**241**	**400**
2	135200	342	395	12930	2.38	26,345	35465	40531	75996	244	405
3	140400	351	400	13091	2.41	26,673	35906	41036	76942	247	410
4	145600	360	405	13244	2.44	26,985	36326	41516	77842	250	415
5	**150800**	**368**	**409**	**13390**	**2.47**	**27,282**	**36726**	**41973**	**78699**	**253**	**420**
6	156000	377	413	13529	2.49	27,566	37108	42409	79516	256	424
7	161200	386	418	13661	2.52	27,836	37472	42825	80296	258	428
8	166400	395	421	13788	2.54	28,094	37819	43222	81041	260	432
9	171600	404	425	13909	2.56	28,341	38152	43602	81754	263	436
10	**176800**	**412**	**429**	**14025**	**2.58**	**28,578**	**38470**	**43966**	**82437**	**265**	**440**
11	182000	421	432	14137	2.60	28,805	38776	44315	83090	267	443
12	187200	430	435	14243	2.62	29,022	39068	44649	83718	269	446
13	192400	439	438	14346	2.64	29,231	39349	44970	84320	271	450
14	197600	448	441	14444	2.66	29,431	39619	45279	84898	273	453
15	202800	456	444	14539	2.68	29,624	39879	45575	85454	275	456
16	208000	465	447	14630	2.69	29,810	40128	45861	85989	276	459
17	213200	474	450	14717	2.71	29,988	40369	46136	86504	278	461
18	218400	483	452	14802	2.73	30,160	40600	46400	87001	280	464
19	223600	492	455	14883	2.74	30,326	40824	46656	87479	281	467
20	**228800**	**500**	**457**	**14962**	**2.75**	**30,486**	**41039**	**46902**	**87941**	**283**	**469**

1 Using the dairy industry's aim of 4% increase in productivity each year and assuming total MS production as an indicator of productivity. A uniform 5300 kg MS is added each year (4% of 130,000 = 5300 kg MS) rather than a compound increase on each year's new total. This is because of the way the statistic was likely calculated (e.g. summed production divided by number of years = production change/year). Note that a non-compounding calculation is also conservative. If it had been used then the twenty year targets would be 273,890 kg MS from 547 cows at a 3.3 cows/ha stocking rate.

2 Assumes 500 kg MS/cow is achievable within 20 years. Requires 8.8 kg MS gain per cow per year for the Billington farm.

3 Based on 7.9 su/cow (500kg LW producing 180 kg MF/cow), 550 kg DM/ha/yr per stock unit pasture requirement, and 80% utilisation.

4 Higher stocking rates may require the use of feed pads or herd homes

5 Current feed and fertiliser inputs were expressed on a per cow basis, and extrapolated linearly to the changes in herd size.

OVERSEER® scenario analysis

OVERSEER® was rerun using three scenarios for the three time intervals of interest (Year_05, Year_10, Year_20) and the predicted changes in production and inputs calculated in the previous table. All other OVERSEER® variables remained unchanged from the base scenario (Year_01).

However, base scenario N-losses associated with the effluent disposal system and unfenced waterways were calculated external to the OVERSEER® model. It is reasonable to expect N-losses would increase from both these sources according to the intensifications predicted in Table 1. To save repeating the somewhat arduous manual calculations for each scenario, a co-factor is calculated and applied to each N-loss value modelled by OVERSEER®. This is simply a percent of N-loss from unfenced waterways and effluent disposal relative to the proportion of N-loss calculated by the base OVERSEER® scenario (i.e. 2.1 kg N/ha divided by 26 kg N/ha multiplied by 100 = 8%).

Scenario analysis results

N-loss increases from **26 kg N/ha** (Year_01) to **29 kg N/ha** (Year_05), then up to **31 kg N/ha** (Year_10), and finally **36 kg N/ha** for Year_20.

Nitrogen Budget Change

Predicted changes over 20 years

	(kg N/ha/yr)			
Inputs	Year 01	Year 05	Year 10	Year 20
Fertiliser	98	103	108	115
Effluent added	0	0	0	0
Atmospheric/Clover N	48	58	67	87
Irrigation	0	0	0	0
Slow release	0	0	0	0
Supplements	23	24	25	27
Outputs				
Product	50	58	68	87
Transfer	2	3	3	3
Supplements removed	0	0	0	0
Atmospheric	49	54	58	66
Leaching/runoff *	**26***	**29***	**31***	**36***
Immobilisation/absorption	43	43	42	40
Change in inorganic soil pool	0	0	0	0

** Adjusted by a factor of 0.08 (8%) to include losses associated with the effluent application system and unfenced waterways.*

Other changes				
P loss risk	LOW	LOW	MEDIUM	MEDIUM
Minimum effluent area for 150 kg N/ha/yr loading	19.5 ha	22 ha	24.2 ha	28.1 ha
Minimum effluent area for 100 kg K/ha/yr loading	28.7 ha	32 ha	36.1 ha	42.1 ha
Methane from animals*	3292*	3710*	4100*	4822*
N_2O emissions*	1751*	1932*	2089*	2354*
CO_2 emissions*	942*	994*	1053*	1161*
Approximate area of forest to absorb farm CO_2 equivalents (pine @ 1 net rotation)	102 ha	113 ha	124 ha	142 ha

** units = kg CO2 equivalents*

Implications

Two situations are presented below to show the degree of N-loss reduction the Billington farm may have to make over the next 20 years. The first represents no change in existing N-loss, whereby the current 26 kg N/ha N-loss remains constant for the twenty year period. The second is calculated from predicated changes in production.

Situation 1: Uniform N-loss for 20 years (kg N/ha/yr)				
Year	*2010*	*2015*	*2020*	*2030*
Current N-loss (constant for 20 years)	**26**	**26**	**26**	**26**
Horizons N-loss limits for Billington	**20**	**19**	**17**	**16**
Difference (required reduction)	*+6*	*+7*	*+9*	*+10*

Situation 2: Production increase (kg N/ha/yr)				
Year	*2010*	*2015*	*2020*	*2030*
Predicted N-loss	**26**	**29**	**31**	**36**
Horizons N-loss limits for Billington	**20**	**19**	**17**	**16**
Difference (required reduction)	*+6*	*+10*	*+14*	*+20*

Put into words, the Billington farm needs to reduce N-loss by 10 kg/ha/yr if currently levels of N-loss remain unchanged over the twenty year period. This is unlikely if the farm intensifies. In this case, the Billington farm would need to reduce N-loss by 20 kg N/ha/yr over 20 yrs (effectively 1kg/yr) to remain compliant under the One Plan.

Limitations

- This is an exercise in crystal ball gazing. It is just a prediction based on what is likely to happen based on current trends and world views. Results are included to give an indication of the implications of production vs. N-loss heading into the future.
- Fertiliser and feed input estimates are purely linear – assumes a stock number increase results in a proportional increase in inputs. This may or may not be a valid assumption.
- Similar to the above, the scenarios assume that the style of management does not need to change to achieve the prediction targets.
- Have endeavoured to err on the side of caution. Given that 20yrs is a long time, and given most of the production estimates are attainable (some farmers are already attaining similar total MS production), then the predictions can be considered conservative (the purpose was to design realistic scenarios). **The exercise could be rerun again using more optimistic estimates derived from the performance and intensification trends of today's most aggressive farmers.**

7.7 SHOULD EFFECTIVE AREA OR TOTAL FARM AREA BE USED TO CALCULATE N-LOSS LIMITS?

One Plan N-loss limits have been derived on a whole-of-catchment basis (total catchment area). Nutrient budgeting is often undertaken using effective area. Further, with the current OVERSEER® release, there is no provision for including redundant land that is not vegetated (e.g. land that is not covered in trees or pasture).

The first case study farm includes a sizeable area (~8ha) of redundant land not used for farming (namely river land, but also smaller areas of hard surfaces, school carpark, buildings, residential plots, ponds). According to legal title, all this land is part of the property (i.e. legally owned land), and should therefore be used to calculate both N-limits and current N-loss.

N-loss calculated by OVERSEER® only considers grazed land (94ha) and trees (9ha), which totals **103 ha**. However, Horizons N-loss targets were calculated on a 'whole of catchment' basis. On the one hand, it is reasonable to expect that the council is interested in N-loss for the entire farm. On the other, Rule 13x only applies to intensively used land.

Two options are considered:

1. **Including redundant land in OVERSEER® (total farm area)**: A default N-loss value was applied to redundant land. The default value was 2 kg N ha^{-1} yr^{-1} (which is the equivalent for atmospheric contributions and losses). OVERSEER® was re-run with an additional block called 'redundant' (9 ha). Results below.

Model	Area (ha)	OVERSEER® N-loss result (kg N/ha/yr)
Base model	103	31 kg N
Base model + 'redundant land'	112	29 kg N

   Factoring in 'redundant land' decreases (dilutes) total N-loss from the farm. The reduction was 2 kg N which is considerable.

   Implications: All farms with a sizeable proportion of redundant or waste land would effectively dilute the N-loss contribution from their intensely used land.

   Problems: a) N-contributions associated with rainfall are likely to run-off some of the redundant land anyway (buildings, carpark, lanes) and onto land already used in the OVERSEER® base model. b) In principle, Horizons are only interested in N-loss from intensely used land. c) OVERSEER® is not yet configured to account for the redundant land discussed here (although it will be included in the next release). d) OVERSEER® makes some spatially implicit assumptions about some types of redundant land, such as assuming a dairy model will have a proportion of area dedicated to tracking (however, while this is used to estimate nutrient transfer, it is not used to report N-loss on a block or whole farm basis).

2. **N-loss calculated from OVERSEER® areas (effective area + trees)**: The same area of land that was used in the OVERSEER® base-model (103 ha) is used to calculate N-loss targets. Put another way, all redundant land was blanked out from the LUC layers, effectively removing it from the calculation. This was done for each scale of LUC classification. Results below.

Table: Comparison of N-loss calculated at 112ha & 103ha across three scales

	N-loss target (kg N ha^{-1} yr^{-1})			
1. LOW DETAIL SCALE	*Yr1*	*Yr5*	*Yr10*	*Yr20*
Whole farm (112 ha)	25.7	23.1	20.6	19.6
Without redundant land (103 ha)	25.8	23.2	20.6	19.6
Change in N-loss target	+0.1	+0.1	+0.1	+0.1
2. MEDIUM DETAIL SCALE				
Whole farm (112 ha)	23.7	21.3	19.0	18.1
Without redundant land (103 ha)	24.6	22.1	19.7	18.8
Change in N-loss target	+0.9	+0.8	+0.7	+0.7
3. HIGH DETAIL SCALE				
Whole farm (112 ha)	**22.8**	20.6	18.4	17.5
Without redundant land (103 ha)	**23.6**	21.3	19.0	18.1
Change in N-loss target	**+0.8**	+0.7	+0.7	+0.6

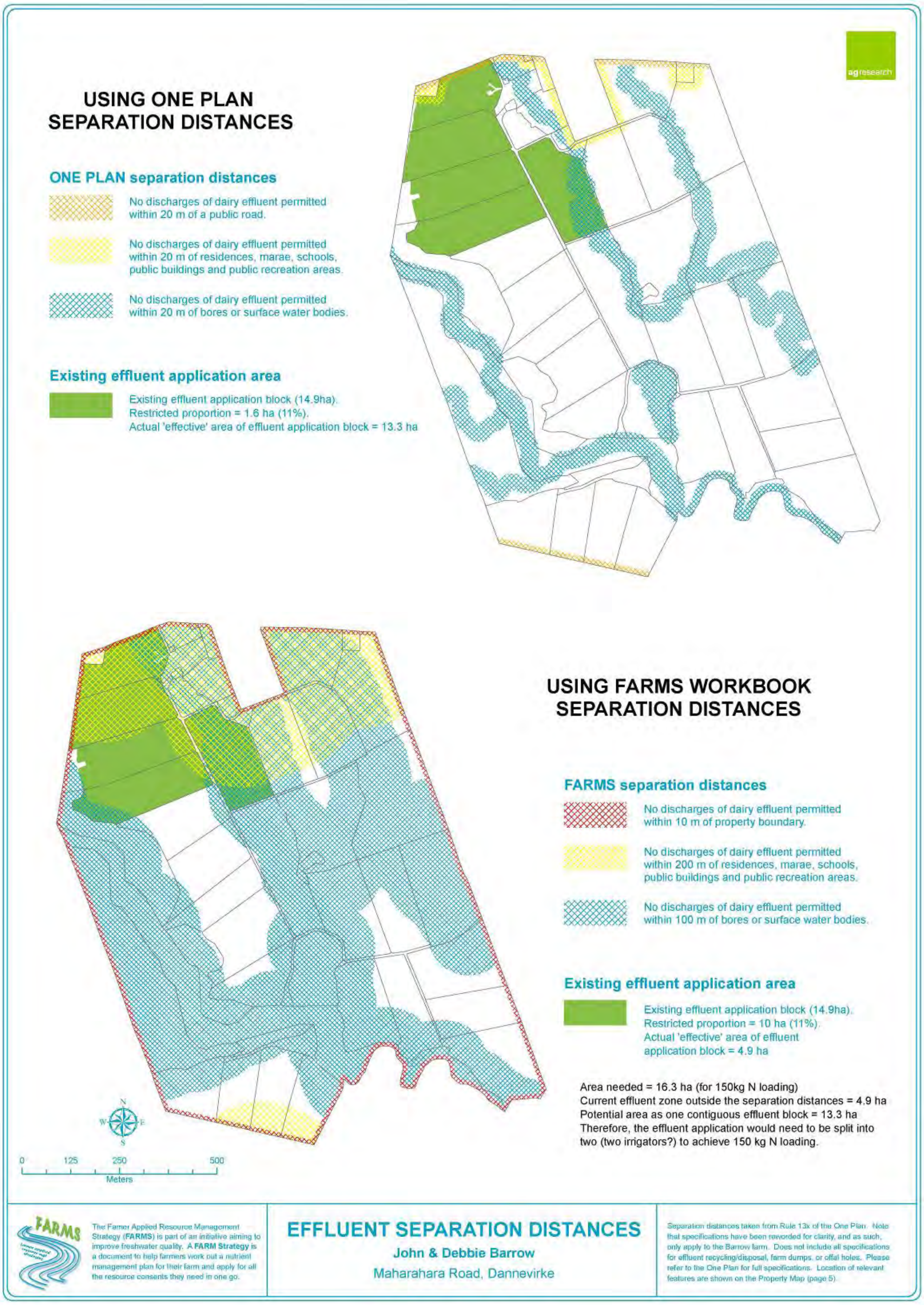
For this property, the effect of using OVERSEER® area (103 ha) is to increase N-loss targets across all scales of mapping. The smallest change occurs with the LOW DETAIL mapping (+0.1 kg N ha^{-1} yr^{-1}). The HIGH DETAIL change (+0.8 kg N ha^{-1} yr^{-1}) is of most interest, however, because it effectively says the farm can leach an additional 1 kg N ha^{-1} yr^{-1}.

Recommendation: That the FARM Strategy approach uses total farm area to calculate both N-targets and OVERSEER® N-loss. This is inline with the underlying farm-to-catchment philosophy (i.e. using effective farm area alone would require the revaluation of One Plan N-limits on a whole of catchment basis), and represents a comparison of 'apples with apples'. While technically OVERSEER® does not currently incorporate the concept of 'redundant land', assuming a uniform 2 kg N/ha loss (i.e. that same that OVERSEER® uses for 'Trees') is adequate and readily justified until the next release of OVERSEER® is available.

7.8 EFFLUENT SEPARATION DISTANCES

Effluent-discharge separation distances specified in the One Plan are different than those specified in the FARMS Workbook. Both were calculated and mapped for Case Study #1 to evaluate implications (see maps).

The area of land available for effluent disposal would be severely restricted using Workbook separation distances. To achieve compliance the effluent block would need to be split in two, possibly requiring two separate irrigators and an investment in new piping. It is conceivable that workbook separation distances applied to some dairy farms would make legal application of effluent to land impossible (i.e. whole farm becomes a non-effluent area). It is recommended that One Plan separation distances be used for FARM Strategies.



7.9 NUTRIENT CONTRIBUTIONS FROM DIRECT DEFECTION OF STOCK TO WATERWAYS, CASE STUDY #1

OVERSEER® generates an estimate of diffuse-source N-losses. Currently it cannot yet account for point and quasi-point sources of N-loss such as direct defecation by stock into waterways. The case study property has a sizeable area of land dissected by a river, and approximately 10 paddocks dissected by sizeable streams. Direct contamination by stock is estimated by calculating the number of river crossings required each year for 250 cows (200 in winter), and the proportion of cows grazing land on the other side of streams (as a proportion of total paddock area). Estimates are conservative, and are provided for demonstration purposes. Calculations for both N and P are included.

River crossing evaluation

Number of cow-crossings per year

The farm is dissected by the Oruakeretaki "Stream" into the K-Road blocks (14ha effective) and the rest of the farm. During the milking season (20 Aug to 25 May = 278 days), the full herd (250 cows) crosses the river 6 times per grazing rotation (1 rotation = 20 days). During the off-season only two crossing are made (200 cows wintered on-farm).

> A 20 day rotation over 278 days equates to **14 complete rotations per year** during the milking season (278 / 20 = 14).
> At 6 crossings per grazing rotation this equates to **84 crossings** for the full milking season (6 x 14 = 84).
> At 250 cows per crossing this equates to the equivalent of **21,000 cow-crossings** during the milking season (250 x 84 = 21,000).
> Add to this the two winter crossings (200 cows x 2 crossings = 400 cow-crossings), and the total comes to **21,400 cow-crossings** for the year.

Number of direct defecations per year

Davies-Colley *et al*. (2002) measured the water quality impact of 246 cows crossing a stream ford (the Sherry River study, Tasman). Their findings indicate that 10% of cows will defecate directly into the water as they make their way from one side to the next.
For the Barrow farm, if 10% of cows defecate at crossings, then there are around 2140 individual defecation events (10% of 21,400 cow-crossings). Put another way, **the herd may defecate 2140 times a year directly into the Oruakeretaki Stream**.

Direct N-loss from cow-crossing defecation events

A single cow pat contains around 7.6 g of N for a Friesian-Jersey cross (calculated from Vanderholm, 1984. See Appendix 1 for full calculation).
For the Barrow property, if 7.6 g N is excreted in each cow pat, then the total amount of dung-N being deposited at the crossing would be 16.3 kg N yr^{-1} for the whole farm (7.6 x 2140 = 16264g = 16.3 kg).
Expressed on a per hectare basis, there is an estimated **0.17 kg N ha-^{1} yr^{-1} lost to water from dung at crossings** (16.3 / 94ha).

Direct N-loss from cow-crossing urination events

Unfortunately Davies-Colley *et al*. (2002) did not record urination events, and when approached, Dr Davies-Colley could not refer us to any similar study regarding direct urinations of dairy cattle at crossings (Davies-Colley, personal communication, 25/07/07). However, they did measure the yield of total N deposited by the herd they studied. This can be used to estimate the contribution of direct-deposition urine-N, and the percent of the herd contributing.

> Background: 25 mostly Friesian cows from a herd of 246 defecated at the stream crossing (~10% of the herd). Yield of total N attributed to stock crossing averaged 724 g N (total yield accounts for background/upstream N).
> At 8.0 g N per defecation event (higher for Friesians – see Appendix 3), then total N contributed via dung is 200 g (8 g x 25 cow pats). That leaves 524 g N attributable to urine-N (724g – 200 g = 524 g). The amount of N in urine has been calculated at 14.4 g N per urination event (see appendix 3). This means there were around 36 urination events (524g / 14.4g = 36.4), which equates to **14.8% of the herd having urinated at the crossing**. However, this does not account for N dragged into the river on hooves & legs (although this contribution is thought to be small).

Applied to the barrow farm, if 14.8% of cows urinate at crossings, then there are around 3167 individual urination events (14.8% of 21,400 cow-crossings). **The herd is estimated to be urinating 3167 times a year directly into the Oruakeretaki Stream**.
Total nitrogen from a single urine event is 13.7 g N for a Friesian-Jersey cross (calculated from Vanderholm, 1984.).
For the Barrow property, if 13.7 g N is excreted in each urine event, then the total amount of urine-N being deposited at the crossing would be 36.9 kg N yr^{-1} for the whole farm (13.7 x 3167 = 43391g = 43.4 kg).
Expressed on a per hectare basis, and estimated **0.46 kg N ha-^{1} yr^{-1} is lost to water from urine at crossings** (43.4kg / 94ha).

Total N loss from direct dung and urine loss at the Barrow's stream crossing is estimated at 59.7 kg N yr^{-1} or 0.64 kg N ha^{-1} yr^{-1} (whole farm).

Unfenced streams evaluation

There are 10 paddocks that contain sizeable streams. The farmer considers most to be marginal as to whether or not they qualify as targeted streams under the Clean Streams Accord (wider than a stride, deeper than a red band gumboot). When the streams were evaluated mid-winter (peak flows), most if not all would have fallen on the qualifying side of marginal (more like wider than a leap and deeper than a calf-length gumboot). However, depth and width will vary with season.
The farmer expressed practical concern for fencing of streams. All are irregular and uneven in terms of flow direction (Map 2, overleaf), so not only is there a potential to loose a large area of grazed land, but fencing costs would be high if bends and twists were accounted for. Further, these particular streams produce high biomass in the form of water weeds (e.g watercress), that traps sediment and builds the river bed up. When streams flood the weed and sediment is dislodged and moves downstream as a mass, often damming the stream and occasionally causing the blow-out of culverts. Having stock graze the waterweed and stir up the sediment is an effective strategy for reducing these risks.

Even so, the potential contribution of N via direct defecation to streams is worth evaluating. The time may come when these waterways must be fenced, so it is worth knowing the effect of reduced N-loading.
There is no recommended method for calculating the contribution of N to streams in the grazed paddock. A conservative estimate is provided below (Table:). Method involved calculating percent of paddock area grazed on the other side of a stream for each paddock, which was used to distribute stocking rate to identify the number of cows crossing the streams each year. Davies-Colley's *et al*. (2002) factor of 10% was used to estimate the number of defecation events directly to water, and the derived 14.8% used to estimate urine contributions (see previous discussion under the River Crossing Evaluation).

Table: Direct N losses to water via *in situ* grazing

Paddock	Entry side area (ha)[1]	Area grazed across stream (ha)	Total paddock area (ha)	% of paddock across the stream	# cows crossing per year[2]	# cow pats[3] @ 10%	# urine events[4] @ 14.8%	N from dung[5] (kg)	N from urine[5] (kg)	Total N loss per paddock (kg)[6]
P_01	1.769	3.42	5.189	65.91%	2307	231	341	1.75	4.67	6.4
P_02	2.934	0.03	2.961	0.91%	32	3	5	0.02	0.06	0.1
P_03	2.096	1.49	3.582	41.49%	1452	145	215	1.10	2.94	4.0
P_04	1.11	1.11	4.818	76.95%	2693	269	399	2.05	5.45	7.5
P_05	3.414	0.04	3.458	1.27%	45	4	7	0.03	0.09	0.1
P_06	3.121	0.08	3.199	2.44%	85	9	13	0.06	0.17	0.2
P_07	2.635	0.54	3.174	16.98%	594	59	88	0.45	1.20	1.7
P_08	2.619	0.25	2.868	8.68%	304	30	45	0.23	0.62	0.8
P_09	1.345	1.21	2.552	47.30%	1655	166	245	1.26	3.35	4.6
P_10	0.205	0.18	0.389	-	-	-	-	-	-	-
P_11	2.863	0.21	3.077	6.95%	243	24	36	0.18	0.49	0.7
								7.15	19.05	**26.2**

[1] Part of the paddock where the main gate is located. Note that all areas are effective areas.
[2] Assuming all paddocks are grazed within one rotation (20 days). Given 250 cows per paddock once every rotation, then for 14 rotations over the milking season this equates to 3500 individual cow-grazings per paddock per year. Excludes P_10 which is a holding paddock. Also excluded is winter grazing (80 day rotation = each paddock grazed once) because of break-feeding complications.
[3] Based on a study of 246 cows crossing a stream where 10% of the herd defecated directly into water (Davies-Colley *et al*., 2002)
[4] Calculated from findings reported in Davies-Colley et al., 2002. See previous discussions under the River Crossing Evaluation.
[5] N content of dung (7.6 g N) and urine (13.7 g N) events calculated from Vanderholm, 1984. See Appendix 3.
[6] At least four paddocks have culverted crossings. Stock using these crossings will not be defecating directly into water. However, no information is available for stock preference of culvert crossings. Further, the effect may be averaged out by the number of stock entering water but not crossing the streams (e.g. stock entering the stream to drink water or graze waterweed). More research is needed here.

Direct N-loss to unfenced streams on the Barrow farm is estimated to be 26.2 kg N yr^{-1} for the whole farm, or 0.28 kg N ha^{-1} yr^{-1} on a per hectare basis. This is a very conservative estimate.
For comparison, Bagshaw (reported in Collins et al., 2007) observed dairy cattle defecation directly to streams in an *in situ* grazing environment over two summers and one spring. She found that 0.5% of defecations in a paddock were made directly to water. There was no reporting of urinations to water. However, applied to the Barrow property, 250 cows per day produce around 3000 pats per grazed paddock, which equates to 42,000 pats per paddock during the milking season (3000 pats/paddock grazed x 14 rotations). This means 210 pats directly to water for each paddock (0.5% of 42,000), with each pat containing 7.6 g of N. Total contribution **from dung alone** could be upwards of 15.96 kg N per year (210 pats x 0.0076 kg N x 10 paddocks). On a per hectare basis = 0.17 kg N ha^{-1} yr^{-1}.

Total N losses to waterways from crossings and unfenced streams for the Barrow farm equates to an estimated 0.8 kg N ha^{-1} yr^{-1}

Direct loss of P to waterways evaluation
An estimate of P loss directly to waterways is made from the method developed in the previous section. Assumptions include:
- The herd defecates 2140 times and urinates 3167 times directly to water at the river crossing each year.
- The herd defecates 941 times and urinates 1393 times directly into unfenced streams during the year.
- A single cow pat contains 1.9g P, and a single urine patch contains 0.1g P (see Appendix 3).

Total loss of P directly to water is estimated at 6.3 kg P yr^{-1} for the whole farm, or 0.07 kg P ha^{-1} yr^{-1} on a per hectare basis (~67g/ha/yr).
It is therefore fair to say that the Barrow's contribution of P to waterways directly from cow excreta is so small it is likely to be insignificant.

References and values used to calculate the N & P content of dung & urine.

Table: N & P content of dairy cow excreta		
	Friesian	FxJ cross
Live weight (kg)	**500**	**475**
Total N* per cow (kg per day)	0.24	0.228
Total P* per cow (kg per day)	0.025	0.02375

Source: Vanderholm 1984. FxJ cross values calculated according to the method recommended by Vanderholm also. Values are for pasture-grazed dairy cows.
* Values are for combined dung & urine (freshly voided).

Table: Percent of nutrient returned as dung and urine		
	%N	%P
Dung	40%	95%
Urine	60%	5%

Source: Summarised from average values and discussion in Haynes & Williams, 1993.

Table: Separation of nutrient from dung and urine		
	Friesian	FxJ
Total Dung N (kg per day)[1]	0.096	0.0912
Total Urine N (kg per day)[1]	0.144	0.1368
N per cow pat (kg per day)[2]	0.008	0.0076
N per urine event (kg per day)[3]	0.0144	0.01368

[1] E.g If 40% of excreta-N is returned in dung then 0.4 x 0.24 kg N = 0.144 kg
[2] Assuming the average cow produces 12 pats each day (average from studies reported in Haynes & Willams 1993, and values estimated by Bagshaw 2002 for calculations).
[3] Assuming the average cow urinates 10 times per day (average from 9 studies with results tabulated in Haynes & Williams, 1993).

References

Collins et al., 2007. Best mgt practices to mitigate faecal contamination. NZ Journal of Agricultural Research, 50: 267-278.

Vanderholm, D.H., 1984. “Agricultural Waste Manual”. New Zealand Agricultural Engineering Institute Project Report No. 32. NZAEI, Lincoln College, New Zealand.

DEC (Dairying and the Environment Committee) 2006. Managing farm dairy effluent (3rd revised and updated edition). Dairying and the Environment Committee, Wellington, New Zealand.

Bagshaw, C.S. (2002). Factors Influencing Direct Deposition of Cattle Faecal Material in Riparian Zones. MAF Technical Paper No: 2002/19. Wellington, New Zealand.

Note: Bagshaw discusses the number of cattle defecations per day as reported by Hafez & Bouissou (1975), Wagnon (1963), and Sahara et al. (1990). Bagshaw considers these studies to propose 11.5 defecations per day per animal as an average suitable for calculation purposes.

Davies-Colley, R.J., Nagels, J.W., Smith, R.A., Young, R.G., Phillips, C.J. 2004. Water quality impact of a dairy cow herd crossing a stream. New Zealand Journal of Marine and Freshwater Research 38:569-576

Haynes, R. J.; Williams, P. H. 1993: Nutrient cycling and soil fertility in the grazed pasture ecosystem. *Advances in Agronomy 49*: 119-199.

7.10 A PRAGMATIC INTERPRETATION OF ONE PLAN REQUIREMENTS FOR CASE STUDY #4

Introduction

A FARM Strategy has been prepared for the Day Farm to evaluate the implications of the proposed One Plan's Rule 13.x as they relate to 'intensive' sheep and beef farming (see RMS #003a). While the farm is not targeted under Rule 13.x (not classed as 'intensive' nor located in a priority catchment), it is taken through the FARMS process to examine current and permitted N-loss, mitigation options for N, P and faecal bugs (including cost estimates), and 'other' One Plan requirements such as excluding stock from waterways, ensuring trough or dam water in every paddock, and bridging or culverting stream crossings.

Rigid application of Rule 13.x to the Day Farm would result in challenging and expensive compliance requirements. Requirements include the erection of 40 km of new riparian fencing (or equivalent protection); installing 28 new culverts, 45 new troughs, 18 new dams; and installing a new bridge (to keep 3 ha for grazing). Total cost was estimated at $455,000 or $475,000 if a new bridge was constructed.

However, **the Day Farm represents an extreme case** because it is regarded as 'extensive' rather than 'intensive' under the One Plan. Extensive sheep and beef farms tend to be less developed per unit area than more intensive farming types. Put simply, an extensive sheep and beef farm will require considerably greater investment to become compliant when compared against a dairy farm, which is likely to be much smaller, and already well developed in terms of fencing, troughs, etc. Similarly, it would be expected that an 'intensive' sheep and beef farm would be much nearer compliance simply because of development status. As such, the Day Farm is not particularly representative as a case study example; at best it represents an extreme case. Further, in being in the Tararua District beneath the shadow of the Tararua Ranges, the property has a particularly high incidence of perennial waterways that require stock exclusion, culverting and perhaps bridging.

Even as an extreme case, compliance levels required by a rigid application of Rule 13.x are seriously onerous. The purpose of this report is to re-evaluate compliance requirements and associated cost estimates through a less rigid and more practical interpretation of Rule 13.x.

Method

Nutrient Management Blocks were used as a basis for classifying the farm into extensive and semi-intensive. 'Extensive' represents the harder hill country blocks, and the steeper and more exposed parts of the farm located within the Tararua Ranges. All troughs, dams, bridges, culverts and riparian fencing recommended under RMS #003a that fall within the 'extensive' block were excluded. Riparian fencing in the 'semi-intensive' block was divided further according to cattle grazing policies. New riparian-fence regimes were recommended for areas with continual cattle grazing (permanent cattle/sheep fencing required) and occasional cattle grazing (temporary cattle fencing required). "Occasional cattle grazing" fencing refers to a temporary one-wire electric erected around the water course every time the paddock is grazed by cattle. Sheep are not excluded, on the basis that sheep do not exhibit the same attraction, or defecation response, to waterways relative to cattle. They are therefore less likely to defecate, play in, damage the banks of, and stir up sediment of water courses.

Results

Requirements and estimated costs are reduced by a substantial margin (Table 1). While $50,700 is still a lot of money, the Day Farm represents an extreme case of what would be regarded as 'intensive' under the One Plan, and therefore would require greater development and investment to become compliant. Similar 'intensive' sheep and beef farms would be expected to be at a higher level of development, and would therefore, in principle, require comparatively less development to achieve the same level of compliance.

Table 1: Practical interpretation of One Plan requirements

	Strict interpretation of Rule 13x		**Practical interpretation of Rule 13x**	
	Units required	Cost estimate	Units required	Revised cost estimate
Troughs	45	$19,475	35	$15,150
Culverts	28	$15,000	21	$11,250
Dams	18	$18,000	2	$2000
Bridge[1]	*1*	*$20,000*	*1*	*$20,000*
Permanent riparian fencing[2]	40 km	$400,000	10.6 km	$19,610
Temporary riparian fencing[3]	-	-	13 km	-
Other compliance costs	-	$2700	-	$2700
Total cost		**$455,000**[4]		**$50,700**[4]

1 New bridge is optional and depends on a decision to retain or retire 3ha.
2 Previous costs based on $10/m for a 4 wire electric hill-country system to exclude sheep. New cost based on $1850/km for 2-wire electric that only needs to exclude cattle.
3 Assumes no additional capital cost. However there will be an increased labour requirement.
4 Excludes new bridge cost.

Conclusion
A literal interpretation of Rule 13x of the One Plan for extensive sheep and beef farms may result in onerous requirements and disproportionately high costs. Practical interpretation of the Rule to allow segregation of sheep and beef farms into extensive and intensive (or semi-intensive), and temporary fencing of streams in paddocks occasionally grazed by cattle, reduces requirements and costs to achievable levels. While financial outlay would still be high for the Day Farm, this represents an extreme case and lower requirements/costs would be expected for more developed sheep and beef properties that do actually qualify as being 'intensive' under the One Plan.

Recommendation
That discretionary provisions be incorporated into Rule 13x especially for (intensive) sheep and beef FARM Strategies to allow:

1. The evaluation of predicted N-loss against permissible N-loss on a whole farm basis, irrespective of intensive/extensive farming blocks (N-loss from intensive areas is spread across extensive areas thereby making compliance more achievable).
2. Extensively and intensively farmed blocks to be evaluated separately for all other Rule 13x compliance requirements.

Consideration is also recommended for allowing temporary fencing that excludes cattle but not sheep from streams, in paddocks where cattle are infrequently grazed.

7.11 EXAMPLE OF MINIMUM REPORT REQUIREMENTS FOR FARM STRATEGIES RECOMMENDATIONS

FARM Strategy

Glenbrook Farm, Hukanui

Summary

Rule 13.1 of the regional council's proposed One Plan requires Glenbrook Farm to be operating under a FARM Strategy by April 1st 2010. Glenbrook is a 188ha seasonal supply dairy farm located at Hukanui. Purpose of this report is to assess compliance requirements in terms of permissible nitrogen-loss (N-loss) limits, options to minimise waterway contaminant risk, and other various compliance requirements specified in the FARMS Workbook.

Current N-loss via leaching and runoff is estimated at 26 kg N/ha. Phosphorus runoff risk (P-loss) is rated as LOW. One Plan N-loss limits are calculated at 23 kg N/ha/yr for 2010, decreasing to 18 kg N/ha/yr for 2030. N-loss limits were calculated using unverified regional-scale Land Use Capability classifications. Glenbrook Farm needs to reduce N-loss by 3 kg N/ha/yr to be compliant with 2010 targets.

Several options for reducing N-loss are evaluated. A reduction of 3 kg N/ha/yr can be achieved by fencing waterways (3.1 km still unprotected) and upgrading effluent application through a Larall system. Both options are recommended because they are also requirements under either the Clean Streams Accord or the One Plan, or both. Several other N-reduction options are available, such as N-inhibitors, for ensuring N-losses can remain within N-limits going into the future.

Other compliance requirements can be achieved by installing guttering on the milking shed (to divert storm water to land rather than the yards), and by installing three new culverts necessitated by fencing the waterways.

Introduction

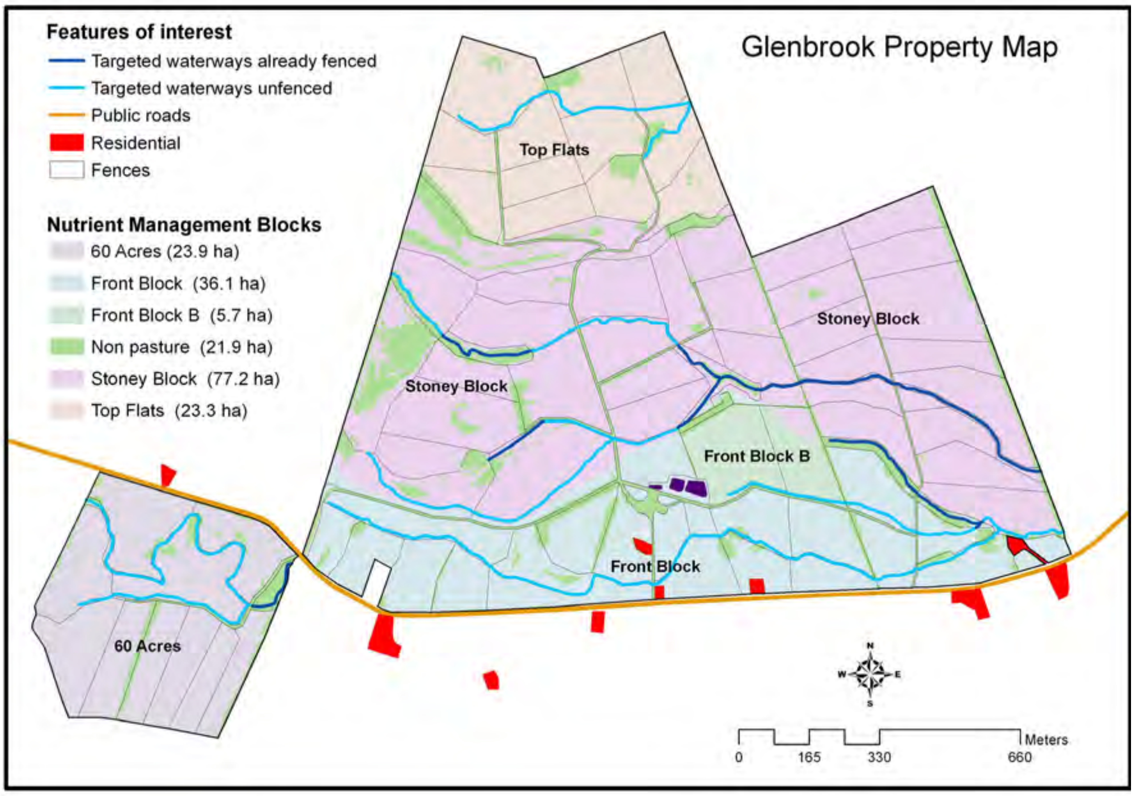
Resource consents are required for intensive farms operating in sensitive catchments of the Manawatu-Wanganui Region. Consent application requires a FARM Strategy to be completed.

This FARM Strategy is prepared for Glenbrook Farm, a 188ha (166 ef ha) seasonal supply dairy farm located near Hukanui. This places the farm within a sensitive catchment (Middle Mangatainoka). Purpose of this report is threefold:

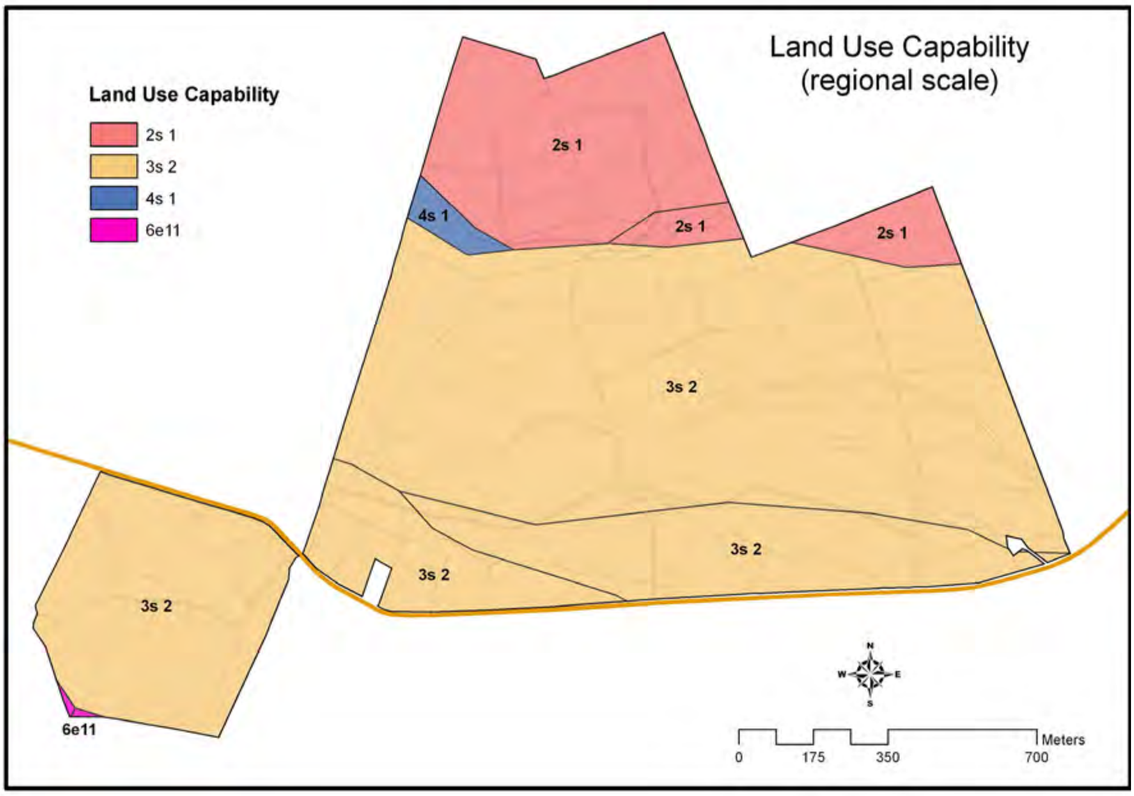
1. Assess if the farm is operating within regional council nitrogen-loss limits.
2. Identify contaminant management options for minimising nitrogen, phosphorus and faecal microbe contamination of freshwater resources.
3. Assess and make recommendations on other FARM Strategy compliance requirements.

Farm description

A 188 ha (166 ha effective) seasonal-supply dairy farm growing 9,500 kg pasture DM/ha/yr and milking 368 predominantly Friesian cows (2.22 cows/grazed hectare) and producing ~830 kg MS/ha/yr under a 50:50 sharemilking agreement. Production performance is above average. Topography is mostly flat with stony shallow soils located in the former Mangahao River bed (80 ha), bordered by various terraces with Kopua silt loam soils (108 ha). Average rainfall is 1865 mm. Map 1 shows features of relevance to this FARM Strategy.



Map 1: Property map showing features of relevance to this FARM Strategy



Map 2: Regional Land Use Capability classifications for Glenbrook Farm

Legal area is reported in Table 1. No additional land is farmed (e.g. river land that is not under legal title).

Table 1: Legal descriptions and areas

Legal description	Area
WN26D/607, LOT 1 DP 55781	26.273 ha
WN46A/61, SECT 160 Blk I Mangaone Survey District	32.6767 ha
WN25A/134, SECT 161 Blk I Mangaone Survey District	48.5623 ha
WN89/198, SECT 110 Blk I Mangaone Survey District	40.6557 ha
Pt SECT 111, Blk I Mangaone Survey District	40.014 ha
	188.1817 ha

Clean Streams Accord status

Approximately 4.5 km of farm waterways qualify under the Accord. Cows are excluded from 1.4 km, leaving 3.1 km of meandering streams that need stock exclusion. Current effluent discharge (368 cows @ 50 l/cow/day = 18.4 m^3/day) is far higher than that permitted under existing consent conditions (9 m^3/day), and therefore requires attention under the Accord.

Nitrogen leaching

Seven nutrient blocks were identified (Map 1) for modelling with OVERSEER® Nutrient Budgets (v 5.2.6.0). All model inputs and assumptions are detailed in Appendix 1 (signed off as being true and correct). Key output tables are included as Appendix 2.

OVERSEER® estimates current N-loss for Glenbrook Farm at 26 kg N/ha/yr. This is considered low for dairy farming, largely because N-loss for Glenbrook Farm is being averaged across the less intensively farmed areas (trees, etc.).

Permissible N-loss limits

One Plan permissible N-loss limits are calculated from the class and area of Land Use Capability (LUC) present on a farm. LUC is a 1-8 ranking of land according to its capacity to sustain productive agricultural uses (and therefore has higher permissible N-loss limits), where class 1 is elite land suitable for intensive uses, and class 8 is non-productive land unsuitable for agriculture.

Glenbrook Farm is identified as having four LUC classes using regional-scale classifications extracted from the NZLRI database (Map 2). LUC classifications are used to calculate One Plan N-limits for four periods of interest (Table 2).

Table 1: Calculation of One Plan N-loss limits

LUC	Area (ha)	One Plan N-limits by period (kg/ha)				Farm N-limits by unit (kg N/unit)			
		2010	2015	2020	2030	2010	2015	2020	2030
2s1	32	29	25	22	21	925	797	701	670
3s2	154	22	21	19	18	3394	3240	2931	2777
4s1	2	16	16	14	13	27	27	24	22
6e11	0	10	10	10	10	2	2	2	2
Permissible N-loss limits for Glenbrook Farm (kg N/ha/yr) =						**23**	**22**	**19**	**18**

The quality of nitrogen that Glenbrook Farm is permitted to lose via leaching and runoff in 2010 is 23 kg N/ha/yr (or 4.3 tn N across the entire farm). This decreases to 18 kg N/ha/year by 2030. Relative to current N-loss (26 kg N/ha/yr), Glenbrook Farm is required to reduce N-loss by 3 kg N/ha/yr to achieve the 2010 permissible N-loss target.

Phosphorus runoff risk

OVERSEER® estimates total P-loss for Glenbrook Farm at 0.8 kg P/ha/yr, thereby attributing the farm with an over all LOW P-loss risk rating.

Contaminant minimisation strategies

Many options are available for reducing nitrogen losses (Table 3). Most will also go someway towards reducing P-loss and faecal bug risks.

Table 3: Contaminant mitigation strategies for Glenbrook Farm

Option	Potential N-loss reduction	Comments
Use urease-inhibitor urea (at same rates) and spray pasture with nitrification inhibitor.	↓5kg N/ha/yr (20% less leaching)	High potential impact on N-loss, greenhouse gases and pasture production, but the estimate is tentative.
Decrease current urea use by 10 kg N/ha/yr	↓1kg N/ha/yr	Reduces N-loss but has implications for production losses.
Reduce cow numbers by 8%; supplements by 33%; urea by 5%	↓1kg N/ha/yr	Potentially a more efficient and profitable use of inputs, but requires land development.
Fence unprotected waterways	↓0.2kg N/ha/yr	Non-negotiable requirement under both the Clean Streams Accord and the One Plan.
Fenced and planted riparian buffers around unprotected waterways, to a minimum width of 10m.	N-loss risk↓	Likely to incur high costs associated with fencing, planting, and retiring productive land
Upgrade siphon tube system to a travelling irrigator for effluent disposal	↓1.6 kg N/ha/yr	Requires doubling of existing pond capacity. These systems tend to be labour intensive.
Upgrade to a Larall effluent system	↓2.6 kg N/ha/yr	High cost but low labour, and can be used with existing pond dimensions.

To achieve 2010 N-targets, it is recommended that all waterways be protected with fencing, (~3.1 km) and that an investment is made to upgrade to a Larall type effluent system. Fencing streams is a non-negotiable requirement under both the Clean Streams Accord and the One Plan. Upgrading the effluent system may also be a requirement. These practices will also decrease risks associated with faecal bug contamination and P-loss to water. Longer term N-limits can be accommodated by adopting N-inhibitors, which promises to reduce N-losses by up to 5 kg N/ha/yr, and will likely result in pasture production increases.

Other One Plan compliance requirements

Regulated activities relevant to Glenbrook Farm have been assessed to identify current levels of compliance using FARMS Workbook specifications. Five items will likely require attention (Table 4).

Table 4: Compliance requirements

Requirement	Description	Recommendation
Farm N-loss must be within N-loss targets	A reduction of 3 kg N/ha required to achieve 2010 targets	Fence waterways and upgrade effluent system
Ancillary storm water must not discharge into ponds or sumps	Rain water from milking shed currently discharges to the yards then to the pond	Install guttering and direct the discharge to land
Stock must be excluded from targeted waterways	3.1 km of targeted waterways require some form of stock exclusion	Erect two-wire electric fencing where necessary
Stock crossings must have a bridge or culvert	Waterway fencing would necessitate 3-crossing areas to link divided paddocks	Install three culverts at the new crossing points
Effluent disposal area must be compliant	OVERSEER® suggests a 20 ha effluent area is required to achieve 150 kg N max loadings	Increase effluent area to 20 ha
Effluent system must be compliant	It is unlikely that the Council would issue a new consent with the current siphon-tube system	Upgrade to a Larall effluent system

Most compliance items are minor and/or are required under the Clean Streams Accord. Requirements concerning effluent are unclear. Enlarging the effluent area to achieve a 150 kg N/ha loading is not specified, but the loading is a widely accepted standard known to minimise N-loss via leaching (which is why it is included in OVERSEER®). Accordingly, the 150 kg N/ha loading would likely be specified as a consent condition to ensure all practicable steps are being taken to minimise N-loss.

Similarly, the current siphon-tube effluent disposal system does not explicitly breach any One Plan specification or requirement. However, in being such an unusual system the Council may require a shift to a less risky system as a consent condition (i.e. effluent can only be applied to land through an irrigator or spray line system).

Conclusion

Current N-loss exceeds One Plan permissible N-loss limits for 2010 by 3 kg N/ha. N-loss compliance can be achieved by fencing 3.1 km of waterways and adopting a Larall effluent system. Permissible N-loss targets get increasingly constrictive out to 2030, but there are several options available to ensure long term compliance.

Other compliance requirements can be addressed by installing guttering on the milking shed, and installing three new culverts.

Appendix 1: OVERSEER® inputs and assumptions, Glenbrook Farm

Production inputs

- 368 Freisan cows (peak) @ 138,258 kg MS/yr.
- 92 replacements grazed off at weaning.
- Main herd is wintered off-farm (out end of June; back end of July). Paddocks grazed out.
- 74 tn DM of balage, 23 tn DM good quality hay, 135 tn DM palm kernel, 43 tn DM corn silage, 10 tn DM Starch Pro.

Effluent management

- Two pond system + land application via siphon tube (set up in Overseer as '2 pond + discharge' because effluent system analysed separately).
- Sludge excavated every two years and applied to Front Block B.

Resource information

- Farm located 39 km from coast.
- Annual rainfall is 1865 mm (supplied by Horizons Regional Council).
- All blocks are classed as FLAT according to Overseer topography categories.

Block	Ha	Soil	Soil test results May 2007							
			Olsen P	Qt K	OrS	TBK	Qt Ca	Qt Mg	Qt Na	PR
60 Acres	23.9	Kopua silt loam (deep & wet phases)	26	7	20	-	12	20	11	-
Front Block[1]	36.1	Kopua stoney silt loam	50	8	7	-	12	30	8	-
Front Block B[1]	5.7	Kopua stoney silt loam	50	8	7	-	12	30	8	-
Stoney Block	77.2	Kopua stoney silt loam (shallow & bouldery phases)	50	8	7	-	12	30	8	-
Top Flats	23.3	Kopua silt loam (deep phase)	31	5	28	-	11	20	10	-
Trees & non grazeable	21.9									

[1] No soil test information available. Assumed values from Stoney Block.

Fertiliser

- 17 tonne urea-N across whole farm (2005/06). 102 kg N/ha.
- No winter application of urea (May, June, July).
- No inhibitors used.
- 400 kg of 30% potash superphosphate on October or March.
- Lime 1/3 of farm each year (~55 ha) using good quality lime at 2.5 tonne lime per hectare.

Fertiliser nutrient applied (kg nutrient/ha/yr)							
Area (ha)	N	P	K	S	Ca	Mg	Na
Whole farm	102	26	60	30	348	3	0

Pasture management

- Development status for all blocks has been set at DEVELOPED.
- Clover levels have been set at MEDIUM (the Overseer default).
- Pasture utilisation is estimated at an annual average of 80% (Overseer default for Friesians is 85%).
- Pasture utilisation estimated at 80% based on local information.

Assurance statement:

To the best of our knowledge, the information provided above is true and correct at the time the Overseer analysis was undertaken (December 2007).

Farm owners, operator or manager

Name:

Date:

Signed:

Nutrient management consultant

Name: Andrew Manderson

Date:

Signed:

Appendix 2: OVERSEER® output reports

Block Budget for: Current Block: Stoney Block

	N	P	K	S	Ca	Mg	Na	H+
	(kg/ha/yr)							
Inputs								
Fertiliser	111	26	60	30	348	3	0	-16.6
Effluent added	0	0	0	0	0	0	0	0.0
Atmospheric/Clover N	56	0	3	5	4	9	36	0.0
Irrigation	0	0	0	0	0	0	0	0.0
Slow release	0	3	12	0	3	5	6	0.0
Supplements	26	5	19	4	3	6	1	-0.6
Outputs								
Product	57	10	14	3	13	1	4	-0.5
Transfer	27	3	25	2	4	3	1	-0.4
Supplements sold	0	0	0	0	0	0	0	0.0
Atmospheric	41	0	0	0	0	0	0	0.0
Leaching/runoff	26	0	15	31	62	21	66	-1.6
Immobilisation/absorption	42	25	0	4	0	0	0	0.0
Change in inorganic soil pool	0	-4	40	0	280	-2	-27	-14.6

* Acidity - kg H+/ha

Block Budget for: Current Block: 60 acres

	N	P	K	S	Ca	Mg	Na	H+
	(kg/ha/yr)							
Inputs								
Fertiliser	111	26	60	30	348	3	0	-16.7
Effluent added	0	0	0	0	0	0	0	0.0
Atmospheric/Clover N	56	0	3	6	5	10	41	0.0
Irrigation	0	0	0	0	0	0	0	0.0
Slow release	0	3	12	0	3	5	6	0.0
Supplements	26	5	19	4	3	6	1	-0.6
Outputs								
Product	57	10	14	3	13	1	4	-0.5
Transfer	27	3	25	2	4	3	1	-0.4
Supplements sold	0	0	0	0	0	0	0	0.0
Atmospheric	41	0	0	0	0	0	0	0.0
Leaching/runoff	27	0	13	60	65	28	78	-1.7
Immobilisation/absorption	41	17	0	-25	0	0	0	0.0
Change in inorganic soil pool	0	4	42	0	277	-8	-35	-14.6

* Acidity - kg H+/ha

Block Budget for: Current Block: Front Block

	N	P	K	S	Ca	Mg	Na	H+
	(kg/ha/yr)							
Inputs								
Fertiliser	111	26	60	30	348	3	0	-16.6
Effluent added	0	0	0	0	0	0	0	0.0
Atmospheric/Clover N	56	0	3	5	4	9	36	0.0
Irrigation	0	0	0	0	0	0	0	0.0
Slow release	0	3	12	0	3	5	6	0.0
Supplements	26	5	19	4	3	6	1	-0.6
Outputs								
Product	57	10	14	3	13	1	4	-0.5
Transfer	27	3	25	2	4	3	1	-0.4
Supplements sold	0	0	0	0	0	0	0	0.0
Atmospheric	41	0	0	0	0	0	0	0.0
Leaching/runoff	26	0	15	31	62	21	66	-1.6
Immobilisation/absorption	42	25	0	4	0	0	0	0.0
Change in inorganic soil pool	0	-4	40	0	280	-2	-28	-14.6

* Acidity - kg H+/ha

Block Budget for: Current Block: Top Flats

	N	P	K	S	Ca	Mg	Na	H+
	(kg/ha/yr)							
Inputs								
Fertiliser	111	26	60	30	348	3	0	-16.6
Effluent added	0	0	0	0	0	0	0	0.0
Atmospheric/Clover N	56	0	3	5	4	9	37	0.0
Irrigation	0	0	0	0	0	0	0	0.0
Slow release	0	3	14	0	3	5	6	0.0
Supplements	26	5	19	4	3	6	1	-0.6
Outputs								
Product	57	10	14	3	13	1	4	-0.5
Transfer	27	3	25	2	4	3	1	-0.4
Supplements sold	0	0	0	0	0	0	0	0.0
Atmospheric	41	0	0	0	0	0	0	0.0
Leaching/runoff	26	0	10	60	52	23	65	-1.6
Immobilisation/absorption	41	19	0	-25	0	0	0	0.0
Change in inorganic soil pool	0	2	47	0	290	-4	-26	-14.6

* Acidity - kg H+/ha

Block Budget for: Current Block: Front Block B

	N	P	K	S	Ca	Mg	Na	H+
	(kg/ha/yr)							
Inputs								
Fertiliser	111	26	60	30	348	3	0	-14.6
Effluent added	136	41	143	23	38	24	7	-4.2
Atmospheric/Clover N	20	0	3	5	4	9	36	0.0
Irrigation	0	0	0	0	0	0	0	0.0
Slow release	0	3	8	0	3	5	6	0.0
Supplements	26	5	19	4	3	6	1	-0.6
Outputs								
Product	57	10	14	3	13	1	4	-0.5
Transfer	27	3	25	2	4	3	1	-0.4
Supplements sold	0	0	0	0	0	0	0	0.0
Atmospheric	61	0	0	0	0	0	0	-0.3
Leaching/runoff	30	0	15	53	65	20	64	-2.0
Immobilisation/absorption	118	25	0	4	0	0	0	-0.4
Change in inorganic soil pool	0	38	179	0	314	23	-19	-15.7

* Acidity - kg H+/ha

Block Budget for: Current Block: Non pastoral

	N	P	K	S	Ca	Mg	Na	H+
	(kg/ha/yr)							
Inputs								
Fertiliser	0	0	0	0	0	0	0	0.0
Effluent added	0	0	0	0	0	0	0	0.0
Atmospheric/Clover N	2	0	3	5	4	9	37	0.0
Irrigation	0	0	0	0	0	0	0	0.0
Slow release	0	0	0	0	0	0	0	0.0
Supplements	0	0	0	0	0	0	0	0.0
Outputs								
Product	0	0	0	0	0	0	0	0.0
Transfer	0	0	0	0	0	0	0	0.0
Supplements sold	0	0	0	0	0	0	0	0.0
Atmospheric	0	0	0	0	0	0	0	0.0
Leaching/runoff	2	0	3	5	4	9	37	0.0
Immobilisation/absorption	0	0	0	0	0	0	0	0.0
Change in inorganic soil pool	0	0	0	0	0	0	0	0.0

* Acidity - kg H+/ha

Nutrient Budget

Farm Budget for: Current

	N	P	K	S	Ca	Mg	Na	H+
	(kg/ha/yr)							
Inputs								
Fertiliser	98	23	53	27	307	3	0	-14.6
Effluent added	0	0	0	0	0	0	0	0.0
Atmospheric/Clover N	48	0	3	5	4	9	37	0.0
Irrigation	0	0	0	0	0	0	0	0.0
Slow release	0	3	11	4	3	4	5	0.0
Supplements	23	4	17	3	3	5	1	-0.5
Outputs								
Product	50	9	12	3	11	1	3	-0.5
Transfer	2	1	11	0	1	1	0	-0.1
Supplements removed	0	0	0	0	0	0	0	0.0
Atmospheric	49	0	0	0	0	0	0	0.0
Leaching/runoff	24	0	13	36	55	21	64	-1.5
Immobilisation/absorption	43	21	0	0	0	0	0	0.0
Change in inorganic soil pool	0	-1	47	0	250	-1	-25	-13.0

' Acidity - kg H+/ha

Nitrogen report

Whole farm report

	Units	Average NZ farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		48
Fertiliser N	kg N/ha/yr		98
Other N	kg N/ha/yr		23
Environmental losses			
Leaching loss	kg N/ha/yr	30-50	24
Direct winter N loss	kg N/ha/yr		0
N loss from effluent pond to water	kg N/ha/yr	3-5	2
N_2O emissions	kg N/ha/yr		3.6
Indices			
Farm N surplus	kg N/ha/yr	100-180	119
N conversion efficiency	%	25-40	30
Average nitrate conc. in drainage (+/- about 30%)	mg N/ml	5-10	na

Effluent report

Whole farm report

	Units	Current farm
Current effluent area		
Area of effluent blocks	ha	0.0
% of pastoral farm area	%	0.0
Area of farm to apply effluent to achieve rates of:		
150 kg N/ha/yr	ha	19.5
Maintenance K	ha	N/A *
100 kg K/ha/yr	ha	28.7
Source of N applied to effluent blocks		
Effluent from farm dairy	%	100
Effluent from wintering pad	%	0
Effluent from feed pad	%	0
Average fertiliser N	kg N/ha/yr	0
Average other effluents	kg N/ha/yr	0

Block nitrogen report

For: Current

Block name	N in drainage * (ppm)	N leached	N surplus	Added N **
		(kg N/ha/yr)		
Stoney Block	1.8	26	136	111
60 acres	1.7	27	136	111
Front Block	1.8	26	136	111
Top Flats	1.8	26	136	111
Front Block B	2.1	30	236	246
Non pastoral	na	2	2	0
Overall farm	na	24	119	

* Estimated N concentration in drainage water (+/- 30%). Maximum recommended level for drinking water standard is 11 ppm.

Appendix 3: Compliance checklist

ACTIVITY	REQUIREMENTS	STATUS	NOTES
Farming within N-loss target?	1. Farm N-loss must be within N-loss targets	✗	Currently above 2010 N-targets
Produce animal effluent?	1. No direct discharge of effluent to water from yards or pads	✓	
Store animal effluent?	1. No direct discharge of effluent to water from ponds & sumps	✓	
	2. Ancillary storm water must not discharge into pond or sump	✗	A proportion of storm-water from milking parlour roof is deposited on the yards and then into the ponds
	3. Effluent storage must be sealed and not leaking	?	Seepage noted around base of pond walls but may be from natural drainage and water table fluctuations. Difficult to evaluate within project limits so assumed compliant until proven otherwise.
	4. Effluent pond or sump must have capacity to hold 2-days of effluent between applications (if applied to land)	✓	
Apply effluent to land?	1. No substantial leaks in irrigation pipes or equipment	✓	
	2. Discharge application must be > 20m from surface water bodies, bores, or the CMA	✓	
	3. Discharge application must be > 20m from public areas & roads, or residences	✓	
	4. Discharge application must be > 50m from protected archaeological or biodiversity areas	✓	
	5. Must have a nutrient budget (emphasis on N)	✓	
	6. Must not apply on days when drift will cause problems for neighbours	✓	
	7. No surface ponding for more than 5hrs after application	✓	Highly unlikely given porous soils and surface runoff characteristics of the site
Surface or ground water take?	1. Surface or ground water takes require a consent	✓	
Use biosolids or soil conditioners?	1. Application of biosolids and/or 'soil conditioners' requires a consent	✓	
Active farm dump or offal hole?	1. Farm dumps or offal holes require a consent	✓	
Stock have direct access to waterways?	1. Stock must have adequate (reticulated) trough water available in each paddock (ideally to meet peak demand)	✓	
	2. Waterways that qualify under the Clean Streams Accord must be fenced	✗	3.1 km of riparian fencing required

	3. Stock crossings must have a bridge or culvert	✗	Farm well served with existing culverts and bridges but riparian fencing would necessitate 3 extra culverts
	4. Runoff from bridges and culverts must be directed to land rather than water	✓	
Apply fertiliser?	1. No application of fertiliser directly to water bodies	✓	
	2. No application into protected biodiversity areas	na	
	3. Must be applied in accordance with industry Code of Practice	✓	
	4. N-fertiliser use requires a nutrient budget	✓	
	5. Must not apply on days when drift or odour will cause problems beyond the farm boundary	✓	
Store and feed supplements?	1. Feed storage areas must be sealed to restrict effluent seepage (downwards percolation). Excludes silage pits <500m² and presumably hay sheds	✓	
	2. Feed storage areas must be protected from water runoff entry	✓	
	3. Runoff from feed storage areas must not enter surface water bodies	✓	
	4. Feed storage areas must not be sited within 50m of protected areas, or within 20m of bores, water bodies or the CMS	✓	
	5. Feeding out must not take place within 50m of protected areas, or within 20m of bores, water bodies or the CMS	✓	
	6. Feed storage and feeding out shall not result in objectionable odour, dust or drift beyond the farm boundary.	✓	

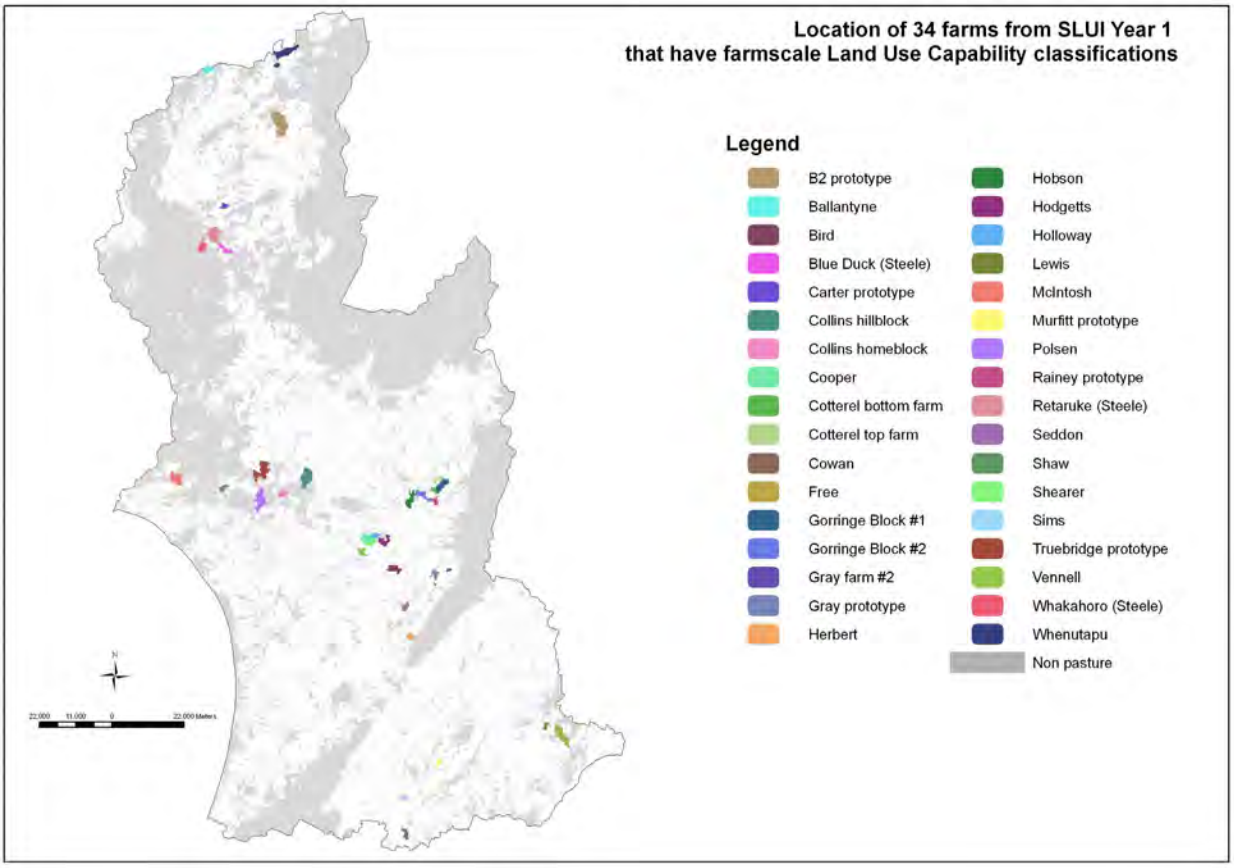
7.12 PERMISSIBLE N-LOSS COMPARISON (SLUI YR1 LUC)

INTRODUCTION

The One Plan proposed method of calculating permissible N-loss for intensive farms requires Land Use Capability (LUC) classification for individual farms. LUC is available for the whole Manawatu-Wanganui Region at a 1:50,000 scale, but this is generally considered too coarse for farm management purposes. Ideally, farm-scale LUC is required (scales of ~1:5,000 to ~1:30,000 depending on farm size), but rarely are such information available. New farm surveys would be necessary, and these can be expensive.

An objective of the FARMS test farms project was to compare the implications of calculating One Plan permissible N-loss limits using both scales of LUC classification (i.e. regional and farm-scale). Results were variable and no definitive conclusion could be drawn.

This appendix presents results from an addendum study using 34 farm-scale LUC classifications (captured as part of the first year of SLUI implementation – see map) and regional-scale classifications (from the NZLRI database). **RESULTS ARE LIKELY TO BE BIAS** because SLUI farms tend to be extensive sheep and beef operations rather than intensive farms targeted under the One Plan. However, the results provide an additional degree of insight into how scale of LUC may influence the calculation of N-loss limits.



METHOD

Farm-scale LUC classifications were obtained from Horizons for 34 farmed units. LUC was aggregated back to the class level (i.e. one of eight classes), and linked to One Plan Year 1 N-loss limits. N-loss limits were multiplied by LUC class area per farm, and averaged by total farm area to give whole farm permissible N-loss for year 1. Farm boundaries were used to clip relevant portions of the regional-scale NZ Land Resource Inventory database, and the same process was used to calculate permissible N-loss limits. Pivot tables were created to compare N-loss limits between scales.

RESULTS

Results are tabled below. Firstly, as would be expected for predominantly hill country farms, permissible N-loss limits are all quite low (averaging 9.5 and 10.1 kg N/ha for farm-scale and regional-scale respectively). Secondly, there is considerable variation between the percentages of LUC that make up a farm at different scales, most likely because of mis-classification and generalisation of the regional-scale LUC classifications. Thirdly, N-limit differences between most comparisons are small to negligible, despite the variation between farm LUC percentages. On average, the difference is well less than 1 kg N/ha/yr. However, when marked differences are apparent, they tend to be major differences. These range from +3kg N/ha down to -5.3 kg N/ha, and would have a significant impact on N-loss requirements for the farms involved. All these results are similar to those obtained for the FARMS case study farms.

FARM		LUC as a percent of total farm area (%)								N_Limit
		I	II	III	IV	V	VI	VII	VIII	(kg N/ha)
Farm 01	Farmscale	0%	0%	5%	17%	0%	46%	30%	2%	10.2
	Regional	0%	0%	7%	16%	0%	75%	2%	0%	11.6
Farm 02	Farmscale	0%	0%	5%	12%	0%	82%	0%	0%	11.3
	Regional	0%	0%	0%	23%	0%	76%	0%	0%	11.4
Farm 03	Farmscale	0%	1%	8%	2%	0%	63%	21%	5%	10.0
	Regional	0%	28%	0%	0%	0%	72%	0%	0%	15.3
Farm 04	Farmscale	0%	0%	2%	4%	0%	45%	43%	6%	8.3
	Regional	0%	0%	2%	9%	0%	17%	58%	15%	7.2
Farm 05	Farmscale	0%	0%	2%	3%	0%	33%	61%	0%	8.0
	Regional	0%	0%	0%	0%	0%	29%	71%	0%	7.2
Farm 06	Farmscale	0%	0%	0%	3%	0%	4%	89%	4%	6.3
	Regional	0%	0%	0%	4%	0%	0%	96%	0%	6.4
Farm 07	Farmscale	0%	11%	4%	0%	0%	53%	23%	10%	10.7
	Regional	0%	23%	0%	1%	0%	72%	4%	0%	14.3
Farm 08	Farmscale	0%	8%	1%	3%	0%	82%	2%	3%	11.5
	Regional	0%	9%	0%	0%	0%	87%	0%	3%	11.5
Farm 09	Farmscale	0%	2%	6%	4%	0%	69%	19%	0%	10.7
	Regional	0%	0%	1%	0%	0%	99%	0%	0%	10.2
Farm 10	Farmscale	0%	0%	4%	4%	0%	92%	0%	0%	10.7
	Regional	0%	3%	0%	0%	0%	97%	0%	0%	10.6
Farm 11	Farmscale	0%	0%	8%	0%	0%	86%	6%	0%	10.7
	Regional	0%	0%	10%	0%	0%	84%	6%	0%	11.0
Farm 12	Farmscale	0%	0%	0%	1%	0%	54%	45%	0%	8.3
	Regional	0%	0%	0%	1%	0%	52%	47%	0%	8.2
Farm 13	Farmscale	0%	0%	2%	1%	0%	52%	45%	0%	8.5
	Regional	0%	2%	0%	0%	0%	49%	49%	0%	8.4
Farm 14	Farmscale	0%	4%	6%	2%	0%	78%	7%	3%	11.1
	Regional	0%	9%	5%	0%	0%	87%	0%	0%	12.2
Farm 15	Farmscale	0%	0%	16%	0%	2%	78%	0%	3%	11.7
	Regional	0%	0%	9%	0%	0%	87%	4%	0%	10.9
Farm 16	Farmscale	0%	5%	4%	21%	0%	28%	40%	1%	11.0
	Regional	0%	0%	6%	0%	0%	64%	30%	0%	9.5
Farm 17	Farmscale	0%	0%	8%	7%	0%	66%	12%	7%	10.3
	Regional	0%	0%	0%	0%	0%	87%	13%	0%	9.5
Farm 18	Farmscale	0%	0%	1%	5%	0%	59%	27%	8%	8.6
	Regional	0%	0%	0%	0%	0%	63%	28%	8%	8.3
Farm 19	Farmscale	0%	0%	3%	1%	0%	74%	21%	1%	9.5
	Regional	0%	0%	6%	0%	0%	87%	7%	0%	10.5
Farm 20	Farmscale	0%	0%	12%	2%	0%	64%	21%	0%	10.7
	Regional	0%	0%	14%	0%	0%	86%	0%	0%	11.7
Farm 21	Farmscale	0%	0%	22%	12%	0%	27%	39%	0%	11.7
	Regional	0%	0%	0%	24%	0%	9%	67%	0%	8.7

Farm 22	Farmscale	0%	0%	5%	13%	0%	13%	66%	4%	8.5
	Regional	0%	0%	0%	15%	0%	30%	55%	0%	8.7
Farm 23	Farmscale	0%	0%	4%	4%	0%	39%	53%	0%	8.6
	Regional	0%	0%	9%	0%	0%	21%	70%	0%	8.3
Farm 24	Farmscale	1%	18%	4%	0%	0%	21%	52%	4%	11.5
	Regional	4%	12%	10%	0%	0%	41%	32%	0%	13.2
Farm 25	Farmscale	0%	1%	2%	2%	0%	41%	52%	2%	8.3
	Regional	0%	1%	0%	0%	0%	78%	20%	1%	9.4
Farm 26	Farmscale	0%	0%	2%	11%	0%	38%	45%	3%	8.8
	Regional	0%	1%	2%	11%	0%	49%	36%	0%	9.7
Farm 27	Farmscale	0%	0%	1%	0%	0%	22%	66%	11%	6.6
	Regional	0%	0%	0%	0%	0%	8%	77%	15%	5.7
Farm 28	Farmscale	0%	23%	1%	0%	1%	6%	68%	1%	11.8
	Regional	0%	32%	2%	0%	0%	58%	8%	0%	15.9
Farm 29	Farmscale	0%	0%	2%	2%	0%	72%	21%	4%	9.1
	Regional	0%	0%	10%	0%	0%	39%	49%	2%	9.0
Farm 30	Farmscale	0%	0%	6%	2%	0%	84%	9%	0%	10.4
	Regional	0%	0%	0%	0%	0%	96%	4%	0%	9.9
Farm 31	Farmscale	0%	0%	5%	2%	0%	6%	83%	3%	7.2
	Regional	0%	0%	2%	0%	0%	14%	81%	3%	6.7
Farm 32	Farmscale	0%	12%	4%	7%	0%	38%	36%	4%	11.4
	Regional	0%	9%	0%	0%	0%	57%	33%	0%	10.5
Farm 33	Farmscale	0%	0%	2%	4%	0%	12%	66%	16%	6.6
	Regional	0%	4%	3%	0%	0%	12%	72%	8%	7.6
Farm 34	Farmscale	0%	0%	17%	11%	0%	54%	18%	0%	12.0
	Regional	0%	0%	22%	14%	0%	51%	12%	0%	13.0
Total combined	**Farmscale**	**0%**	**2%**	**5%**	**6%**	**0%**	**44%**	**40%**	**3%**	**9.5**
	Regional	**0%**	**4%**	**4%**	**5%**	**0%**	**52%**	**34%**	**1%**	**10.1**

CONCLUSIONS

Results suggest that there is little advantage in opting for farm-scale LUC classification for calculating One Plan N-loss limits for hill country farms. Differences on average are almost insignificant, and do not therefore justify the extra cost of commissioning farm-scale surveys on a wholesale basis. However, occasionally large differences suggest that farm-scale LUC may have important implications for the calculation of N-loss limits for some farms. Accordingly, it is recommended that Horizons retain the option of giving farmers discretion over whether they use regional or farm-scale LUC for the calculation of N-loss limits.

THESE RESULTS AND CONCLUSISONS APPLY ONLY TO HILL COUNTRY FARMS. THEY ARE NOT REPRESENTATIVE OF INTENSIVE FARMS. While there is variation between LUC percentages for each farm, it can be expected that regional-scale hill-country LUC will be more similar to farm-scale hilly-country LUC simply because landforms are the defining criteria for hill-country LUC classification (landforms are easy to recognise). In contrast, soils are likely to be the most defining criteria for intensive-farming LUC, and these are considerably less likely to be adequately represented at the regional scale (soils are hidden from view, and are therefore much more difficult to identify).

In short, it is more readily argued that hill-country LUC will result in similar N-loss limits when calculated at both regional and farm scale, while intensive-farm LUC are more likely to result in dissimilar N-loss limits.

7.13 ALTERNATIVE MITIGATION STRATEGIES, CASE STUDY 2

Introduction: Glenbrook Farm was assessed as having to reduce current N-leaching by 6 kg N/ha/yr to achieve compliance with One Plan N-cap levels. Nitrification inhibitors were recommended as an N-loss reducing option. However, the latest research opinion is that N-inhibitors are unlikely to be fully effective for this particular property because of high annual rainfall (1865 mm) and associated high drainage losses (~1300 mm/yr). Alternative mitigation strategies are required, with a combined effectiveness sufficient to reduce N-leaching losses by at least 3 kg N/ha/yr. Two alternatives are proposed:

Proposal 1: Adjust fertiliser policy in response to the new effluent area

The original report recommended expanding the effluent application area to 20.5 hectares, and upgrading the irrigator system to achieve a maximum 150 kg N/ha/yr loading. Fertiliser value of the effluent is estimated by OVERSEER® at 46 kg N/ha, 16 kg P/ha and 126 kg K/ha (plus S, Ca and Mg), worth a combined $7,782 (2008 prices). These are higher than earlier estimates (see Appendix 3, page 33 of the Glenbrook FARM Strategy).

Completely removing all fertiliser from the block (102 kg urea-N/ha, 400 kg 30% K super) would decrease soil P by 2 units, but increase soil K and Mg by 1.8 and 2 units respectively. Given that current Olsen P levels are well above optimal (50 cf. 30-40), and N additions from supplement, effluent and clover are sufficient to offset nil urea use, then a nil-fertiliser policy for this block is unlikely to result in any lost production over the short to medium term.

Cost reductions are estimated at $3,346 for urea (2091 kg N @ $1.60/kg N applied), and $5,500 for the K-super (8.2 tn @ $610/tn, $36.30/tn application cost, and $20/tn cartage @ 20km to depot).

Ceasing urea use on this block would reduce whole-farm N-leaching losses by 1 kg N/ha/yr. Ceasing all fertiliser use would save the farm an estimated $8,810/yr. No loss of production would be expected. P-fertiliser probably wouldn't be needed for another five years (decrease of 2 units per year over 5 years would bring Olsen P back down to optimal ranges).

Proposal 2: Reduce urea use by substituting maize silage to offset decreased pasture yields

Continuing current urea use across the remainder of the farm means 102 kg N/ha would continue to be applied over 145.7 ha (i.e. farm effective area less the new effluent block area).

The optimal urea-reduction + maize silage combination to achieve a 2 kg N/yr leaching reduction is 25% less urea (down to 77 kg urea-N/ha), and the addition of 31.8 tonnes DM maize silage (Table 1). This amount of maize silage is estimated to be sufficient to offset reduced pasture yield (255 kg DM/ha) associated with reduced urea use (assuming a 10:1 response). The net difference between savings (from less urea) and new costs (purchased maize silage) is estimated at $5,520/yr.

Table 1: Options and impacts of reducing urea and increasing maize silage									
N-urea reduction	New application (kg N/ha)	Reduced total N applied (kg N)	Less DM @ 10:1 response (kg DM)	Reduced ME @ 9 Mj ME/kg pasture DM (Mj/kg)	Maize silage equiv @ 10.5 Mj ME/kg DM (tonnes)	Urea saving @ $1.60/kg N applied	Silage cost at $0.36/kg DM	Net difference (cost of mitigation)	Whole farm N-leaching (kg N/ha)
10%	91.8	1486	14861	133753	12.7	$ 2,378	$ 4,586	$ 2,208	22
20%	81.6	2972	29723	267505	25.5	$ 4,756	$ 9,172	$ 4,416	21
25%	76.5	3715	37154	334382	31.8	$ 5,945	$ 11,465	$ 5,520	20
30%	71.4	4458	44584	401258	38.2	$ 7,133	$ 13,757	$ 6,624	20
100%	0	14861	148614	1337526	127.4	$ 23,778	$ 45,858	$ 22,080	17

Conclusion: Stopping all fertiliser for the new effluent block (including urea) is unlikely to have any negative production impacts, and promises to save the farm $8,810/yr. However, reducing urea across the remainder of the farm to 77 kg N/ha/yr will likely cost an extra $5,520/yr to purchase maize to offset pasture yield reductions.

Adopting both these options would reduce modelled N-leaching by the required 3 kg N/ha/yr. Net financial implication is a saving of $3,300 per year.

7.14 DAIRY CONVERSION ANALYSIS BY SHEPPARD AGRICULTURE

Nutrient Management Plan for A. DAY

With special consideration to Dairy Conversion

SHEPPARD AGRICULTURE

SHEPPARD AGRICULTURE
Farm, HR & Valuation Consultants

January 2008

1. Introduction

Intensive farms in select catchments of the Manawatu-Wanagnui region will need to farm according to N-loss limits proposed in Horizons Regional Councils One Plan. Increasingly tighter N-loss limits are to be implemented over a twenty year period.

As part of the AgResearch study on N-loss on seven case study farms, Sheppard Agriculture has been asked to evaluate the impact, if any, of Nitrogen mitigating strategies a Dairy Conversion on part of A. Days sheep and beef property may have.

The objectives of this report are to:
- Demonstrate and evaluate the impact the N & P loss limits may have on the current sheep & beef operation
- Evaluate the feasibility of converting approximately 265 ha (243 ha effective) of the farm to dairying with consideration to One Plan rules & limits, now and for the next 20 years

Andrew Day owns a property 973 ha farm, including a lease block, giving 885 ha (estimated effective area) situated in the Ballance area in the Tararua district.

The property falls within the following water management zones. Somewhat ironically, Andrew's farm does not fall within any of the priority catchments targeted by Horizons, however the property is being treated as a case study, meaning for the purposes of the report, the farm is being examined as if it was in a priority catchment. The farm straddles four (sub) catchments. Management zones & subzones tabulated below.

Hectares	% of farm	Mgt_Zone (major catchment)	Subzone (subcatchment)
46.2	5%	Middle Manawatu (Mana_10)	Aokautere (Mana_10e)
508.7	52%	Upper Gorge (Mana_9)	Lower Mangahao (Mana_9e)
174.7	18%	Middle Manawatu (Mana_10)	Middle Manawatu (Mana_10a)
243.2	25%	Upper Gorge (Mana_9)	Upper Mangahao (Mana_9d)
972.8			

For this project Andrew's property is classed as an intensive livestock property. Andrew is currently running it as a sheep and beef property with dairy grazers, however wants to investigate the option of converting some of the farm into Dairy, while operating within the boundaries of the One Plan.

2. Current Farm System

- Farm Physical Characteristics:

  - *Location*

Andrew Days property is located in the Balance area South of Woodville on the Tararua side of the Pahiatua track, just under the Tararua Range.

  - *Contour*

The contour of the property is easy to very steep with most of the farm rolling to easy hill as a sheep and beef unit.

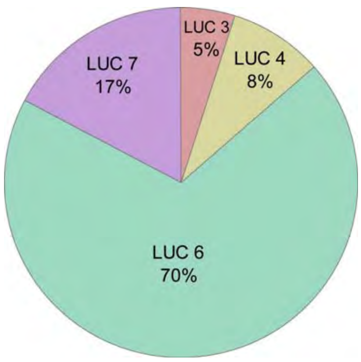
  - *Soil Type*

(The Land Use Capability Information)
The current farm consists of the following LUC classes

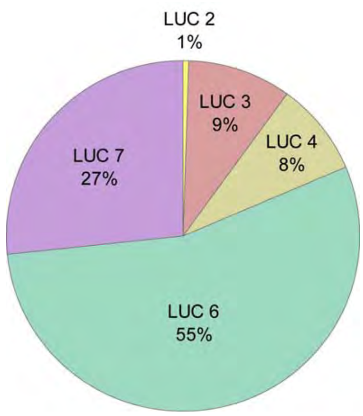
  - IIIc1, IIIe1, IIIw1, IVe1, VIc1, VIe1, VIe8, VIe9, VIw1, VIIe2, VIIe4

(A pie graph shows the percentages of the different LUC's on the current property)

NZLRI	
LUC	Hectares
LUC 3	49.578
LUC 4	82.037
LUC 6	672.39
LUC 7	168.777



Farmscale	
LUC	Hectares
LUC 2	5.9
LUC 3	92.1
LUC 4	82.4
LUC 6	531.8
LUC 7	260.5



- *Soil Fertility*

(Data supplied by A. Day on soil test samples – 06 Dec 2006)

Soil Analysis:

Sample Name	pH	Olsen P	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Sulphate	Organic Sulphur
Utiku	5.8	17	5	13	7	5	4	6
Steep Hill	5.5	23	5	24	8	8	8	9
Rolling	5.7	25	4	10	5	4	7	77
Flat	5.8	50	8	18	6	7	8	8
G W Rolling	5.8	20	5	15	8	8	12	11
Top Farm	5.6	20	6	17	9	7	15	15
Wind Farm	5.7	5	3	15	9	7	13	13

- *Annual Rainfall*

The property is located in the foothills of the Tararua Ranges, in a high rainfall, summer moist area, with exposure to wind which prevails from the west & south west.
Average rainfall: 1600mm per year (A. Day quoted)
Mean Air temperature: 12.4 degrees Celsius - NIWA
Total Sunshine hours: 1795 hours – NIWA
Height above sea level: 160 – 240 metres ASL for the whole property

- *Area*

The current size of the property is 973 ha (including the lease block) with an estimated 885 ha effective.

- *Drainage*

The farm does become slightly water logged in the winter.

- *Water Supply*

Currently the property has a reticulated water system that is fed by water tanks. Dams and the streams are also utilized in paddocks for stock water supply.

- *Buildings*

There are currently four houses on the property, a hay shed, old woolshed and a recently renovated woolshed.

- *Fences*

The farm is currently fenced in 8-wire conventional.

- *Paddocks*

Currently the farm is subdivided into 133 paddocks including the lease block.

- *Tracks*

There is sufficient tracking on the property for the sheep and beef operation.

- *Power Supply*

There is 3 phase power supply to the woolshed currently with 1 phase running along the road to the southern end of the property.

- *Production*

The property is currently a sheep and beef breeding and finishing property, while also grazing some dairy heifers. Presently the farm is wintering 8369 total SU (Sheep 6083 SU & Cattle 2286 SU) on 973 ha (885 ha effective) with about a 70:30 sheep to cattle ratio (2006 records).

The Coopworth composite cross ewe flock is producing around a 140% lambing percentage with 1200 lambs being sold prime at weaning with the remainder being sent to the works over the summer period. The tail end lambs are sold in mid to late May.

The breeding cows have traditionally been Friesian Angus Hereford cross with a move now to Angus and using a Charolais/ Simmental terminal sire to improve the calves being produced.

The cows are mainly farmed on the lease block with the heifers staying on the home farm along with the bull claves (the Friesian bull calves are brought in Spring (Late October – December). The bull claves are grazed in a semi cell system until they are sold from December through until April at a 260kg carcass weight.

Dairy heifers are also grazed on the property with a May to May contract. They too are grazed in their own exclusive cell systems until sheep weaning. From December through to April they are grazed in conjunction with the sheep.

3. Dairy Conversion – The Proposal

(Farm System assumptions)

(Farm map included to show the area of the current property to be converted into the Dairy operation, while the remainder of the property is managed as a Dry stock unit).

- **Proposed Farm System:**

Farm Physical Characteristics:

- *Location*

Andrew Days property is located in the Balance area South of Woodville on the Tararua side of the Pahiatua track, just under the Tararua Range.

- *Contour*

The 265 ha (243 ha effective) proposed as a dairy unit is on rolling land with an easy contour. (LUC III to LUC VI)

- *Soil Type*

The proposed milking platform consists of:

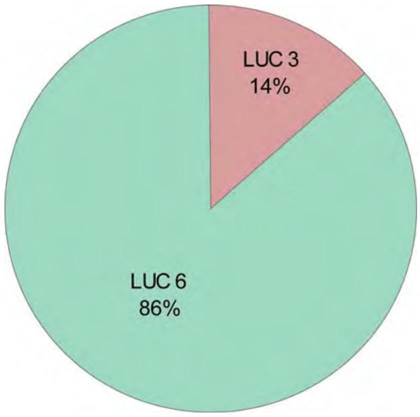
- Predominantly (VIe1) strongly rolling to moderately steep hill country with predominately loess soils with a moderate erosion limitation under pasture. Highly suitable for pastoral use.
- (IIIw1) flat to undulating valley floors or alluvial flats with moderately well drained or imperfectly drained soils (moderate wetness limitation) limiting crop choice and/ or requiring special management practices. Suitable for some crops, pasture or forestry.
- (IIIe3) Small areas of undulating to rolling colluvial foot slopes with a moderate sheet & rill erosion hazard when cultivated. Heavier textured sub-soils limit the choice of crops. Suitable for some cropping, pasture and forestry.
- (IVe5) Rolling argillite hill land with wind, sheet and rill erosion limitations when cultivated, and a risk of summer droughtiness. Suitable for some fodder crops and intensive pastoral grazing.
- (IVe1) Rolling to strongly rolling hill country with predominately loess soils with a severe sheet & rill erosion limitation when cultivated. Occasionally suited for some fodder cropping, but best use is pastoral farming.
- (VIe9) Moderately steep to steep slopes in sandstone hill country. Can have moderate soil slip & tunnel gully erosion limitations under pasture. Generally requires conservation plantings under pastoral use, and has a medium site index value for forestry.

- (VIw1) low lying area in rolling hill country with very poorly drained soils (water table at, or near, the surface for most of the year). Drainage is generally unsuitable. Most suitable for pastoral farming or wetland retirement.

(A pie graph shows the percentages of the different LUC's on the proposed dairy unit)

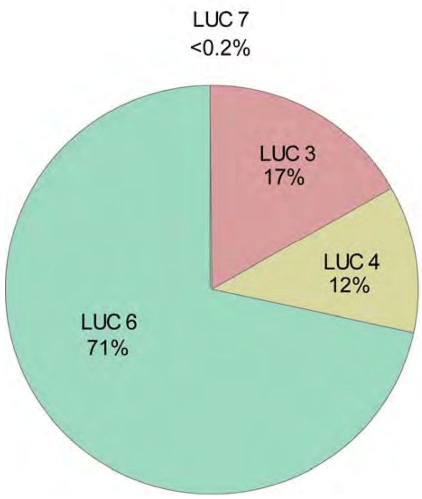
Dairy NZLRI areas LUC

LUC_txt	hectares
LUC 3	36.235
LUC 6	228.413



Dairy farmscale areas LUC

LUC_txt	hectares
LUC 3	44.97
LUC 4	30.45
LUC 6	189.06
LUC 7	0.16



Land Use Capability Nitrogen Leaching/ Run-off Values allowable as per Horizons Regional Council (HRC) One Plan.

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Year 1 (when rule comes into force) (kg of N/ ha/ year)	32	29	22	16	13	10	6	2
Year 5 (kg of N/ ha/ year)	27	25	21	16	13	10	6	2
Year 10 (kg of N/ ha/ year)	26	22	19	14	13	10	6	2
Year 20 (kg of N/ ha/ year)	25	21	18	13	12	10	6	2

- *Soil Fertility*

(Taken from reference to “Rolling” data supplied by A. Day on soil test samples – 06 Dec 2006)

Milking platform:

pH	Olsen P	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Sulphate	Organic Sulphur
5.7	25	4	10	5	4	7	7

Dairy Farm target:

pH	Olsen P	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Sulphate	Organic Sulphur
5.8-6.0	25-30	4 +	8-10	6-8	4	10-12	15-20

- *Annual Rainfall*

The property is located in the foothills of the Tararua Ranges, in a high rainfall, summer moist area, with exposure to wind which prevails from the west & south west.
Average rainfall: 1600mm per year (A. Day quoted)
Mean Air temperature: 12.4 degrees Celsius - NIWA
Total Sunshine hours: 1795 hours – NIWA
Height above sea level: 160 – 240 metres ASL for the whole property

- *Area*

The Dairy unit has a proposed milking platform of 265 ha total, 243 ha effective (note: this information has been taken from the farm map calculating all the paddock areas).

Milking Platform: made up of three parts separated by roads, with road frontages on:

- Pahiatua Aokautere Road, Tararua Road, Makomako Road and Balance Valley Road.

The grazing area for dry stock (R1's, R2's) is:

- grazing on another property from May – May.

- *Drainage*

The farm does become slightly water logged in the winter and there are a few small areas that will need to be fenced off from stock access, the feed pad on the dairy unit will be utilised for a winter stand off pad to compensate for this.

- *Water Supply*

Currently the property has a reticulated water system that is fed by water tanks. Dams and the streams are also utilized in paddocks for stock water supply. Although there is a good source of water for the dairy unit, the conversion will require an upgrade to the existing water system

- *Buildings*

There is a significant amount of building required for the dairy unit to be operational. This will include, the dairy shed, silage pits, a feed pad, calf facilities, a hay shed and an implement shed.

- *Fences*

The farm is currently fenced in 8-wire conventional with the proposal for the dairy unit to be re-fenced in 3 wire electric

- *Paddocks*

The dairy unit is to be subdivided into 56 paddocks with an average size of 4.2 ha

- *Tracks*

Extensive track work will be required to convert the dairy unit into an efficient, operational system

- *Power Supply*

Some initial capital expenditure will be required to upgrade the 1 phase wire to the dairy shed site to a 3 phase wire.

- *Production*

It is estimated that with 170 ha of the proposed Dairy unit being regrassed, the annual pasture production will be approximately 9146 Kg DM/ ha/ year.

Stock numbers:

Area effective 243 ha
2008 SR 2.5/ha = 608 cows, 2009 SR 2.6/ha = 632 cows, building to 656 cows (SR 2.7/ha) over three years
Replacement weaner claves are grazed off farm from 12 weeks of age to 4 weeks pre calve (approximately from 3 months of age through to 18 months of age)

STOCK CLASS	RATE
Weaners (Dec – May)	$4.00/ head/ week
R1's (June – May)	$7.00/ head/ week
R2's (May – July)	$12.00/ head/ week

Calving dates for the R2's is 20th July with the cows starting 1 Aug
Heifers are synchronised to calve 10 days earlier than the cows

Milking Cows – stocking rate

YEAR	STOCKING RATE	COW NUMBERS
2008	working on 2.5 cows/ha	608
2009	working on 2.6 cows/ha	632
2010	working on 2.7 cows/ha	656

Replacements – Based on 20% entering the herd (refer to Milk Production from Pasture)

YEAR	REPLACEMENT NUMBERS
2008	122
2009	126
2010	131

Calves are fed milk from the vat along with pellets & grass up until 12 weeks of age (thereafter they are fed pasture only).
This equates to:

Milk L/ calf over 12 weeks = 243.6 L milk

Pellets Kg/ calf over 12 weeks = 49 kg pellets

Therefore,

YEAR	EQUATION	AMOUNT FOR CALVES
2008	(122 x 243.6) + (122 x 49)	29,719.2 L milk & 5,978 kg pellets
2009	(126 x 243.6) + (126 x 49)	30,693.6 L milk & 6,174 kg pellets
2010	(131 x 243.6) + (131 x 49)	31,911.6 L milk & 6,419 kg pellets

Production: (Milksolids sold)

Production year 1	280 kg/cow	701 kgMS/ha
Production year 2	305 kg/cow	793 kgMS/ha
Production year 3	305 kg/cow	891 kgMS/ha

Feed Budget Assumptions:

Pasture Growth Rates:

The pasture growth rates used in developing a feed budget for this dairy system are based on monitoring information collected by Dexcel on a dairy farm located at Eketahuna. This information was adjusted (reduced) by 25% for A. Days property.

MONTH	**DEXCEL – EKETAHUNA (kgDM/ ha/ day)**	**A. DAYS (kgDM/ ha/ day)**
August	16	12
September	22	16.5
October	51	38
November	50	37.5
December	55	41
January	58	43.5
February	52	39
March	29	22
April	23	17
May	19	14
June	17	13
July	11	8
TOTAL PRODUCTION (kgDM/ ha/ year)	12225 kgDM/ha/ year	9145.5 kgDM/ha/ year

Fertiliser:

Use N April (12 weeks response) at 50 kg N/ ha (10:1 response)

= (10x 50) x 209.4 = 104,700 kgDM
Use N August (10 weeks response) at 50 kg N/ ha (10:1 response) = (10x 50) x 209.4 = 104,700 kgDM
Apply 151 tonne Potassic Super/ year
Apply 50 tonne of Lime/ year

* Apply 7 kg/ha of 20% Potash Super for every 10kg/ha MS (base it on 891kgMS/ha)

Subdivision:

56 paddocks = a split herd will be operated with approximately 28 paddocks each of average size 4.2 ha

Supplements:

- **Surplus Feed:**

Conservation of 22ha of hay over summer – (harvest in February)

At 4000 kgDM/ ha, approximately 88,000 kgDM will be conserved.

Hay will be conserved in 2007, 2008, 2009 & 2010

Pasture Renewal over 170ha of farm completed in 2007 – (prior to commencement of dairy farming). This will result in an increase in pasture production, enabling an increase in the stocking rate and milksolids production over time.

Assume with new pasture over 70% of the farm that annually there will be 9000 kgDM /ha grown.

- **Crop:**

Crop 33.6 ha in Triticale with 2 grazings (15 days end of April, 30 days in July), harvested as silage in January 2009 with the paddocks then put into permanent pasture.
Use the crop in 2007 to graze the beef cattle already on the property in April and July, allowing the harvested silage in January 2008 to be fed to the dairy cows.

Yield estimates of the crop are:

MONTH	YIELD	BUDGETED SILAGE FED
April	2.5-3 tonne/ ha	2.5 tonne/ ha
July	2.5-3 tonne/ ha	2.5 tonne/ ha
January	12-16 tonne/ ha	14 tonne/ ha

Source: Joanne Amyes, Wrightson seeds, Technical Assistant.

- **Silage:**

2008 use 390 tonne DM, 2009 use 441 tonne DM & in 2010 use 608 tonne DM of silage. With an increased stocking rate in the 2012/2013 season there will be a shortage of silage from August – January. To overcome this shortfall more silage could be made (requiring a larger area of land to be put into crop), or silage could be purchased in. Alternatively more urea could be used in the spring.

- **Hay:**

In 2008 it is estimated the Dairy system will use 75 tonne DM, in 2009 140 tonne DM & in 2010 use 134 tonne DM.

With 88 tonne DM being harvested each year, it will be necessary to purchase additional hay from 2009. Alternatively more Nitrogen or other supplements could be used.

▪ 4. Infrastructure required & estimated capital cost

INFRASTRUCTURE	ESTIMATED COST	INFORMATION SOURCE
Cowshed – 60 bail	$840,000	Keegan Contractors Limited & Davidson Engineering
Cow Shed Site Preperation	$25,000	Infracon
Refrigeration Unit	$16,500	DTS
Stock (Cows) @ $ 2,500/cow	$1,570,000	RD1 website
Feed pad	$245,000	Keegan Contractors Limited
Silage Bunker (x2)	$90,000 each = $180,000	Keegan Contractors Limited
Effluent Disposal	$130,000	HiTech Environ Solutions
Fences (3 wire electric) including Labour	$1,850.00/ Km 38.7km x $1,850.00 = $ 71,595	Turton Farm Supplies
Tracks	Races & Tanker track work on $2.80/ m^2 (All metal on Farm) 5.5km x 8m wide laneway = $123,200	Infracon - Need m^2 area
Underpass (x1) - 3m x 2m, 12 m length	$45,000 materials + $25, 000 installation x 2 = $70,000	Hynds
Bridge (x2)	$40,000	Emmets - Wanganui
Culvert (x10 @ 900 & 29 @ 450) Need 39 new culverts (4 optional)	900 - $1000 450 - $350 = $20,150	Hynds
Electricity connection	$50,000	Scan Power
Water Supply	1.6 km + 6 Km to troughs $30/ trough for fittings and $20,000 for pipe = (20 x 30 + 20,000 + gst) $25,425	McDougalls – Palmerston North
Re-grassing	$107,950	
Calf Shed (6 bay) – Including Labour	$13,800.00	Turton Farm Supplies
Implement Shed (3 bay) – Including Laour	$8200.00	Turton Farm Supplies

Hay Shed (9 bay) – Including Labour	$23,000.00	Turton Farm Supplies
Tractor (x2)	$180,000 + gst = $202,500	Norwood Farm Machinery
Feed out wagon (Hay)	$8,500 + gst = $ 9,562.5	Norwood Farm Machinery
Feed out wagon (Silage)	$25,000 + gst = $ 28,125	Norwood Farm Machinery
Troughs (20)	$8,400	RD1
Calf milk feeders	$10,198	RD1
Calf pellet feeders	$2,350	RD1
Consents *		
Fonterra Shares	$1,469,900	Fonterra
Contingency (10%) of total development costs	$529,086	
TOTAL	$5,819,941	$5.8 million ($21,969/ha)

Note: All costs are estimates only. An in depth planning and costing process would need to be undertaken once a decision has been made to thoroughly evaluate the opportunity in depth and present a case study to obtain finance for the project.

***Resource consents – fees and charges are worked out on a case by case basis, however there is reference to the Horizons Regional Council standard policy of charges associated with resource consents in the appendix.**

- **Production targets for first three years (feed budgets attached):**

	KgMS/ cow	KgMS/ Ha	TOTAL KgMS
Production year 1	280 kgMS/cow	701 kgMS/ Ha	170,240 total kgMS
Production year 2	305 kgMS/cow	793 kgMS/ Ha	192,760 total kgMS
Production year 3	330 kgMS/cow	891 kgMS/ Ha	216,480 total kgMS
Pasture Production	9146 kgDM/ ha / year		

- **Management System:**

The management structure proposed is to have three full time equivalent labour units running the dairy operation.

A. Day would continue to run the sheep & beef unit whilst overseeing the dairy unit. He has proposed employing a Variable Order Sharemilker, who will in turn employ the necessary dairy farm labour.

Variable Order Sharemilker:
"This is a sharemilking agreement where the Sharemilker provides no stock but their labour and expertise in return for a percentage of the income and pay a percentage of the costs, usually related to that of milk production only i.e. rubber ware, detergents and electricity for the farm dairy. The Sharemilker is an independent contractor and contracts are usually on a year-by-year basis.

This system is covered by an act of parliament and there are statutory requirements attached to it, however most of these relate to herds of 300 and under.

In herds over 300 cows the percentage and terms and conditions are nearly all totally negotiable including who is responsible for employing other staff in Variable Order Sharemilking contracts. 20% of the income seems to be the norm in the industry at the moment." – (Things to take into account when planning a dairy conversion, G. Maughan).

- **5. Dairy Conversion – Cost Analysis & Opportunity Cost**
  - Cost Benefit Analysis of the Conversion

    - **Grazing**

    Weaner claves are grazed off farm from 12 weeks of age to 4 weeks pre calve

    Grazing for replacements –

STOCK CLASS	RATE
Weaners (Dec – May) 6 months/ 24 weeks	$4.00/ head/ week
R1's (June – April) 10 months/ 40 weeks	$7.00/ head/ week
R2's (May – July) 3 months/ 8 weeks	$12.00/ head/ week

(Weaner claves are grazed off farm from 12 weeks of age to 4 weeks pre calve = 72 weeks)

YEAR	NUMBERS	TOTAL AMOUNT ($)
2008	122 weaners & 122 R1's	$ 44,912
2009	126 weaners & 126 R1's & 122 R2's	$ 59,088
2010	131 weaners & 131 R1's & 126 R2's	$ 61,352 *

* could look at purchasing a grazing block for this cost

- **Calf Pellets**

RD1, Val – inclusive of GST
Calf pellets - $21.99 (25Kg)
If a tonne is purchased = $20/25Kg = $800

YEAR	AMOUNT (Kg)	EQUATION	TOTAL AMOUNT ($)
2008	5,978 kg pellets	(6 x 800)	$4,800
2009	6,174 kg pellets	(6 x 800) + 153	$4,953
2010	6,419 kg pellets	(6 x 800) + 369	$5,169

- **Fertiliser**

(Source: Caroline Jefferd, Balance AgriNutrients)

Application over the year:

  - Use N April (12 weeks) at 50 Kg/ Ha (10:1 response) (= 104,700 Kg N over 12 weeks)
  - Use N Aug (10 weeks) at 50 Kg/ Ha (10:1 response (= 104,700 Kg N over 10 weeks)
  - Apply 151 tonne Potassic Super per year
  - Apply 50 tonne of Lime per year

(Should not load on more than 50 kg N/Ha in one hit - Farm Technical Manual)

	COST ($)
April application of N @ 1.50/kg N applied	$ 15,705
August Application of N @ 1.50/kg N applied	$ 15,705
Application of Potassic Super	$ 40,347
Application of Lime	$ 4,500
Total Cost/ Year	$ 76,257

- **Cropping and Harvesting Hay**
  - The cost for cropping 33.6 Ha of DoubleTake Triticale. The recommended sowing rate is 145kg/ha (based on a 52g 1000 seed weight)
    = $350/ ha
  - The cost for cutting and stacking the Triticale silage = $11,908
  - The cost to re-grass after cropping = $280/ ha
  - The cost of harvesting hay on 22 Ha – looking to harvest about 400 round bales (4400 small conventional).
    Conventional = $2.20 each
    Round Bales = $25/ round (10 equivalent)
  - The cost of re-grassing 170 Ha all at once using Bealey Perennial Ryegrass (Agriseeds).
    = $380/ ha

- **Compliance monitoring costs** (see appendices)

- **Labour**

Variable order sharemilker & employs other worker at 20% of total income per year

- **Milk Payout from Fonterra over 3 years**

According to a report by H. Eaton and published in the Baker & Ag newsletter it suggests that most banks want to see a MS price of $5.00/kg used for long term viability budgets, however $5.40/kg MS is considered by may in the industry as a reasonable figure to use for the 3-year term.

- **Freight**

Weaner @ $10.00/hd		
18 month @ $15.68/hd		
YEAR	NUMBERS	COST ($)
2008	122 R1's	$ 1,220
2009	126 R1's	$ 1,260
2010	131 R1's &126 R2's back	$ 3,285.68

- **Assumptions for calculating Stock Purchases and Stock Sales**

Stock Sales

- Bobbies:
  - 95% calf survival with total calves- replacements = bobbies
  - Bobbies liveweight = 28kg @ 146 cents/kg = $40/hd - $5/hd freight = $35.00/hd
- Empties & Culls:
  - 10% empty, 3% deaths & 5% culls
  - Therefore sell 15%
  - 400kg liveweight @ 50% DO = 200kg carcass weight @ $1.90/kg (freight included) = $380.00/hd

Stock Purchases

- Replace 15% (for empties & culls) and additional number to make it to total cow numbers required for the season until own replacements come into the system in 2010/2011 season

Year 1: 2008/2009 (608 cows)

INCOME		
Milk	170240 KgMS @ $5.40	$919,296
Stock	456 bobbies @ $35/hd & 91 culls @ $380/hd	$50,540
TOTAL		$969,836
EXPENSES		
Stock Purchases	133 cows @ $2500/hd	$332,500
Farm Working Expenses		
Wages	Variable Sharemilker 20%	$183,860
Animal Health	$51 per cow	$31,008
Herd Improvement	$30 per cow	$18,240
Electricity	$36 per cow	$21,888
Calf Rearing (pellets)		$4,800
Cowshed Expenses	$22 per cow	$13,376
Freight (replacement cartage @ 160Km)		$1,220
Weed & Pest	$8 per cow	$4,864
Feed		
Hay (round bales)	$25/ round x 400	$10,000
Silage (Triticale)		$11,908
Grazing replacements		$ 47,376
Cropping (Triticale)	$537 x 33.6 ha	$18,043
Re-grassing	$635 x 33.6 ha	$21,336
Calf milk	29719.2 x 9% @ $5.40	$14,445
Fertiliser		
Nitrogen ($ applied)	$15,705 x 2	$31,410
Lime ($ applied)	$4,500	$4,500
Potassic Super ($ applied)	$40,080	$40,347
Repairs & Maintenance	$68 per cow	$41,344
Vehicles	$27 per cow	$16,416
Administration	$67 per cow	$40,736
Standing charges	(0.06 x 170240)	$10,214
General Expenses	(0.01 x 170240)	$1,702
TOTAL FARM EXPENSES		$921,533
FARM SURPLUS (EBIT)		$48,303

Some expenses have been taken from the Financial Budget Manual 2006

Year 2: 2009/2010 (632 cows)

INCOME		
Milk	192760 KgMS @ $5.40	$1,040,904
Stock	474 bobbies @ $35/hd & 95 culls @ $380/hd	$52,690
TOTAL		$1,093,594
EXPENSES		
Stock Purchases	138 cows @ $2500/hd	$345,000
Farm Working Expenses		
Wages	Variable Sharemilker 20%	$217,181
Animal Health	$51 per cow	$32,232
Herd Improvement	$30 per cow	$18,960
Electricity	$36 per cow	$22,752
Calf Rearing (pellets)		$4,953
Cowshed Expenses	$22 per cow	$13,904
Freight (replacement cartage @ 160Km)		$1,260
Weed & Pest	$8 per cow	$5,056
Feed		
Hay	$25/ round x 400	$10,000
Silage		$11,908
Grazing replacements		$61,352
Cropping (Triticale)	$537 x 33.6 ha	$18,043
Re-grassing	$635 x 33.6 ha	$21,336
Calf milk	30693.6 x 9% @ $5.40	$14,915
Fertiliser		
Nitrogen ($ applied)	$15,705 x 2	$31,410
Lime ($ applied)	$4,500	$4,500
Potassic Super ($ applied)	$40,080	$40,347
Repairs & Maintenance	$68 per cow	$42,976
Vehicles	$27 per cow	$17,064
Administration	$67 per cow	$42,344
Standing Charges	(0.06 x 192760)	$11,566
General Expenses	(0.01 x 192760)	$1,928
TOTAL FARM EXPENSES		$990,987
FARM SURPLUS (EBIT)		$102,607

Some expenses have been taken from the Financial Budget Manual 2006

Year 3: 2010/2011 (656 cows)

INCOME		
Milk	216480 KgMS @ $5.40	$1,168,992
Stock	492 bobbies @ $35/hd & 98 culls @ $380/hd	$54,460
TOTAL		$1,223,452
EXPENSES		
Farm Working Expenses		
Wages	Variable Sharemilker 20%	$245,599
Animal Health	$51 per cow	$33,456
Herd Improvement	$30 per cow	$19,680
Electricity	$36 per cow	$23,616
Calf Rearing (Pellets)		$5,169
Cowshed Expenses	$22 per cow	$14,432
Freight (replacement cartage @ 160Km)		$3,286
Weed & Pest	$8 per cow	$5,248
Feed		
Hay	$25/ round x 400	$10,000
Silage		$11,908
Grazing replacements		$63,712
Cropping (Triticale)	$537 x 33.6 ha	$18,043
Re-grassing	$635 x 33.6 ha	$21,336
Calf milk	31911.6 x 9% @ $5.40	$15,509
Fertiliser		
Nitrogen ($ applied)	$15,705 x 2	$31,410
Lime ($ applied)	$4,500	$4,500
Potassic Super ($ applied)	$40,080	$40,347
Repairs & Maintenance	$68 per cow	$44,608
Vehicles	$27 per cow	$17,712
Administration	$67 per cow	$43,952
Standing Charges	(0.06 x 216480)	$12,989
General Expenses	(0.01 x 216480)	$2,165
TOTAL FARM EXPENSES		$688,677
FARM SURPLUS		$534,775

Some expenses have been taken from the Financial Budget Manual 2006

5. Cost Benefit of the Dairy Conversion

Note: Estimated figures do not constitute a registered valuation & figures are based on a $5.40/kgMS payout

Cost of converting to dairying:

- Opportunity Cost:
    - Loss of income from sheep & beef farming (est EBIT of $151,000)
    - Loss of finishing ability for lambs & cattle on sheep & beef enterprise
    - Potential loss of land ownership (Equity Partnership) of 250ha
- Increased financial risk from additional borrowings
- Management control reduced with equity partner and lower order sharemilker
- Loss of sheep & beef lifestyle
- Compliance costs with Horizons Regional Council & Fonterra

Benefits for converting to dairying:

- New Pasture
- Increase in income
- Capital Gain of $1,272,039 for the new dairy venture
  (10,430,200 – (3,338.220 + 5,819,441))
- Diversification
- Synergies with investor
- Reduction in workload for Andrew

Points to consider:

- Lag phase, 6 months to implement
- Need for an investor of 1.8 million, what will they want (land ownership, dividends, control).

Development Cost:

Land Development & Infrastructure	$2,780,041
Shares	$1,469,900
Stock (cows)	$1,570,000
Total	**$5,819,941**

Estimated Figures on Conversion to support cost and benefit comments:

- Increased total income created by the dairy system equates to an EBIT of $534,775
- ROC = 9.2% (net return on capital)

- Say interest cost = 30% GFI ($1,223,452)
- Then interest = $367,036
- Capital that can be borrowed = $4,078,178 (based on 9% interest rate)
- Times interest covered (TIC) = 1.5 (Banks do not like this to be below 1.3)
- Andrew has 65% of the investment with $3,338,220
- Investor has 35% of the investment with $1,741,763
- Total money invested by equity partnership = $5,079,983
- Money borrowed by equity partnership = $4,078,178
- Total Capital = $9,898,119
- Capital gain through development estimated to be $1,272,039

Costs:

- 243ha effective @ 10.5 su/ha
- Current EBIT = $314/ha over 910ha, however the 243ha concerned probably represents 53% of the total EBIT (Bulls, Heifers & Lamb Finishing)
    - Total EBIT = $285,740
    - 53% of this =$151,442 or $623/ha
    - Therefore EBIT improvement from dairying (Dairy EBIT – Sheep & Beef EBIT) = $534,775 – $151,442
      = $383,333 Net increase in EBIT
- Interest cost from dairy conversion = $367,036
- Therefore marginal gain (cash surplus) = $16,297 (at the $5.40 payout)

Capital Gain:

- Value of sheep & beef property, say 243 ha = 2829su @ $ 1,100/su = $3,111,900 Market Value today, plus livestock at $80/su = $226,320
    - Capital Value = $3,338,220
- In three years dairying land & buildings value at $40/kgMS @ 216480kgMS produced = $8,659,200
- Capital Gain $5,547,300 ($8,659,200 - $3,111,900)
    - 656 cows at $2,500/cow = $ 1,640,000
      Plus replacements 131@ 1000 = $131,000
      = $1,771,000
    - Capital Value $10,430,200 – 3,338,220 = $7,091,980
    - To achieve this they have to spend/ invest $5,819,941
    - Net Capital Gain = $1,272,039 (65% to A. Day, 35% to Investor)
- A. Day = 1,272,039 x 0.65 = $826,825
- Equity gain ($826,825/ $3,338,220) = 24.8% in 3 years, roughly 8.3%/ year

Capital Analysis:

- ROC = ($534,775/ $10,430,200) = 5.1%
- ROE = ($534,775 – $367,036)/$5,079,983 = 3.3%

Sensitivity Analysis:

$ PAYOUT	INCOME	EXPENSES	EBIT	ROC	ROE
$7.40	$1,656,412	$688,677	$967,735	9.3%	11.8%
$6.40	$1,439,932	$688,677	$751,255	7.2%	7.6%
$5.40	$1,223,452	$688,677	$534,775	5.1%	3.3%
$4.40	$1,006,972	$688,677	$318,295	3.1%	-1.0%
$3.40	$790,492	$688,677	$101,815	1.0%	-5.2%

As a point of reference the current equity of the 250ha is 3,338,220. With an EBIT of $151,442 the current ROE is 4.5% (assumes no borrowing exists). With a $5.40 payout the ROE from dairying is lower at 3.3% from dairy farming.

Note:
EBIT (Earnings Before Interest & Tax) is GFI (Gross Farm Income) – FWE (Farm Working Expenses)
ROC (Return On Capital) & ROE (Return On Equity) are based on budgeted production figures in 3 years time.

- ROC = EBIT/Total Capital Employed after year three
- ROE = (EBIT - Interest Cost)/Opening Equity

The future (3 year) value of the dairy farm is based on status quo market value for dairy farms (ie. No appreciation of land values has been accounted for). Appreciating land values in the dairy sector of 10% per year make the conversion more attractive from a financial perspective.

9. Summary

Please note that this project has been carried out at a time of high payout's from Fonterra which has increased the number of conversions and land being converted into dairy. This has followed with an increase in demand for stock especially. It must also be noted that there are many assumptions that have been made and the pricing should be regarded as estimates only.
An in depth planning and costing process would need to be undertaken once a decision has been made to thoroughly evaluate the opportunity in depth and present a case study to obtain finance for the project.

10. Appendices

1. Horizons Regional Council Standard Resource Consent Policy, taken from their website.

*Resource consents – fees and charges

As an applicant you pay 100% of the processing costs for your resource consent up until the point where it is determined a hearing is required. At this point you may be charged between 60 - 100% of the processing costs.You pay an application deposit when you apply for consent, and your application cannot be processed until this deposit is paid. Depending on the type of resource consent, the application deposit covers advertising (notified only), administration, and routine investigation. It never covers the total cost.

An administration charge also applies to every consent application.

Deposits:

Non-notified $500.00
Notified $1,000.00
(Excludes GST)

The RMA allows us to charge consent applicants for actual and reasonable costs in relation to processing the application. Generally the deposit does not cover the total costs of processing your application, especially the costs of pre-hearings or hearings. Any additional charges will be itemised when you receive notice of the decision made on your application, unless your application goes to a hearing. In that situation a separate decision on processing costs is released 15 days after the hearing decision is released.

What can you do to minimise costs?

- **Check** with us that you have provided the correct details on your application before you lodge it.
- **Complete** applications thoroughly. If there is something left out, we may have to write to you for more information or spend time researching, which can add to the costs. Remember we can spend up to an hour with you at no cost to help you complete the application form correctly.
- **Consult** with and get approval from affected parties. This may be your neighbours, iwi groups, and special interest groups. If this is not done, then your application could be publicly notified and submissions made against it.

You can object under section 357 to the costs charged if you wish.

Charges during the lifetime of resource consents

Once granted, your consent may state monitoring is required. If this is the case, we will visit and inspect the activity covered by the consent and you will be charged an inspection fee following each visit. The cost will depend on the type of activity and whether or not you are found to be complying with the conditions of the consent. Find out more about **consent monitoring and charges**.

Consent inspections/applications

We assist farmers and industries to obtain resource consents by carrying out site inspections and offering advice to ensure compliance with the RMA.

Once a consent has been issued, inspections are carried out to ensure all the conditions of the consent are met.

This type of monitoring applies to both industrial and rural properties and for the following types of consents: water takes, discharges to land or water, discharges to air, placement of structures in watercourses, and earthworks.

There are fixed charges for these inspections.

For rural properties:

Type of inspection	Compliance with consent conditions	Non-compliance with consent conditions
Discharge to Land	$280	$415
Discharge to Water	$280	$415
Water Take (Field Inspection)	$230	$375
Water Take (Data Assessment)	$52	$170
Land Use Activity	$280	$415

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DTS
RD1, Val
HiTech Environ Solutions
Turton Farm Supplies
Hynds
Emmets
Scan Power
Wolland Contracting
Norwood Farm Machinery
Fonterra, Tony Haslett & Greg Maughan
Horizons Regional Council
Cutty's Livestock Services, Greg Cuttance
Wanganui Vets Grazing, Jamie Anderson
Balance AgriNutrients, Caroline Jefferd
Kevin Harris Contracting
McDougalls – Palmerston North

Andrew Day
Farm Description

Current Farming Practice

The farm business is comprised of 950 ha in total. Of this the home farm is 730 ha of which 710 ha is estimated as being effective grazing land. In addition, a 220ha lease block (very poorly developed) is also farmed of which 200 ha is effective. This gives a total effective area of 910 ha.

The farm system can best be described as a breeding and finishing unit operating in a summer moist environment. The topography of the farm is easy to very steep however most of the land is rolling to strongly rolling with the potential for large areas to be cultivated if desired.

Stock Reconciliation

As the grazing management of the lease block improves the pasture species and productivity, the carrying capacity is being raised. In the winter of 2007 the following livestock were carried.

Stock Class	Number	
MA Ewes	4430	
Ewe Hoggets	1620	For the last 2 years have mated half of the ewe hoggets
Wether Hoggets	470	
Rams	35	
Sheep Stock Units	**6083**	
MA Cows	116	2/3 in calf – increased from 30 cows with lease
R2yr Heifers	31	
R1yr Heifers	52	
R2yr Bulls	41	
R1yr Bulls	164	
Breeding Bulls	2	
R1yr Dairy Heifer Grazers	63	normally 140-150 May to May on contract
Cattle Stock Units	**2286**	
Total Stock Units	**8369**	Lower than normal due to dry summer - normally 8700 su wintered
Sheep: cattle	**73:27**	
Stocking Rate	**9.2**	

Sheep Enterprise

The MA ewe flock is a Coopworth Composite cross (Coopworth being of Carthew origins) for the last 3 years. This has evolved from a Composite flock bred to have high fecundity. The Coopworth breed is now being used to regain the robustness of the flock whilst maintain fertility.

A Terminal Sire ram is mated with 1500 MA ewes from 7 April. The remainder of the ewes are mated from 21 April. Ewe Hoggets are mated from 21 April to the Terminal Sire rams.

A consistently high lambing performance is achieved in the ewe flock with lambing percentage averaging 140% (scan 175-180% not counting the triplets). In the ewe hoggets it is typical to obtain 75% lambing in the hoggets (based on the number mated). These hoggets have scanned up to 130%.

Weaning occurs progressively from December through January starting with the Terminal Sire lambs (lamb weaning weight last year was 26-27kg however it is normally 30kg). Lambs are drafted prime at weaning down to 14kg carcass weight with 1200 normally sold prime at weaning. Every 2 weeks after the start of weaning lambs are drafted to the end of January and then every 3-4 weeks at 15.5-16kg carcass weight. In most years the last of the lambs are sold in mid to late May.

To reduce market risk a fixed pricing/supply contract with Bernard Matthews is entered into. This contract also ensures killing space is booked for lambs.

A Split flock 8-10 month shearing system based on the age of the sheep is maintained. However ewes with lambs at foot are not shorn. Lambs are shorn in mid January and the hoggets either pre lamb or in September.

Cattle Enterprise

The breeding cows are mainly farmed on the 220ha lease block (part of a wind farm) .

- Calving is from 20 October and weaning (start May) calves onto the home farm. The cows spend 4-6 weeks on the home farm over TB testing etc.
- Bull calves go into a semi cell system with another 110-120 Friesian bulls. They are then sold from December – March/April at 260kg carcass weight. The tail end 20 are carried over and normally killed in November at 300kg carcass weight.
- Heifer calves stay at the home farm (calves late October). You have been retaining all the heifers to build cow numbers and are aiming to increase cow numbers to 200.
- Friesian bulls are 100kg spring purchased (mid October to early December purchase). The bulls are spread amongst the ewes when they arrive.
- To manage the worm burdens, cells are grazed by the sheep from weaning to the start of April.
- Cows are traditional Friesian Angus Hereford cross.

- Now using Angus.
- Will look to use some Terminal Sire Charolais/Simmental to improve the calves.

Dairy Heifers

- May to May contract.
- Have their own cell systems exclusively until sheep weaning. Once the ewes are weaned, the heifers are run on the country the ewes lambed on.
- These Dairy systems have sheep on them from weaning until April.
- One lot of heifers is on a weight gain system and the other on a flat weekly fee.
- Heifers arrive at 200kg 1 May and leave at 420kg 1May – giving a 220kg weight gain.
- Both mobs of heifers are cross bred.
- You are responsible for animal health however this has been negligible due to the grazing systems.

Animal Health

Sheep

- As little as possible done.
- Normally on 20% of MA ewes drenched at docking.
- Lambs get a monthly drench starting 1 month before weaning.
- Vaccinate for Campylobacter and Toxoplasmosis at hogget stage.
- Vaccinate 5 in 1 pre lamb and in the hoggets in March.

Cattle

- As little as possible.
- Average drench 1/head in young stock/year.
- Bottom 10% of cows may get a drench at weaning.

Grazing Systems

Sheep

- 3-4 mobs of ewes are kept in separate rotations from weaning until set stocking (in age category).
- The mobs are reconfigured at scanning.
- Rotation length through winter is 70 days.
- Set stocking occurs normally on lamb drop (within a week). Visual udder assessment is used to manage timing of set stocking. Later lambers go onto country that is later growing or areas with lower cover.
- Set stocking rates are based on historical paddock performance – feed demand and supply matched 7.5-13.75/ha.

- Lambs are typically set stocked back onto the same country they were lambed onto except for the area required for the ewes.
- After 1 month they get mobbed up more and some come onto the cattle country.
- Ewe hoggets are split into 2 replacement mobs in autumn. Will mate as many as possible (over 36kg liveweight). Mated hoggets are given priority on rotation through winter.
- Dry hoggets have a lower priority with the empty hoggets (identified at scanning) joining them.
- Will often separate twin and single bearing hoggets post scanning.
- Some of the twinning hoggets lamb onto cattle country.
- Single hoggets are lambed onto later hill country.

Cattle

- Once on system in April/May, they go onto a rotation of 50-60 days at the start and then down to a 15 day rotation in September. Generally, you are trying to grow the bulls as well as possible.
- Bulls at 2.5/ha
- Heifers at 3.0/ha

Profit Check Benchmark Analysis

General Production KPI's	2007	Class Average	Comment
Area (ha) effective	910	530	Larger than average
Stocking Rate (su/ha)	8.5	10.2	Low – influenced by lease block
MA Lambing %	139	123	Very good
Hogget lambing %	37.5	42.8	Average
Flock lambing %	113	98	Very good
Sheep deaths and missing	6.4	8.2	Low
Cattle deaths and missing	0	4.4	Very low

Financial KIP's	2006	Class Average	Comment
Sheep GFI/ssu$	67.79	61.24	Above average
Cattle GFI/csu$	62.53	49.16	Well above average
Total GFI/su$	67.44	59.52	Well above average
Total GFI/ha$	572	612	Below average
R&M Expenses ($/ha)	36	48	Below average
Fertiliser (kgP/ha)	9	18.4	Below maintenance
Total FWE $/su	30.44	40.43	Well below average

FWE /GFI %	45	72	Very good
EFS/ha	251	95	Very good
EFS/GFI %	43.9	10.8	Very good
EBIT $/ha	314	198	Very good
Interest & rent/GFI %	13.6	25.1	Low
Return on Capital %	2.2	1.3	Above average
Return on Equity %	1.7	-1.5	Above average
Change in Equity		NA	
% Change in Equity		NA	
Term Borrowings ($/su)	66	NA	Moderate
Times interest Covered	4	NA	Very good

Note:

GFI Gross Farm Income
FWE Farm Working Expenses
EFS Economic Farm Surplus (GFI – FWE +/- adjustments)
EBIT Earnings Before Interest & Tax (GFI – FWE)
NA Not applicable

Specific points to note from the Profit Check financial analysis

- The stocking rate appears low at 8.5 su/ha. This is however influenced by the 220 ha lease block which is managed very extensively and at a very low stocking rate. The land owned has an estimated winter stocking rate of 10.2 su/ha which compares well to the class average (of 10.2 su/ha). In addition the stocking rate lifted by 477 su during the course of the year as the lease block is developed (through better grazing practices) and as more R2 yr bulls were wintered.
- Lambing performance is well above the average (flock lambing performance of 113%) highlighting one of the strengths of the farm operation.
- Sheep deaths and missing is relatively low at 6.4% indicating good nutrition and animal health is maintained on the property. There were no cattle deaths in 2007.
- Calving performance from the cows is slightly below the average reflecting the extensive management system operated on the lease block.
- Wool production and income received from wool in was much lower than the average at 4kg/ssu and $8.67/ssu (compare to the average of 6kg/ssu and $14.47/ssu).
- Overall sheep income per stock unit was nearly 11% above the class average while cattle income was 27% above the average.
- Due to the lower effective stocking rate, the GFI/ha was 6.6% lower than the class average at $572/ha (compare to $612/ha).
- Phosphate inputs in 2007 were below maintenance at just 9kgP/ha. The reason for this being that a substantial amount of Lime was applied in

place of Super Phosphate and DAP 13 S. Normally 40 kgP/ha is applied annually.

- Animal Health expenditure is very low at just $1.36/su compared to the class average of $4.15/su.
- Total FWE amounts to $30.44/su and $258/ha which is considerably lower than the class average. As a percentage of GFI, the FWE accounts for just 45% which provided the resource is being maintained, highlights a tight control on costs and an efficiently operated business.
- The operating surplus (or Earnings Before Interest and Tax, EBIT) is very good at $314/ha (56% above the class average) and the EFS at $251/ha is 264% above the average.
- The Return on Equity (ROE) is positive indicating a gain in the net equity of the business occurred.
- Interest and rent as a proportion of the GFI is 13.6% which is moderate and indicates there is the potential to borrow more to develop and or grow the business.
- Times Interest Covered (TIC) is a measure used to determine the serviceability of debt and rent (EBIT/Interest and Rent). As a rule of thumb, most banks prefer this index to be at least 1.3. A result of 4 indicates a strong level of financial flexibility.

In general terms the business is being managed very well with high levels of livestock and financial performance being attained. With relatively low debt levels and a very strong equity position (94%), the business is being operated in a sustainable manner.

Sheppard Agriculture Feed Budget

Name: A.Day								Date: 2008 season					
Month		August	September	October	November	December	January	February	March	April	May	June	July
Number of days		31	30	31	30	31	31	28	31	30	31	30	31
Area		209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4
(A) Starting Cover (KgDM/ha)		**2100**	**1969**	**1967**	**1998**	**2078**	**2178**	**2447**	**2306**	**2268**	**2465**	**2391**	**2251**
Pasture Growth Rate (kgDM/ha/d)		**12**	**16.5**	**38**	**37.5**	**41**	**43.5**	**39**	**22**	**17**	**14**	**13**	**8**
Grass Fed (kgDM/Cow/d)		7.8	8.0	13.9	12.0	13.0	12.0	10.0	8.0	5.5	7.5	8.0	3.5
Pasture Demand (kgDM/ha/d)		**22.7**	**23.2**	**40.2**	**34.8**	**37.7**	**34.8**	**29.0**	**23.2**	**16.0**	**21.8**	**23.2**	**10.3**
Supplements (kgDM/Cow/d)):													
	Hay	1	2							1			
	Silage	4	4		2			2	3		0.5	2	3
	Palm Kernel												
	Crop									4.5			4.5
	Total/Cow/day	5	6	0	2	0	0	2	3	5.5	0.5	2	7.5
	Nitrogen (kgDM)	41880	41880	20940						34900	34900	34900	
	Hay/Silage Made (kgDM)							-88000					
Total Supplement (kgDM/ha/d)		21.0	24.1	3.2	5.8	0.0	0.0	-9.2	8.7	21.5	6.8	11.4	21.8
(B) Total Feed Supply (kgDM/ha/d)		**33.0**	**40.6**	**41.2**	**43.3**	**41.0**	**43.5**	**29.8**	**30.7**	**38.5**	**20.8**	**24.4**	**29.8**
FEED DEMAND:													
Milkers	Number	368	456	578	608	608	608	608	608	608	0	0	29
	Intake (KgDM/hd/d)	14	15	14	14	13	12	12	11	11	8	10	12
	Milk Production (kgMS/C/d)	1	1.2	1.1	1	1	0.8	0.8	0.7	0.7	0	0	0.9
	Intake (KgDM/ha/d)	**24.6**	**32.7**	**38.6**	**40.6**	**37.7**	**34.8**	**34.8**	**31.9**	**31.9**	**0.0**	**0.0**	**1.7**
Springers	Number	240	152	30							608	608	579
	Intake (KgDM/hd/d)	11	11	11							8	10	11
	Intake (KgDM/ha/d)	**12.6**	**8.0**	**1.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**23.2**	**29.0**	**30.4**
Heifers (R2)	Number												
	Intake (KgDM/hd/d)												
	Intake (KgDM/ha/d)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Heifers (R1)	Number												
	Intake (KgDM/hd/d)												
	Intake (KgDM/ha/d)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
(C) TOTAL DEMAND (KgDM/ha/d)		**37.2**	**40.6**	**40.2**	**40.6**	**37.7**	**34.8**	**34.8**	**31.9**	**31.9**	**23.2**	**29.0**	**32.1**
(D) Surplus/Deficit (kgDM/ha/d)	**(D = B-C)**	-4.2	-0.1	1.0	2.7	3.3	8.7	-5.0	-1.2	6.6	-2.4	-4.7	-2.3
(E) Monthly Cover Change (kgDM/ha)	**(E = D * No. Days)**	**-131.5**	**-1.8**	**31.2**	**79.7**	**100.9**	**268.4**	**-141.2**	**-38.1**	**197.6**	**-74.4**	**-140.2**	**-71.3**
(F) MONTH END COVER (KgDM/ha)	**(F = A+E)**	**1969**	**1967**	**1998**	**2078**	**2178**	**2447**	**2306**	**2268**	**2465**	**2391**	**2251**	**2179**
Feed Con. Eff. (kgDM/kgMS)		**14.0**	**12.5**	**12.7**	**14.0**	**13.0**	**15.0**	**15.0**	**15.7**	**15.7**	**#DIV/0!**	**#DIV/0!**	**13.3**

Note: Enter your information into the Blue Cells only
Change the area on a monthly basis for the removal or addition of land for crops etc.
In order to start at different times of the year you will have to manually change the Month and No. of days

31	36	34.1	30	31	24.8	22.4	21.7	21	0	0	27.9	280
434	450	434	420	403	372	336	341	330	248	300	372	4440

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Sheppard Agriculture Feed Budget

SHEPPARD AGRICULTURE
Farm, HR & Valuation Consultants

Name: A.Day **Date: 2009 season**

		August	September	October	November	December	January	February	March	April	May	June	July
Month		August	September	October	November	December	January	February	March	April	May	June	July
Number of days		31	30	31	30	31	31	28	31	30	31	30	31
Area		209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4
(A) Starting Cover (KgDM/ha)		**2100**	**1902**	**1854**	**1842**	**2061**	**2210**	**2342**	**2337**	**2364**	**2434**	**2287**	**2119**
Pasture Growth Rate (kgDM/ha/d)		**12**	**16.5**	**38**	**37.5**	**41**	**43.5**	**39**	**22**	**17**	**14**	**13**	**8**
Grass Fed (kgDM/Cow/d)		8.2	8.2	13.8	10.0	12.0	13.0	8.0	7.0	6.7	8.0	8.0	3.8
Pasture Demand (kgDM/ha/d)		**24.8**	**24.8**	**41.6**	**30.2**	**36.2**	**39.2**	**24.1**	**21.1**	**20.2**	**24.1**	**24.1**	**11.4**
Supplements (kgDM/Cow/d)):													
	Hay	1	2	1		1			1				1
	Silage	3	4.5		4			4	3			2	2
	Palm Kernel												
	Crop									4.3			4.3
	Total/Cow/day	4	6.5	1	4	1	0	4	4	4.3	0	2	7.3
	Nitrogen (kgDM)	41880	41880	20940						34900	34900	34900	
	Hay/Silage Made (kgDM)							-88000					
Total Supplement (kgDM/ha/d)		18.5	26.3	6.2	12.1	3.0	0.0	-2.9	12.1	18.5	5.4	11.6	22.0
(B) Total Feed Supply (kgDM/ha/d)		**30.5**	**42.8**	**44.2**	**49.6**	**44.0**	**43.5**	**36.1**	**34.1**	**35.5**	**19.4**	**24.6**	**30.0**
FEED DEMAND:													
Milkers	Number	387	469	599	632	632	632	632	632	632	0	0	44
	Intake (KgDM/hd/d)	13	16	15	14	13	13	12	11	11	8	10	12
	Milk Production (kgMS/C/d)	1.1	1.3	1.2	1.1	1	1	0.8	0.8	0.7	0	0	1
	Intake (KgDM/ha/d)	**24.0**	**35.8**	**42.9**	**42.3**	**39.2**	**39.2**	**36.2**	**33.2**	**33.2**	**0.0**	**0.0**	**2.5**
Springers	Number	245	163	33							632	632	588
	Intake (KgDM/hd/d)	11	11	11							8	10	11
	Intake (KgDM/ha/d)	**12.9**	**8.6**	**1.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**24.1**	**30.2**	**30.9**
Heifers (R2)	Number												
	Intake (KgDM/hd/d)												
	Intake (KgDM/ha/d)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Heifers (R1)	Number												
	Intake (KgDM/hd/d)												
	Intake (KgDM/ha/d)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
(C) TOTAL DEMAND (KgDM/ha/d)		**36.9**	**44.4**	**44.6**	**42.3**	**39.2**	**39.2**	**36.2**	**33.2**	**33.2**	**24.1**	**30.2**	**33.4**
(D) Surplus/Deficit (kgDM/ha/d)		-6.4	-1.6	-0.4	7.3	4.8	4.3	-0.2	0.9	2.3	-4.8	-5.6	-3.4
	(D = B-C)												
(E) Monthly Cover Change (kgDM/ha)													
	(E = D * No. Days)	**-197.5**	**-48.4**	**-12.3**	**219.6**	**148.2**	**132.2**	**-4.3**	**27.1**	**70.0**	**-147.8**	**-167.7**	**-104.7**
(F) MONTH END COVER (KgDM/ha)													
	(F = A+E)	**1902**	**1854**	**1842**	**2061**	**2210**	**2342**	**2337**	**2364**	**2434**	**2287**	**2119**	**2014**
Feed Con. Eff. (kgDM/kgMS)		**11.8**	**12.3**	**12.5**	**12.7**	**13.0**	**13.0**	**15.0**	**13.8**	**15.7**	**#DIV/0!**	**#DIV/0!**	**12.0**

Note: Enter your information into the Blue Cells only
Change the area on a monthly basis for the removal or addition of land for crops etc.
In order to start at different times of the year you will have to manually change the Month and No. of days

34.1	39	37.2	33	31	31	22.4	24.8	21	0	0	31	305
403	480	465	420	403	403	336	341	330	248	300	372	4501

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Sheppard Agriculture Feed Budget

Name: A.Day								Date: 2010 season				
Month	August	September	October	November	December	January	February	March	April	May	June	July
Number of days	31	30	31	30	31	31	28	31	30	31	30	31
Area	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4	209.4
(A) Starting Cover (KgDM/ha)	**2100**	**1951**	**1918**	**2046**	**2137**	**2242**	**2328**	**2211**	**2213**	**2476**	**2397**	**2296**
Pasture Growth Rate (kgDM/ha/d)	**12**	**16.5**	**38**	**37.5**	**41**	**43.5**	**39**	**22**	**17**	**14**	**13**	**8**
Grass Fed (kgDM/Cow/d)	7.4	7.8	11.8	11.0	12.0	13.0	9.0	7.0	4.4	7.0	7.0	4.0
Pasture Demand (kgDM/ha/d)	**23.2**	**24.3**	**37.1**	**34.5**	**37.6**	**40.7**	**28.2**	**21.9**	**13.8**	**21.9**	**21.9**	**12.5**
Supplements (kgDM/Cow/d)):												
Hay	1	2							2.5			1
Silage	4.5	5	2	3	1		3	5		1	3	2
Palm Kernel												
Crop									4.1			4.1
Total/Cow/day	5.5	7	2	3	1	0	3	5	6.6	1	3	7.1
Nitrogen (kgDM)	41880	41880	20940						34900	34900	34900	
Hay/Silage Made (kgDM)							-88000					
Total Supplement (kgDM/ha/d)	23.7	28.6	9.5	9.4	3.1	0.0	-5.6	15.7	26.2	8.5	15.0	22.2
(B) Total Feed Supply (kgDM/ha/d)	**35.7**	**45.1**	**47.5**	**46.9**	**44.1**	**43.5**	**33.4**	**37.7**	**43.2**	**22.5**	**28.0**	**30.2**
FEED DEMAND:												
Milkers Number	420	492	622	656	656	656	656	656	656	0	0	53
Intake (KgDM/hd/d)	14	16	14	14	13	13	12	12	11	8	10	12
Milk Production (kgMS/C/d)	1.2	1.4	1.3	1.2	1	1	1	0.9	0.85	0	0	1
Intake (KgDM/ha/d)	**28.1**	**37.6**	**41.6**	**43.9**	**40.7**	**40.7**	**37.6**	**37.6**	**34.5**	**0.0**	**0.0**	**3.0**
Springers Number	236	164	34							656	656	603
Intake (KgDM/hd/d)	11	11	11							8	10	11
Intake (KgDM/ha/d)	**12.4**	**8.6**	**1.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**25.1**	**31.3**	**31.7**
Heifers (R2) Number												
Intake (KgDM/hd/d)												
Intake (KgDM/ha/d)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Heifers (R1) Number												
Intake (KgDM/hd/d)												
Intake (KgDM/ha/d)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
(C) TOTAL DEMAND (KgDM/ha/d)	**40.5**	**46.2**	**43.4**	**43.9**	**40.7**	**40.7**	**37.6**	**37.6**	**34.5**	**25.1**	**31.3**	**34.7**
(D) Surplus/Deficit (kgDM/ha/d) (D = B-C)	-4.8	-1.1	4.1	3.0	3.4	2.8	-4.2	0.1	8.8	-2.6	-3.4	-4.5
(E) Monthly Cover Change (kgDM/ha) (E = D * No. Days)	**-148.7**	**-33.4**	**127.7**	**91.2**	**105.6**	**86.0**	**-117.7**	**2.2**	**263.1**	**-79.1**	**-101.2**	**-138.6**
(F) MONTH END COVER (KgDM/ha) (F = A+E)	**1951**	**1918**	**2046**	**2137**	**2242**	**2328**	**2211**	**2213**	**2476**	**2397**	**2296**	**2157**
Feed Con. Eff. (kgDM/kgMS)	**11.7**	**11.4**	**10.8**	**11.7**	**13.0**	**13.0**	**12.0**	**13.3**	**12.9**	**#DIV/0!**	**#DIV/0!**	**12.0**

Note: Enter your information into the Blue Cells only
Change the area on a monthly basis for the removal or addition of land for crops etc.
In order to start at different times of the year you will have to manually change the Month and No. of days

37.2	42	40.3	36	31	31	28	27.9	25.5	0	0	31	330
434	480	434	420	403	403	336	372	330	248	300	372	4532

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7.15 CASE STUDY 1 REPORT (DANNEVIRKE DAIRY, IRRIGATED)

25 kg N/ha/yr — Barrow N-loss (2007)

24 kg N/ha/yr — N-loss target 2011

18 kg N/ha/yr — N-loss target 2031

RESOURCE MANAGEMENT STRATEGY

John & Debbie Barrow
Maharahara Road, Dannevirke

FARMS
farmer applied resource mgt strategies

Reference: FARMS/2007/RMS#001
Catchment: Mana_5d
Prepared by: AgResearch Ltd.
Date: 10/07/06

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BACKGROUND

THE ONE PLAN & RULE 13*x*: At present eleven important catchments in the Manawatu-Wanganui Region have nutrient levels far in excess of what is desirable. To help address this issue Horizons have proposed a Rule in the One Plan that aims to lessen the nutrient-impact from activities associated with intensive farming. Resource consents concerning irrigation takes, fertiliser, stock feed, biosolids, soil conditioners, dumps, offal holes, and effluent, will be necessary for dairy farming, cropping, market gardening, and intensive sheep and beef farming. Nutrient budgets will be required for operations that apply nitrogen fertiliser to land. The Rule will come into effect at different times for each of the eleven catchments.

ONE FARM; ONE CONSENT: A new consent process will be available under the One Plan. The traditional approach of having several separate consents for a farm is replaced with a single whole-farm consent. This means only one consent – not many – is needed for the entire farm. This promises to make the process simpler, quicker and considerably less expensive. A *FARM Strategy* is a necessary prerequisite for a whole-farm consent.

FARM STRATEGY: A FARM Strategy (Farmer Applied Resource Management Strategy) represents an assessment of permitted and controlled activities for a farm, and a strategic plan to ensure those activities comply with One Plan specifications and water quality targets. It combines a nutrient budget, a comparision of farm nutrient-loss against catchment water-quality targets, an evaluation and recommendation of mitigation options (if the farm is operating outside of catchment water-quality targets) including cost and effectiveness, an assessment of eligibility for relevant consents, and a farm plan of works that spells out the where, when and how much of achieving sustainable land use within the given catchment of interest.

This report summarises an exploratory FARM Strategy for John and Debbie Barrow, who farm a 112 ha dairy property located at Kiritaki near Dannevirke. The farm is situated within the Oruakeretaki Catchment (Mana_5d) in the larger Tamaki-Hopelands Catchment (Mana_5), which in turn is part of the Upper Manawatu Catchment. Rule 13x for these catchments is due to come into effect on the 1st April 2011. The Barrow property represents the first application of the FARM Strategy framework.

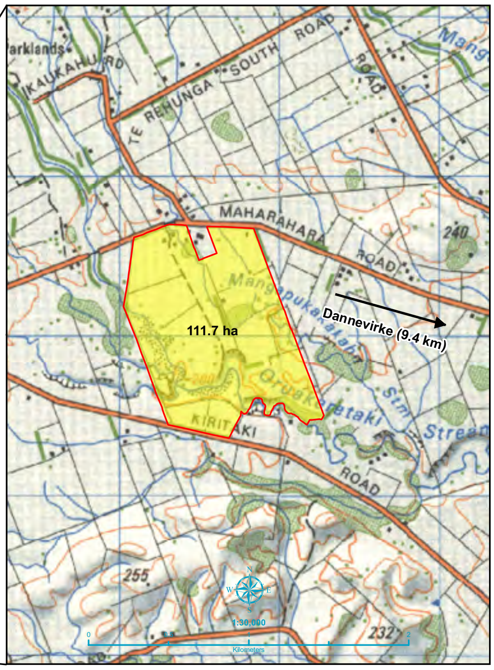
1.0 PLAN SUMMARY

- **Purpose:** Purpose is to identify how the Barrow farming operation can remain compliant under Rule 13*x* of the proposed One Plan. Emphasis is on identifying best options that achieve requirements without placing unnecessary strain on farm performance.
- **Farm overview:** A 112 ha (94 ha effective) seasonal-supply and owner-operated dairy farm growing 14,750 kg pasture DM/ha/yr under irrigation (80.5 ha irrigated) and milking 250 Friesian x Jersey cows (2.65 cows/grazed hectare) and producing ~1050 kg MS/ha/yr (performance considered above district average). Topography is mostly flat with an annual 1200mm rainfall.
- **Clean Streams Accord:** 5.6 km of farm waterways qualify. Approximately 2.4 km are protected, leaving 3.2 km unprotected. Two new culverts are required. Bridging the Oruakeretaki Stream is not required under the Accord, but it is required under the One Plan.
- **Nutrient loss and water quality:** Nutrient loss calculated using the Overseer Nutrient Budget model and ancillary calculations for N-inhibitor effects and the direct deposition of excreta to waterways. **Current N-loss calculated at 25 kg N/ha/yr**. P-loss risk to water is LOW (0.5 kg P/ha/yr). Risk of faecal pathogens entering water was not assessed due to gaps in research understanding.
- **Permissible N-loss:** Detailed Land Use Capability (LUC) mapping was undertaken to link One Plan water-quality targets to the Barrow farm. **Permissible N-loss is calculated at 24 kg N/ha/yr for the first year (2011)**, and becomes gradually tighter over the 20-yr implementation period (permissible N-loss by 2031 is 18 kg N/ha/yr). Compared with current N-loss (25 kg N/ha/yr), **a reduction of 1 kg N/ha/yr is necessary for the farm to achieve catchment water quality targets for 2011.**
- **Mitigations evaluation:** A wide range of mitigation options were assessed and rated in terms of relevance to the farming operation. Highly relevant options were evaluated further to identify likely effectiveness, cost, and future impact on farm revenue.

Option	N & bug effectiveness	Cost	Practicality	Rating
High-E/low-N supplement	N-loss ↓ **2kg N/ha/yr**	No appreciable change	High	✓✓
Off-farm winter grazing	N-loss ↓ **9kg N/ha/yr** & bug risk↓	Potential revenue increase of $7,000 to $13,000	High (but risky)	✓✓
Enlarge effluent area 3ha	N-loss ↓	No appreciable change	High	✓✓✓
Fence waterways	Bug risk↓ & N-loss ↓ **0.2kg N/ha/yr**	$17,400 cost and $2,860/yr lost revenue	Low	✓
Planted riparian buffers	Bug risk↓ & N-loss risk↓	$10,000-$13,000 cost and $28,000 to $86,000/yr lost revenue depending on buffer width (10-30m).	Extremely low	×
Construct bridge	Bug risk↓ & N-loss ↓ **0.6kg N/ha/yr**	$73,000 cost	Low	✓
Install 2 culverts	Bug risk↓ & N-loss risk↓	$3,400 cost	High	✓

✓ *Non-negotiable. Required under Clean Streams Accord and/or One Plan. See below.*

- **Mitigation recommendation:** Aim to have waterways fenced, culverts installed, and the Oruakeretaki Stream bridged in the next 4 years. These are non-negotiable items (they probably have to be done anyway). Implementation will achieve 2011 N-targets. Longer term N-targets can be achieved with off-farm winter grazing, but this mitigation has uncertain viability going into the future.
- **Compliance requirements:** Current practice was evaluated against One Plan requirements. Items that need attention include: effluent pond overflow causing discharge; storm-water discharge to the effluent ponds (from milking parlour roof); farm dump within 100m of surface water and within 10m of the flood plain; absence of trough-supplied water in the western K-Road paddock; stock can access 3.2km of stream; two stream-crossings without culverts; and the Oruakeretaki Stream ford requires bridging.
- **Compliance strategy:** Recommendations for full One Plan compliance are made as fifteen specific objectives for successive implementation over a five-year period (in addition to existing resource consent requirements). Any appreciable change in stock policy, feeding policy, or N-fertiliser use will require a reassessment of farm N-loss against N-targets (i.e. a new nutrient budget).
- **Monitoring and reporting:** It is recommended a more transparent system of monitoring and recording be established for N-fertiliser use (where, when & how much) and effluent application (when, how much & nutrient analysis). This will help with future nutrient budgeting and the development of a schedule for optimal irrigation and effluent application.
- **Compliance cost:** Cost of One Plan compliance is estimated at $99,100 (Clean Streams alone would cost $24,600). Bridge construction is the single most significant cost at $73,000. Several requirements may lead to productivity improvements but these cannot be quantified. Land retired by fencing streams represents a loss of 520kg MS/yr or one whole cow dropped from the milking herd. Revenue could decrease $2,860 per year (at $5.50/kg MS). At $6.40/kg MS the loss would be $3330 annually.
- Recommendations and requirements contained in this report apply only to the Barrow farm for the 2007/08 season. Every effort has been made to ensure robustness and accuracy of estimates, which have been triple-checked by AgResearch scientists, Massey University scientists (Overseer analysis), and DairyTeam farm consultants.



This property is located 9.4 km south west of Dannevirke township.

(Distances calculated by road between farm boundary edge and town centre).

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

FARM LOCATION & ACCESS

John & Debbie Barrow, Maharahara Road, Dannevirke

Prepared for Horizons Regional Council by AgResearch Ltd, as part of the FARMS initiative.
July 2007.

ID	LEGAL DESCRIPTION	AREA
1	DP 26919, HBW3/102, LOT 1	1.4464 ha
2	DP 26920, HBW3/103, LOT 1	64.3209 ha
3	HBA4/742, Tahoraiti 1F2	42.5172 ha
4	Pt Tahoraiti 1F1	3.6629 ha
		111.9474 ha*

* The precision and accuracy of legal land parcels for rural areas can contain appreciable errors. Legal areas are not used in this report. Rather, more reliable information has been calculated using high resolution orthophotography. Total farm area by this method is 111.7 ha.

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LEGAL TITLES AND PARCELS

John & Debbie Barrow, Maharahara Road, Dannevirke

Prepared for Horizons Regional Council by AgResearch Ltd, as part of the FARMS initiative.
July 2007.

2.0 FARM DESCRIPTION

2.1 Existing farm business

2.1.1 The physical resource

- The farm is located at Kiritaki settlement 9.4km south west of Dannevirke township, which places it in the *Oruakeretaki subzone* (**Mana_5d**) of the *Tamaki-Hopelands Water Management Zone* (**Mana_5**).
- Topography is mostly flat, with the farm situated on the lowest glacial terrace found in the district (Ohakea Terrace), characterised by deep gravels (+2m) over a mudstone base, and a thin mantling of either loess (wind-blown sediment from the river below), very old river sediments, or a mix of both. Depth to gravels is highly variable (range = 0m – 1.2m), and the gravels may be inter-bedded with thick bands of silty sands. The upper terrace graduates down to the Oruakeretaki Stream in a series of small sub-terraces with short scarp slopes, and a slightly undulating topography (caused by very old river-bed changes). A steep high scarp/cliff marks the transition from the glacial terrace down to the Oruakeretaki Stream flood plain.
- Soils are dominated by Ashhurst silt loam and stoney silt loams on the drier parts of the upper terrace; Ohakea silt loam for the wetter parts; and recent alluvial soils around the Oruakeretaki Stream.
- Total length of small perennial streams is 3.7 km. Two of these meander their way through a significant area of the farm. Approximately 17% of the farm is located on the other side of the Oruakeretaki Stream (which is more like a river). Access is provided by a ford.
- Annual rainfall is 1200mm, which places the farm in a lower rainfall band relative to most other dairy farms in the Woodville, Dannevirke and Norsewood area. Height above sea level is approximately 200m.
- Total area of the property has been mapped at **111.7 ha** with an estimated **94 ha** in pasture (all non-pastoral vegetation mapped out at a high level of detail – see subdivision map over the page).

2.1.2 Infrastructure

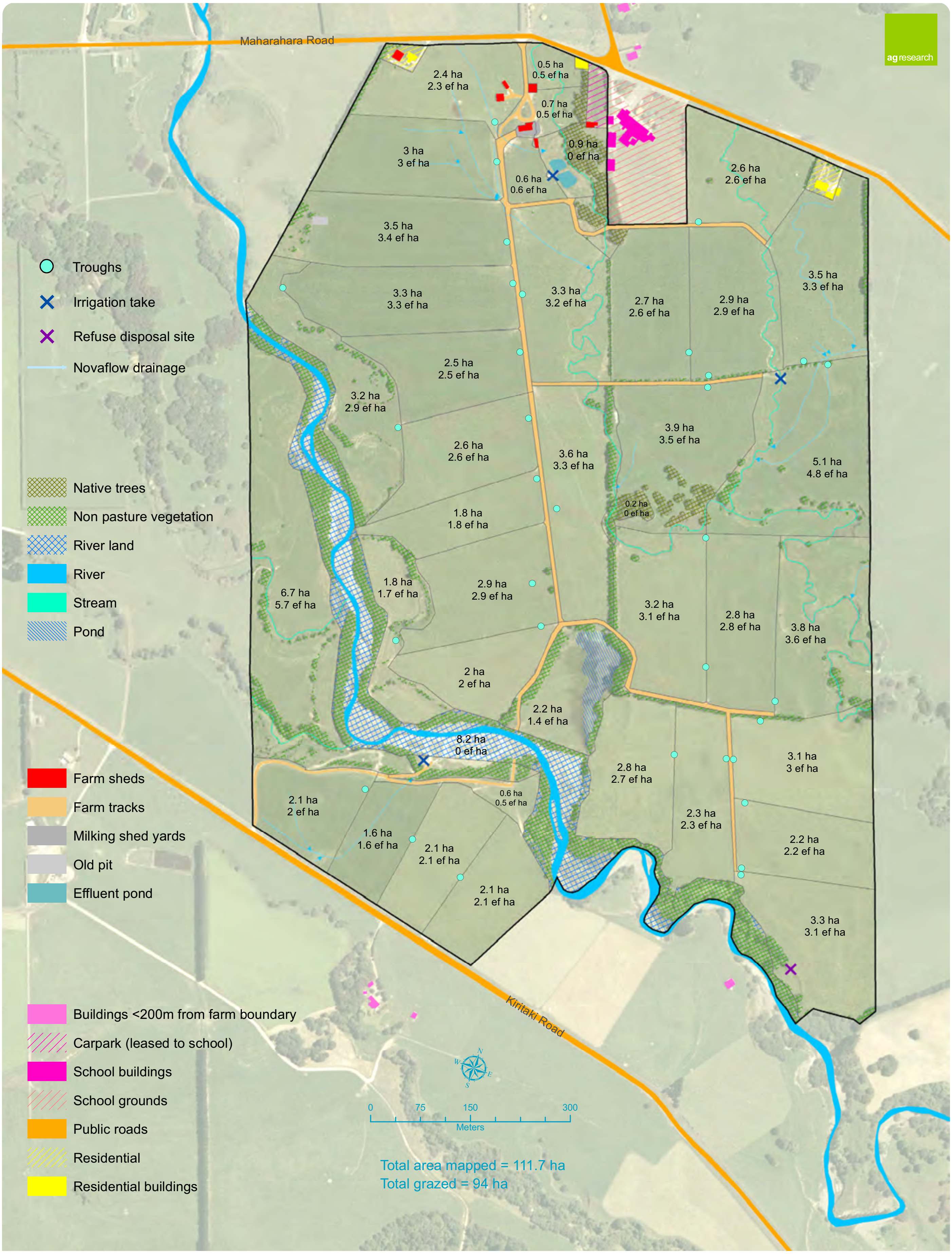
- The property has 2.6 km of fenced laneways with a crushed limestone surface, and an additional 0.6 km of farm tracks.
- Farm buildings, yards and other structures are in good serviceable condition. The milking shed is an older style 25-cup herringbone.
- Average paddock size is 2.8 ha, with a total of 33 paddocks in the main rotation (subdivision map over the page), the largest of which is 6.7 ha. Total length of fencing for the farm is **21.9 km** (boundary fencing = 5.0 km, internal fencing = 16.9 km).
- Stock water is provided through a combination of reticulated trough-water and direct access to streams.

2.1.3 Farm system

- Family owned and operated seasonal supply dairy-farming system running 250 Friesian-Jersey crosses (~460kg/cow) and producing up to 98,200 kg of milksolids (~1050 kg MS ha^{-1} yr^{-1}). Stocking rate is 2.65 cows per grazed hectare.
- All replacement young stock grazed off-farm from weaning (late Nov), until calving (late July). Surplus calves sold at 4 days old in August-September, and cull cows sold throughout late Feb to late May. Herd losses during winter are generally less than 4%.
- Approximately 95% of gross income is achieved from the sale of milk to Fonterra during the months August to May.

Cattle	**2007**
Breed	Friesian-Jersey cross
Live weight	465 kg
Peak numbers milked	250 cows
Replacements	50 heifers
Wintered on farm	200 cows
Stocking Rate	2.65 cows/ha

Deep gravels inter-bedded with sands are a feature of the property



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PROPERTY MAP

John & Debbie Barrow

Maharahara Road, Dannevirke

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement). Effective area calculated by mapping out all non-pastoral vegetation and features, and areas that are not part of the grazing rotation.

2.1.4 Farm system (continued)

- 80.5 ha is irrigated over the drier summer months using a K-Line system at a rate of 25mm/week (an estimated 350mm from January through early March). Approximately 52 ha of the irrigated land receives 38 kg N ha^{-1} yr^{-1} through fertigation.
- Dairy shed effluent is managed through a mechanically-stirred two-pond system, with effluent being applied to land during the milking season at the most opportune times. The effluent application area is 14.9 ha (the Hay Shed Block – see page 10).
- Wetter soils at higher parts of the farm are drained using a Nova-Flow system of perforated pipe and back-filled gravel. Total length of Nova-Flow drainage is approximately 2.4 km.

2.1.5 *Clean Streams Accord* and Fonterra's *Effluent Indicator System*

The dairy industry entered into the *Clean Streams Accord* in 2003. Under the Accord, dairy farms are obligated to:

- Exclude cattle from perennial streams deeper than a "Red Band" (ankle depth) and "wider than a stride".
- Ensure farm races include bridges or culverts where stock regularly cross a watercourse. "Regular" is defined as more than twice a week.
- Manage dairy effluent appropriately according to regional council requirements.
- Manage nutrients using a nutrient budget.
- Protect regionally important wetlands.

The aim is to have 90 to 100% of dairy farms compliant by year 2012 (only five years away). Fonterra has also recently introduced the *Effluent Indicator System* for the 2007/08 season. Regional councils are invited to notify Fonterra about farmers who are "persistently and critically" non-compliant with effluent management. Failure to remedy non-compliance in the short term may result in payout reductions, or refusal to pick up milk over the longer term (3yrs).

- The Barrow farm has 8.2 ha of river land already fenced (the Oruakeretaki Stream). This equates to 2.9 km of fencing, or 1.9 km of meandering waterway already protected.
- There are ten paddocks that contain unfenced waterways. They are considered marginal as to whether or not they qualify as targeted streams under the Accord. When evaluated mid-winter, most if not all would have fallen on the qualifying side of marginal, particularly the stream flowing through the large K-Road paddock (see photo). Fonterra was approached for clarification, and they suggested that all these streams would qualify even during low-flow periods (their deciding criteria is whether or not the stream flows all year around). Total length of small perennial streams is 3.7 km. Approximately 3.2 km can be accessed by stock during the grazing rotation.
- Access to land across the Oruakeretaki Stream is via a ford. On a 23 day rotation over 278 days, an estimated 72 crossings are required during the milking season, and only two during the off-season (80 day rotation). This averages out as 1.85 crossings per week during milking, or 1.4 crossings per week if spread over the entire year. Both are less than the Accord's two crossings per week trigger value. A bridge is not, therefore, required under the Clean Streams Accord. However, it will likely be a requirement under the One Plan (see Section 6.0).
- The property is generally well served with culverts. However, there is two stream crossings in the western K-Road paddock that require culverts to ensure complete stock exclusion from water.
- Effluent treatment and application to land is managed under a resource consent. Every practicable step appears to be made to comply with the consent. However, there are two or three opportunities to improve the current system (see Section 6.0).
- The farm has a nutrient budget prepared by D McNeur of Summit Quinphos Ltd.
- There is a sizeable wetland located on the farm but it is not considered to be of regional importance or significance.

Deeper than a Red Band?

2.1.6 Pasture and grazing management

- Cows are grazed on an estimated 23 day rotation over the 278-day milking season (12 complete rotations per year), and an 80-day rotation during the winter.
- An active pasture development programme is in place, with most paddocks having been recently sown or over-sown with high performance grass cultivars and clovers. Grasses have thrived, but the clover has been suffering persistence problems.
- Standing pasture makes up approximately 90% of annual stock-feed requirements. Silage may be made and fed on-farm when there is a pasture surplus (up to 10 ha in some years). Favour is given to purchasing supplements off-farm, which has included baleage (30-40 tonne DM), or hay for the most recent winter season (54 tonne DM). Supplements are fed out late autumn and winter.
- Depending on the season, winter grazing and supplementary feeding of cows may involve 'standing-off' on the lower river-flats to avoid pugging damage of pasture on the upper flats. These areas may be used only 2-3 days during a mild winter, or up to 30-40 days when soils are at, or above, field capacity for prolonged periods.
- Current pasture production is estimated at **14,750 kg DM/ha/yr** using Overseer Nutrient Budgets (the Overseer model considers soil fertility, stocking rate, production, fertiliser use, irrigation, supplementary feed, and local growing conditions). At a utilisation rate of 80% (as an average for the entire year), this equates to 11,800 kg DM/ha/yr consumed, which fits within an estimate of 11-12 tonne DM/ha/yr provided by the DairyTeam consultant, John Simmonds. This yield is equivalent to the best pasture production figures obtained for other Dannevirke dairy farms, most of which are generally located in the higher rainfall districts closer to the Ruahine Ranges.
- Current levels of pasture production have been distributed across the farm (map opposite) using Land Use Capability units (map on page 14) and carrying-capacities for different units reported in LRG (1981). Similarly, potential carrying capacities have been used estimate potential levels of pasture production, if all manageable limitations were overcome (e.g. optimal pH, soil nutrient status, drainage condition, etc.). Upper limit of potential pasture yield is estimated at **17,300 kg DM/ha/yr**. Many generalisations have been made to produce these maps, so they should be used for comparative or indicative purposes only. However, they do suggest that the Barrow property has wide scope for increasing annual pasture yield into the future.

2.1.7 Financial position

- Information concerning the Barrow's financial position is pending**.**

Barrow financial position preliminary assessment July 2007

Liabilities		**Assets**	
Term loan	$00,000	Land & Building	$0,000,000
Overdraft Limit	$00,000	Livestock	$000,000
		Plant/Machinery	$00,000
	$000,000		**$0,000,000**

2.1.8 Financial and physical performance

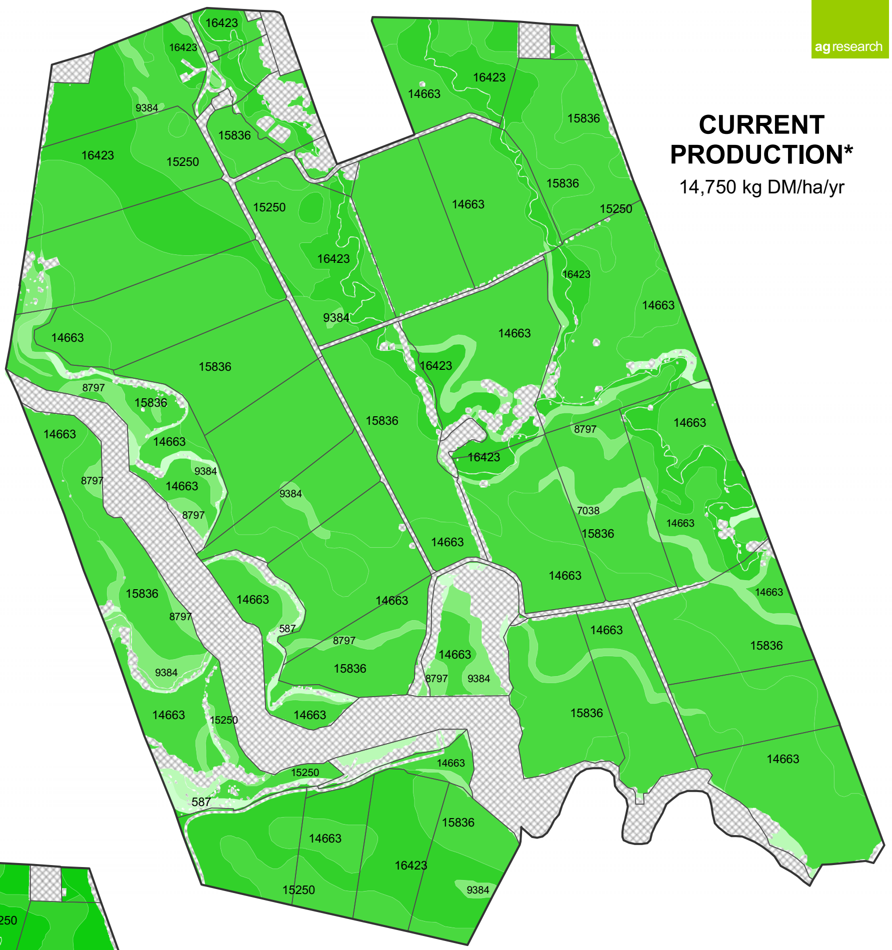
- **Milksolids**: Fonterra provides its suppliers with a district average milksolids comparison throughout the season. The Barrow farm is slightly above the average. However, Fonterra's average does not account for varying feed inputs. DairyTeam considers that the Barrow operation is likely well above the district average for physical efficiency.
- **Benchmarking**: Insufficient resources are available for a valid benchmarking comparison. *DairyBase* is the most promising resource, but it has incomplete local datasets for the 2005-06 season.
- **Financial benchmarking**: The Barrow's accountant, JVBennet Ltd., produces a robust set of localised financial benchmark indicators summarised from 20 local dairy-farm operations (2005/06). Against these indicators the Barrow farm performance is within the median-third quartile range for financial KPIs such as *Gross Cash Farm Income* per hectare, *Operating Expenses* per kg of milksolids, *Economic Farm Surplus* per hectare, and *Percent Return on Capital*.
- The Barrow's equity in their business is very strong and well above the industry average.

ag research

Pasture yield categories

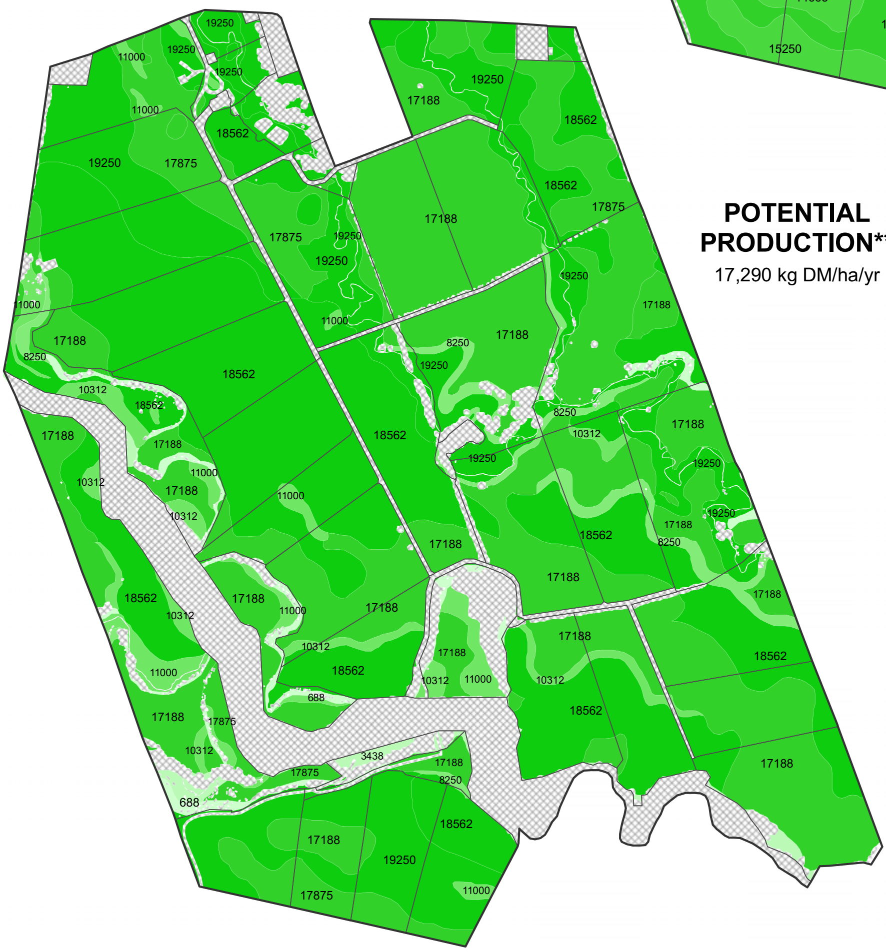
kg DM/ha/yr

- 587 - 2000
- 2001 - 4000
- 4001 - 6000
- 6001 - 8000
- 8001 - 10000
- 10001 - 12000
- 12001 - 14000
- 14001 - 16000
- 16001 - 18000
- 18001 - 20000
- No pasture



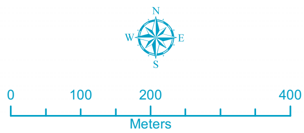
CURRENT PRODUCTION*

14,750 kg DM/ha/yr



POTENTIAL PRODUCTION**

17,290 kg DM/ha/yr



*** Current production estimate**

Calculated from total annual pasture production modelled by Overseer Nutrient Budgets (14,750 kg DM/ha/yr). Assumes uniform management across all land classes. Production from the effluent block and irrigation blocks are likely to be proportionally higher than the figures reported.

**** Potential production estimate**

Potential production calculated from potential stocking rates reported for Land Use Capability (LUC) units in LRG (1981), using 1 su requiring 550kg DM/ha/yr & a pasture utilisation of 80%. Potential stocking rate defined as "the number of stock units per hectare capable of being carried on a particular LUC unit, assessed within the limits of present technology and given favourable socio-economic conditions" (LRG, 1981).

Reference

Land Resources Group. 1981. Stock carrying capacities and fertiliser data for the North Island. Internal report No.22. Aokautere Science Centre, Ministry of Works & Development, Palmerston North, New Zealand.

FARMS

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PASTURE YIELD GAP

John & Debbie Barrow

Maharahara Road, Dannevirke

FOR COMPARITIVE PURPOSES ONLY. Current production estimated from Overseer Nutrient Budgets and distributed according to Land Use Capability (LUC) classes for the property. Potential production estimated from carrying capacities reported in LRG (1981), using 1 su requiring 550 kg DM/ha/yr and utilisation at 80%. Calculations assume a uniform management regime across all land units (i.e. does not account for differences in fert, stock mgt, or irrigation).

Fertiliser Inputs (2006)

Hayshed block (14.9 ef ha)

4 t of Clover King LS/MS (33 kg P ha^{-1}, 20 kg SO^4-S ha^{-1}, 17 kg ES ha^{-1}, 89 kg Ca ha^{-1}, 2 kg Mg ha^{-1})

Rest of farm (78.1 ef ha)

41 t of Clover King LS/MS+7K (56kg P ha^{-1}, 35 kg K ha^{-1}, 34kg SO^4-S ha^{-1}, 28kg ES ha^{-1}, 150kg Ca ha^{-1}, 4kg Mg ha^{-1})

Whole farm

200 kg of SustaiN urea (with urease inhibitor), with 38 kg N ha^{-1} applied via fertigation across 52 ha, and 10 kg N ha^{-1} applied during the winter months.

Soil test results (Oct 2004)

Block	pH	Olsen P	Qt K	OrS	TBK	Qt Ca	Qt Mg	Qt Na	ASC
Back block	5.9	22	6	15	0.7	13	30	4	48
House block	5.7	40	8	18	0.7	11	35	5	78
K-Road (irrigated)	5.9	22	10	15	0.8	14	25	6	50
No fert block	-	30.6	12.6	10.8	0.7	10.8	27.9	4.5	48
Top river block	5.8	34	14	12	0.7	12	31	5	55
Btm river block	-	34	14	12	0.7	12	31	5	8
Hay shed block	5.7	53	12	12	0.7	11	29	5	48
K-Road (no irrigation)	5.9	22	10	15	0.8	14	25	6	50
Top river fertigated	5.8	34	14	12	0.7	12	31	5	55
Shed block	5.7	34	14	12	0.7	12	31	5	55

Nutrient Budget

	Nutrient kg ha^{-1} yr^{-1}					
INPUTS	**N**	**P**	**K**	**S**	**Ca**	**Mg**
Fertiliser	181	47	27	52	127	3
Effluent	0	0	0	0	0	0
Atmospheric/Clover N	59	0	2	3	2	4
Irrigation	7	0	4	7	25	6
Slow release	0	3	15	4	4	6
Supplements	12	2	10	2	3	1
OUTPUTS						
Product	69	12	17	4	15	1
Transfer	4	2	2	1	1	1
Supplement removed	0	0	0	0	0	0
Atmospheric	88	0	0	0	0	0
Leaching/runoff	30	0	20	63	65	11
Immoblisation/absorption	68	20	0	0	0	0
Change in inorganic soil pool	0	19	20	0	79	8

Adjusted Nutrient Budget

	Nutrient kg ha^{-1} yr^{-1}					
OUTPUTS	**N**	**P**	**K**	**S**	**Ca**	**Mg**
Leaching/runoff	30	0	20	63	65	11
N-inhibitor adjustment @20%	-6.2	-	-	-	-	-
Losses direct to waterways	+0.8					
Total losses	25	0	20	63	65	11

Nutrient loss and greenhouse gas emissions

Parameter	Barrow	Average NZ Farm
Nitrate leaching loss	25	30-50
Phosphorus Run-off risk	Low	
Greenhouse gases		
Methane	4750	4200-5000
N_20 emissions	3092	2500-3500
CO_2 emissions	1321	400-900

Note.
1. Approximate area of forest to absorb total farm CO^2 equivalents is ***85 ha pine*** *(net 1 rotation)*

Nutrient management blocks

Back block	23 ha	K-Road (no irrigation)	5.7 ha
Bottom river block	6 ha	No fertiliser block	1.0 ha
Hay shed block	15 ha	Shed block no effluent or irrigation	0.6 ha
House block	20 ha	Top river block	13 ha
K-Road (irrigated)	8.3 ha	Top river fertigated	2.0 ha
Trees	8.6 ha		

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NUTRIENT MANAGEMENT

John & Debbie Barrow

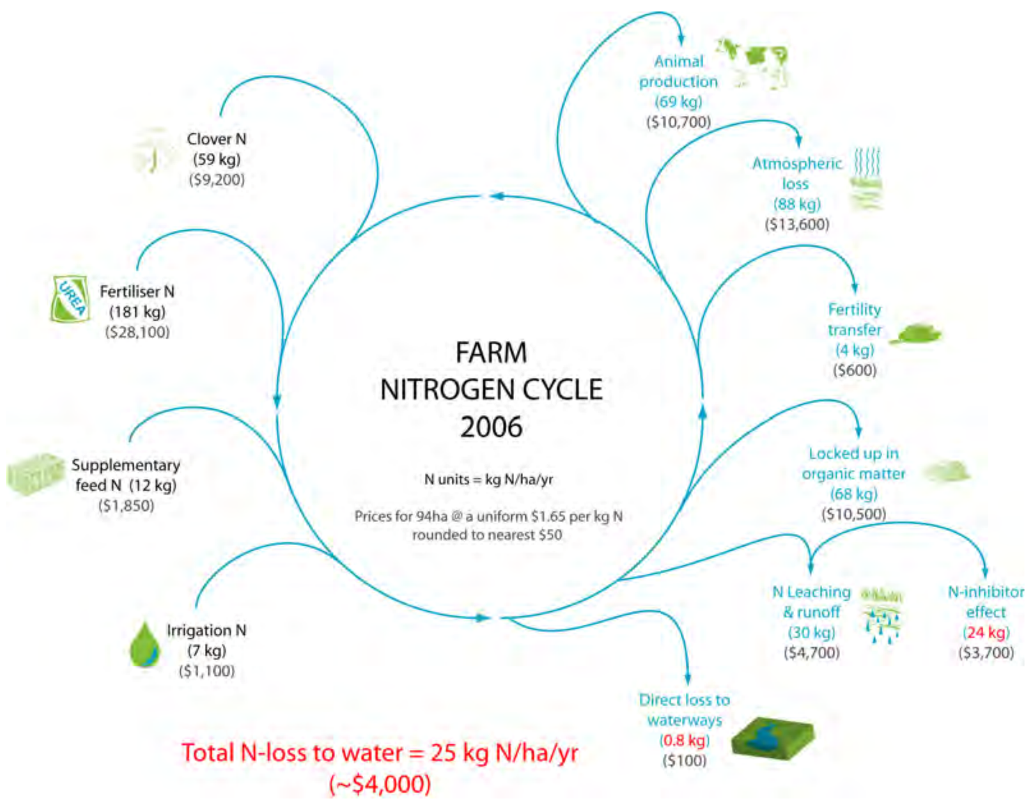
Maharahara Road, Dannevirke

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

3.0 FARM NUTRIENT BUDGET AND WATER QUALITY

3.1 Nitrogen budget and N-losses

- The farm was divided into ten nutrient management blocks for analysis using *Overseer Nutrient Budgets* (v 5.2.6.0). Key inputs and Overseer outputs are summarised in the Nutrient Management Map opposite.
- ***Overseer* calculates N-loss for the Barrow farm at 30 kg N ha^{-1} year^{-1}** (N lost by runoff or leaching). This is at the lower end of average dairy farm N-loss (NZ average for dairy is 30-50 kg N ha^{-1} yr^{-1}).
- Nitrogen inhibitors are used regularly on the farm, including the *Agotain* urease inhibitor with all applied urea (200 kg N ha^{-1} yr^{-1} from *SustaiN* urea), and a dicyanamide (DCD) nitrification inhibitor (*ecoN*) sprayed according to supplier recommended rates and timings. Inhibitor effects are not accommodated in the current *Overseer* version, although they will be in future releases (see below). Very favourable results have been reported for the use of inhibitors, but current findings are insufficient to extrapolate to all farming systems and environmental conditions in NZ. For the interim, architects of the next *Overseer* release have recommended the use of a conservative 20% reduction in the Leaching/Runoff N-loss value for the Barrow property. Accordingly, **using inhibitors is estimated to reduce the Barrow's annual N-loss to 24 kg N ha^{-1} yr^{-1}**.
- Similarly, *Overseer* does not yet differentiate N-loss contributions from around streams, at crossings, or through stock directly voiding into waterways. While some of these pathways are being integrated (due for release Dec 07), *Overseer* in its current form cannot be used to predict the effect of important mitigation options (e.g. fencing streams, installing bridges) as it relates to N-loss. HOWEVER, for demonstration purposes, N-loss, P-loss and faecal microbe contributions have been calculated for these pathways using findings from research studies. While they are very conservative figures, they do serve to demonstrate the relative importance of different nutrient-loss and microbe-contamination pathways, and the implication of adopting mitigation practices.

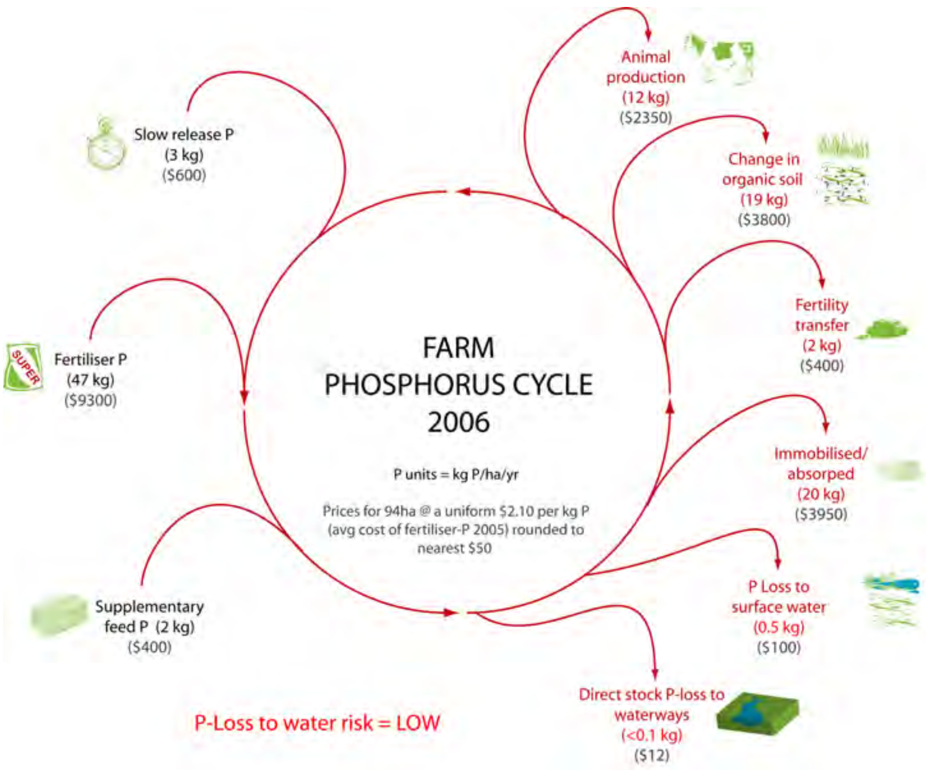


- **River crossing evaluation**: The herd crosses the ford 74 times per year, which equates to 18,400 cow-crossings per year. Studies report 10% of a herd may defecate directly into water while crossing (Davies-Colley *et al*., 2002), and 14.8% of the herd may urinate (factored from Davies-Colley *et al*.'s total downstream N concentration less excreta-N contribution). For the Barrow farm, the herd may be defecating 1840 times and urinating 2723 times directly into the Oruakeretaki Stream each year. On a whole-farm basis, **this would equate to very minor contributions of 0.15 and 0.40 kg N ha^{-1} yr^{-1} for dung-N and urine-N respectively** (total = 0.55 kg N ha^{-1} yr^{-1}).

- **Unfenced streams evaluation**: Ten paddocks are dissected by streams, each of which is grazed 12 times during the milking season according to a 23-day rotation (3000 individual cow-grazings per paddock per year). Number of cows crossing streams is estimated from the proportion of the herd needed to graze the 'paddock area across the stream' relative to the paddock area on the herd-entry side of the stream. Over 8060 cow-crossings were calculated for the ten paddocks, which equates to 807 cow pats/year and 1194 urinations directly into streams using the 10% and 14.8% herd contributions described above. Accordingly, **direct dung and urine N-loss to unfenced streams is estimated to be a very small 0.24 kg N ha^{-1} yr^{-1}** on a per hectare basis. For comparison, other studies have observed 0.5% of total paddock defecations occur in the stream (Bagshaw reported in Collins *et al*., 2007). Applied to the Barrow farm, total contribution **from dung alone** could be upwards of 0.15 kg N ha^{-1} yr^{-1}.

3.2 Phosphorus budget and P-loss

- Overseer estimates total P-loss to surface water at 0.5 kg P ha^{-1} yr^{-1}. Losses include those from soil and runoff, fertiliser type and application, and effluent application. This figure gives the whole farm a **LOW P-loss** estimate, although individually, the Bottom River and Hayshed Blocks both had a MEDIUM P-loss rating.



- **Stock P-loss directly to waterways**: Following the methods used to calculate direct N-loss to water, total P-loss at the ford and in the unfenced streams is estimated as an almost insignificant **0.06 kg P ha^{-1} yr^{-1}**. At a low rate of $2.10 per kg of fertiliser P, this equates to about fifteen-cents ($0.13) per hectare, or $11.84 each year for the entire farming operation.

3.3 Faecal microbes and waterway contamination

- Risk of faecal microbes entering water was not assessed for the Barrow farm due to gaps in research understanding. While there is a body of research on the effectiveness of mitigation practices, the preliminary methods and models of quantifying pathogen risk are still in an early stage of development.
- Direct deposition of dung to streams can represent a disproportional and large source of faecal contaminants to surface water (cf. nitrogen). Installing bridges and culverts at crossings, and excluding stock from waterways, are therefore widely recommended as a chief mitigation option. Based on current river crossings, stock access to streams, and an assumed 10 billion *E. coli* bacteria per cow pat, then it is conceivable that the Barrow operation contributes 2650 billion *E. coli* bacteria per year, or 7.3 billion per day, to *E. coli* loadings in fresh water streams. However, given our current state of understanding, this can only be considered as an indication of potential risk.

- Effluent application to land and artificial drainage are two indirect mechanisms linked to waterway contamination. Both involve water transporting pathogens to waterbodies (either as runoff or drainage). Key mitigations known to be effective include planted riparian buffers, deferred effluent application, and strategic cattle access to poor draining soils (i.e. essentially any practice that minimises runoff or drainage, or avoids land contamination when runoff or drainage is likely to occur).

4.0 RESOURCE ASSESSMENT AND NUTRIENT LOSS TARGETS

4.1 Principles

Annual nitrogen loads for the Upper Manawatu Catchment have been measured by Horizons Regional Council at **744,000 kg N yr^{-1}** (several years of measured data from Hopelands). This is more than two-times greater than the community's water quality standards for the Upper Manawatu (**341,000 kg N yr^{-1}**). Point source contributions are small (~10%); by far the greater contribution comes from diffuse-sources associated with intensive farming (~90%). There is general agreement that nutrient loads need to be reduced, but there is much disagreement over how it should be done.

An easy option is to apply a blanket N-cap to every farm in the catchment. However, this fails to recognise farm-to-farm differences in land use, the quality of land (productive potential), and the current use of mitigations. Through the FARM Strategy approach, a more equitable approach is proposed. At its heart is the identification of farm-particular nutrient-loss targets based on the capability and productivity of land, and the fact that **better land has a higher capacity to sustain high levels of production (i.e. it is more sustainable), relative to attempting comparable levels of production from low quality land by using excessive inputs inefficiently.**

Water quality targets have been related to land production-potentials using the Land Use Capability (LUC) system of land classification. This ranks land according to eight classes, where class 1 represents the most elite land, and class 8 land has very low productive value (e.g. bluffs, swamps, river beds, etc.). Nitrogen-loss targets by LUC class are included in the One Plan (table below), designed to be phased in over a twenty-year period. A farm's relative area of different LUC units will determine the level of N-loss that the farm needs to operate within to achieve catchment water quality targets.

Table 1: One Plan N-loss targets for LUC classes

LUC	*N-loss targets (kg N ha^{-1} yr^{-1})*			
	YEAR_01	YEAR_05	YEAR_10	YEAR_20
I	32	27	26	25
II	29	25	22	21
III	22	21	19	18
IV	16	16	14	13
V	13	13	13	12
VI	10	10	10	10
VII	6	6	6	6
VIII	2	2	2	2

4.2 Land resource assessment

The Barrow's land resource has been described and evaluated according to the Land Resource Inventory (LRI) and Land Use Capability (LUC) Classification. Survey was undertaken at a 1:3,000 scale. The LRI system involves mapping landscape units according to five inventory factors (rock type, soil unit, slope class, erosion type & severity, and vegetation).

LRI is then classified as LUC, which further groups similar units according to their capacity for sustainable production under arable, pastoral, forestry or conservation uses. The LUC code (e.g. 6e7) indicates *general capability* (1-8 classes), the *major limitation* (4 subclass limitations of **w**etness, **e**rosion, **s**oil and **c**limate), and the *capability unit* to link with units with similar management requirements and production opportunities.

Barrow's Land Use Capability is presented over the page. Description of the land resource by LUC is summarised as Table 2. N-loss targets for Barrow farm have been calculated and presented on page 16.

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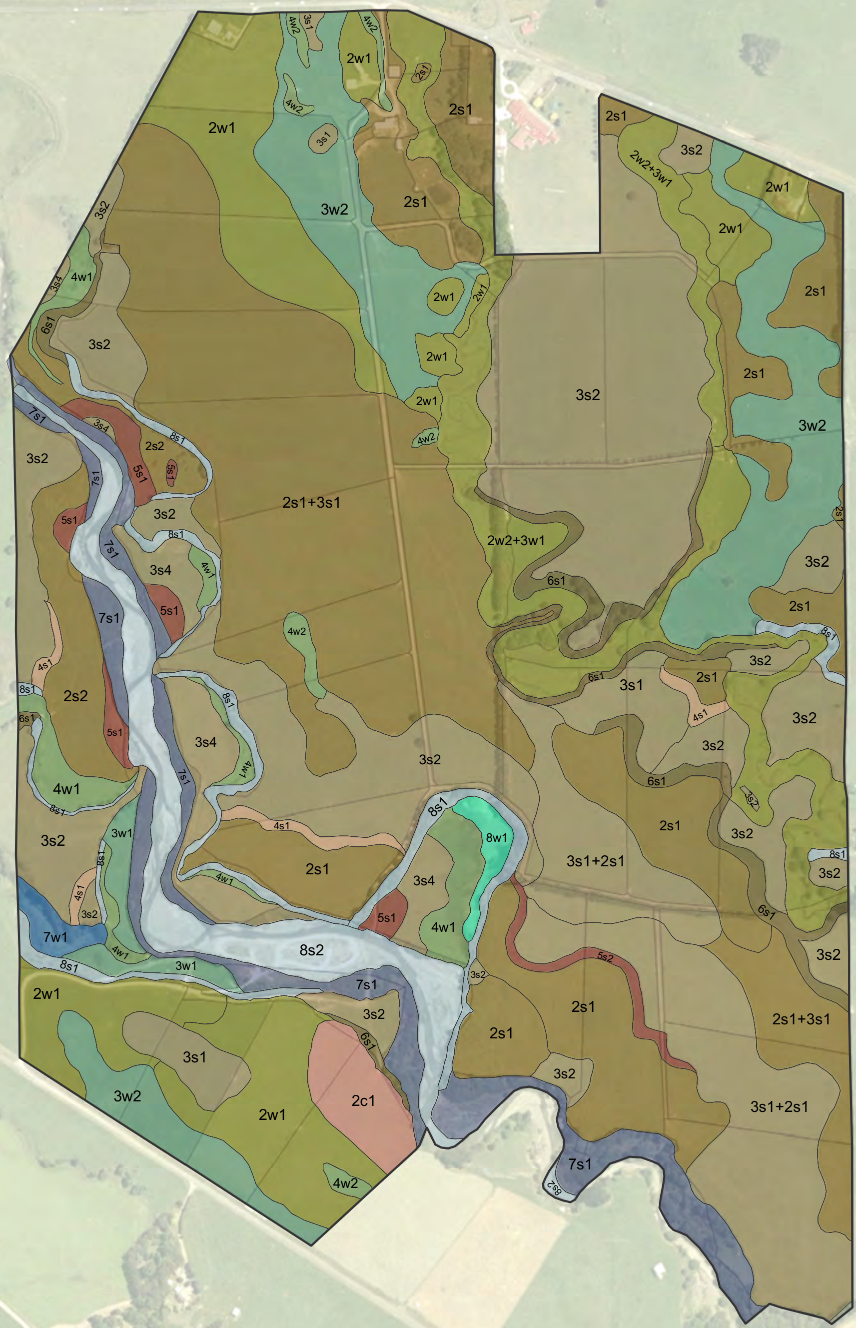
LUC	DESCRIPTION	Ha
IIc1	Flat upper terrace with deep Ashhurst silt loam soils (deep phase >1m to gravels) developed from loess deposits over gravels. No limitations to root development.	1.2
IIs1	Flat upper terrace with Ashhurst silt loam soils (depth to gravels +45cm) developed from loess over gravels. Well drained but compact subsoils. Friable nutty topsoil with a slight pugging risk.	29.9
IIs2	River flats with Rangitikei fine sandy loam soils (depth to gravels >50cm) developed from alluvium. Well drained but young soils with limited structural development.	2.4
IIw1	Flat upper terrace with imperfectly drained Ohakea silt loam soils (distinct orange + brown mottles within 30cm of surface) developed from loess (>80cm deep) on gravels. Moderate to high pugging risk.	10.2
IIw2	Stream flats with a complex of Rangitikei & Parewanui soils. Includes areas of Rangitikei fine sandy loam. Slight streambank erosion.	7.2
IIIs1	Flat upper terrace with stoney Ashhurst silt loam soils (stoney brown phase – depth to gravels ~30cm) developed from shallow loess & old alluvium on gravels. Well to excessively drained. Friable brown topsoil.	10.0
IIIs2	Flat upper terrace & terrace edges with stoney Ashhurst silt loam soils (stoney black phase) from shallow loess + old alluvium on gravel. Distinguished by very friable black topsoil & suspected high allophane content. Well to excessively drained with a slight wind erosion risk.	20.3
IIIs4	River flats with Rangitikei fine sandy loam shallow phase (depth to gravels 35-45cm) developed from alluvium. Young excessively drained & droughty soils.	2.3
IIIw1	Stream flats with Parewanui soils. Poor to very poorly drained.	0.8
IIIw2	Flat to undulating upper terraces with poorly drained Ohakea silt loam soils (gleying just beneath topsoil) developed from loess (>80cm deep) on gravels. High pugging risk.	9.0
IVs1	Terrace scarps that are cultivatable. Ashhurst stoney silt loams and a slight wind erosion risk.	0.6
IVw1	Old river channels with Parewanui heavy silt loams. Water table is at the surface for the wetter months. Very poorly drained with evidence of gleying in the topsoil.	2.1
IVw2	Very poorly drained channels located on the upper terraces. Mainly Ohakea soils but some examples have fine gravels at the surface.	0.6
Vs1	River flats with Rangitikei fine sandy loam stoney phase (<10cm topsoil + stones on surface). Young and excessively drained soil that dries out very quickly in summer.	1.0
Vs2	Terrace scarp slope with stoney Ashhurst silt loam soils that was too step to cultivate when the rest of the area was cultivated. Excessively drained, prone to drying out in summer, and a slight wind erosion risk.	0.4
VIs1	Steep terrace scarp slopes with stoney Ashhurst silt loam soils and a moderate wind erosion risk. Vegetation dominated by pasture.	2.4
VIIs1	River flats with a complex of Rangitikei fine sandy loams (stoney phase) and river stones. Vegetation dominated by willows and riparian species.	4.4
VIIw1	Stream wetland area with the water-table at the surface year-around. Parewanui heavy silt loam.	0.4
VIIIs1	Very steep scarp slopes along the river. Vegetation dominated by shrubby weeds (e.g. blackberry, broom), natives & pasture.	2.3
VIIIs2	Open river bed with stones and patches of Rangitikei series soils.	3.9
VIIIw1	Wetland and pond formed in an old river channel. Pond extent fluctuates with season.	0.4



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The Land Use Capability (LUC) system

Land Use Capability (LUC) is a classification of land according its capacity for sustainable production under various land uses (arable, pastoral, forestry, conservation). The LUC code has three parts:

VII s 1

CLASS SUBCLASS UNIT

LUC CLASS indicates the general capacity of land for sustained production. Eight classes are used, ranging from Class I (elite land) through to Class VIII (land with nil or limited production value for agriculture or forestry).

LUC SUBCLASS indicates the major LIMITATION that constrains land use in some manner. Limitations include Wetness (e.g. poor drainage), Soil (e.g. stoniness, droughtiness), Climate (e.g. above the snow line), and Erosion (including surface & mass movement types).

LUC UNIT breaks down the subclass further according to special management requirements, production potentials, soil conservation measures, and specific crop/pasture/forestry suitabilities. Units are numbered in order of decreasing versatility, so (for example) a VIs1 will generally be better than a VIs9.

NOTE: LUC units on this map are specific to the Barrow property. See Table 1 for regional equivalents.

FARMS

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

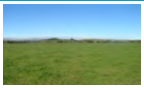
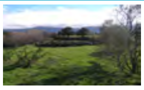
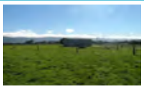
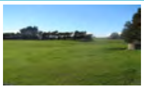
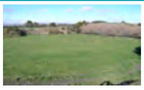
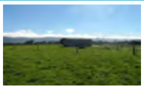
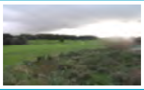
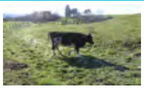
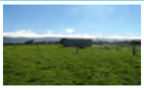
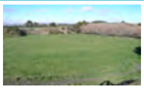
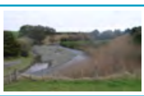
LAND USE CAPABILITY

John & Debbie Barrow

Maharahara Road, Dannevirke

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

TABLE 2: Land resource description by LUC unit

	FARM LUC	Ha	DESCRIPTION	rLUC	ROCK	SOIL	SLOPE	VEGETATION	EROSION
	IIc1	1.2	Flat upper terrace with deep soils from loess.	2c1	Deep loess over gravels	Ashhurst silt loam (deep phase)	0-3^0	Pasture	Nil.
	IIs1	30	Flat upper terrace with medium depth soils (depth to gravels +45cm) developed from loess over gravels. Compact subsoil.	2s1 *b*	Shallow loess over gravels	Ashhurst silt loam	0-3^0	Pasture	Nil.
	IIs2	2.4	River flats with fine sandy loam soils (depth to gravels >50cm). Well drained but young soils with limited structural development.	2s1 *a*	Fine river sands and silts (alluvium)	Rangitikei fine sandy loam	0-3^0	Pasture	None. Potentially severe streambank erosion & deposition during flooding.
	IIw1	10	Flat upper terrace with imperfectly drained silt loams (distinct orange + brown mottles within 30cm of surface).	2w1 *b*	Loess over gravels	Ohakea silt loam (imperfectly drained)	0-3^0	Pasture	Nil.
	IIw2	7.2	Stream flats with a complex of alluvial soils.	2w1 *a*	Stream silts and sands (alluvium)	Complex of Rangitikei & Parewanui soils	0-7^0	Pasture	Occasional slight streambank erosion. Potentially moderate streambank & deposition during flooding.
	IIIs1	10	Flat upper terrace with stoney soils (depth to gravels ~30cm). Well to excessively drained. Friable brown topsoil.	3s2 *b*	Shallow loess on gravel + old alluvium deposits	Ashhurst silt loam (stoney brown phase)	0-3^0	Pasture	Nil. Potentially slight wind erosion if cultivated
	IIIs2	20	Flat terrace & edges with stoney soils. Very friable black topsoil & suspected high allophane. Well to excessively drained.	3s2 *c*	Shallow loess on gravel + old alluvium + gravels	Ashhurst silt loam (stoney black phase)	0-3^0 & 4-7^0	Pasture	Nil. Potentially slight to moderate wind erosion if cultivated
	IIIs4	2.3	River flats with shallow sandy loam soils (depth to gravels 35-45cm). Young excessively drained & droughty soils.	3s2 *a*	Fine river sands, silts and gravel (alluvium)	Rangitikei fine sandy loam (shallow)	0-3^0	Pasture	Nil. Potentially severe streambank erosion & deposition during flooding.
	IIIw1	0.8	Stream flats with wet soils. Poor to very poorly drained.	3w1 *a*	Stream silts and sands (alluvium)	Parewanui silt loam & heavy silt loam	0-3^0	Pasture	Nil. Potentially severe streambank erosion & deposition during flooding.
	IIIw2	9.0	Flat to undulating upper terraces with poorly drained silt loam soils developed from loess (>80cm deep) on gravels.	3w1 *b*	Loess over gravels	Ohakea silt loam (poorly drained phase)	0-7^0	Pasture	Nil.
	IVs1	0.6	Terrace scarps that are cultivatable, and have stoney soils.	4s4*	Asst. of gravel, loess & old river deposits	Ashhurst silt loam (brwn & blck stoney phases)	8-15^0	Pasture	Nil. Potentially slight sheet erosion.
	IVw1	2.1	Old shallow river channels where the water table is at the surface for the wetter months. Very poorly drained.	4w1 *a*	Fine river silts and sands (alluvium)	Parewanui heavy silt loam	0-7^0	Pasture & rushes	Nil. Potentially severe deposition during flooding.
	IVw2	0.6	Very poorly drained channels on the upper terraces. Includes gleyed silts on gravel through to fine gravels at the surface.	4w1 *b*	Asst. of gravel, loess & alluvium + colluvium	Ohakea silt loam (poorly drained phase)	0-3^0	Pasture	Nil.
	Vs1	1.0	River flats with stoney sandy soils (<10cm topsoil + stones on surface). Young & excessively drained.	4s1*	Sands and gravel (alluvium)	Rangitikei fine sandy loam (stoney phase)	0-3^0	Pasture	Nil. Potentially severe streambank erosion & deposition during flooding.
	Vs2	0.4	Scarp slope with stoney soils. Too steep to cultivate with rest of paddock. Excessively drained, prone to drying out in summer.	4s4*	Asst. of gravel, loess & old river deposits	Ashhurst silt loam (brwn & blck stoney phases)	15-20^0	Pasture	Slight sheet erosion. Potentially moderate sheet erosion.
	VIs1	2.4	Steep terrace scarp slopes with stoney soils and a moderate wind erosion risk.	6s1	Mainly gravel	Ashhurst silt loam (brwn & blck stoney phases)	16-30^0	Pasture	Slight to moderate sheet erosion. Potential for moderate to severe sheet erosion.
	VIIs1	4.4	River flats with a complex of fine but stoney sandy loams and river stones. Vegetation dominated by willows and riparian species.	7s1	Sands, silts, gravels & bare rock (Br)	Rangitikei fine sandy loam (stoney)	0-3^0	Willows & riparian species	Severe streambank erosion & deposition during flooding.
	VIIw1	0.4	Stream wetland area with the water-table at the surface year-around.	7w1*	Fine alluvial material with high organic content	Parewanui heavy silt loam	0-3^0	Swamp associations	Nil. Potentially severe deposition during flooding.
	VIIIs1	2.3	Very steep scarp slopes along the river. Vegetation mostly shrubby weeds (e.g. blackberry, broom), natives & pasture.	8e3*	Mainly gravels	Stoney Ashhurst soils + bare rock (gravel)	26- >35^0	Gravel, shrub weeds, native shrubs, grass	Moderate to severe sheet erosion exacerbated by stock.
	VIIIs2	3.9	Open river bed with stones and patches of shallow sandy soils.	7s1*	Bare rock, gravels, sands & silts	Bare rock + patches of Rangitikei soils	0-3^0	Bare rock, willows, riparian species	Severe streambank erosion & deposition during flooding.
	VIIIw1	0.4	Wetland area and pond formed in an old river channel.	8w2*	Fine river silts (alluvium)	Parewanui heavy silt loam + water	0-3^0	Water, rushes, pasture	Nil.

4.3 N-TARGETS for the Barrow Farm

To remain compliant under the One Plan the Barrow farm is required to operate within the N-loss limits described below (Table 3). They represent the maximum permissible N-loss from leaching and runoff beginning April 2011. N-targets will not change over the 20 year period unless Land Use Capability changes (unlikely). Calculation of N-targets used the same land area used for the Overseer analysis. When Rule 13 of the One Plan first comes into effect for the Upper Manawatu Catchment (April 2011), N-loss for the Barrow farm must be no greater than 24 kg N/ha/yr.

Table 3: Permissible N-loss limits for Barrow farm (N-targets)				
Year	*2011*	*2016*	*2021*	*2031*
N-target (kg N/ha/yr)	**24**	**21**	**19**	**18**

4.4 Implications

4.4.1 Uniform N-loss over 20 years

Current N-loss for the Barrow farm has been calculated at 25 kg N/ha/yr. A reduction of 1 kg N/ha/yr is required by 2011, and a further 6 kg N/ha/yr is required by 2031 (Table 4). Accordingly, management needs to aim at reducing N-loss by 7 kg over 20 years, which works out at approximately 1 kg every three years. Note this assumes no change in existing N-loss, such that the current 25 kg N/ha N-loss remains constant for the twenty year period.

Table 4: Reduction required at a uniform N-loss				
Year	*2011*	*2016*	*2021*	*2031*
Current N-loss (kg N/ha/yr)	25	25	25	25
N-target (kg N/ha/yr)	**24**	**21**	**19**	**18**
Difference (required reduction)	*1*	*4*	*6*	*7*

4.4.2 Predicted intensification N-loss over 20 years

The current loss of 25 kg N/ha/yr can legally increase under the One Plan provided sufficient mitigation options are available to offset any increase. Further, industry trends suggest farm production will change significantly over the next 20 years, and these changes will likely impact on N leaching and runoff losses. A scenario for change has been constructed for the Barrow farm. Reliable predictions cannot be made for such a long time period, so the results are at best a 'considered approximation'. They have been included solely to demonstrate how current production trends may impact on future N-loss.

The dairy industry has recommended farms should be aiming to achieve 4% productivity growth. Using total milk solid production as an indicator, the Barrow farm would need a 20-year target of 176,000 kg MS (1,872 kg MS/ha) using a baseline increase (i.e. 4% of 100,000 kg MS = 4,000 kg MS gain per year) or 210,685 kg MS using a compound increase. Some sectors are already aiming for 500 kg MS/cow, based on current genetic gains reported by the LIC (+3.6 kg MS/cow/yr), ongoing improvements in technology and management, and levels of production currently being achieved by top farmers (++400 kg MS/cow). Using 20-year targets of 176,000 kg MS and 500 kg MS/cow (20 years is quite a long time), the herd would need to increase to 352 cows or 3.75 cows/ha. A linear relation between cow numbers and inputs such as fertiliser and supplementary feed was assumed (a big assumption but one that errs on the side of being conservative). These predicted changes were modelled through Overseer Nutrient Budgets, and used to simulate how N-loss may change over the next 20 years (Table 5). Figures adjusted by a cofactor regarding inhibitor use and N contributions to waterways.

Table 5: Predicted N-loss reduction required under an intensification scenario				
Year	*2011*	*2016*	*2021*	*2031*
Predicted N-loss (kg N/ha/yr)	25	29	34	43
N-target (kg N/ha/yr)	**24**	**21**	**19**	**18**
Difference (required reduction)	*1*	*8*	*15*	*25*

Under this scenario the Barrow farm would need to aim at offsetting N-loss by 25 kg over 20 years, which works out at 1.25 kg each year on average.

5.0 MANAGEMENT OPTIONS FOR MITIGATING N, P AND BUGS

5.1 Existing practice

The Barrow operation is already implementing a wide variety of N-loss mitigation options, some of which include:

- Retirement and fencing of Oruakeretaki Stream & some of the smaller streams (~3km riparian fencing and 2.2km of stream length protected).
- Uses urease and nitrification inhibitors regularly.
- All small streams where lanes cross have culverts.
- No winter application of effluent.
- Recycling of effluent to land.
- Adheres to a 'best bang for your buck' approach to N-fertiliser management (optimal rates, timings, split dressings, minimal wastage, applications only when pasture is actively growing, optimal nutrient levels, etc.).

Several of these options are not yet fully captured within the Overseer Nutrient Budgets model, so it is difficult to estimate what their contribution to lowering Barrow's total N-loss may be. Further, most if not all, carry some form of cost to the farming business, either as long term capital investments (e.g. fencing, culverts), ongoing variable costs (e.g. inhibitors), or they have an unaccounted labour cost.

Contributions and costs from new and existing mitigation options are evaluated in the next section (where possible). It is also important to recognise that existing mitigations need to continue as part of this FARM Strategy (see Section 6.3.1).

5.2 Additional mitigation options

A range of recognised best management practices have been listed and rated in terms of relevance to the Barrow farming operation (Table 6). Those with the highest relevance are evaluated further according to potential effectiveness and cost. Note that the listed mitigation practices are generally geared towards nitrogen, but with a recognition that many also affect P-loss, faecal microbes, and sediment loss. "Effectiveness" is judged by rerunning the *Overseer* model under the proposed mitigation where possible. Note that the implementation of one practice can have implications for other practices (e.g. wintering cows off farm may negate the need for N-applications during winter, feeding of supplements on-farm, etc.).

5.2.1 High energy/low-N supplements

Supplements with a high Metabolisable Energy (ME) content and a low Crude Protein percent (CP%) can be used as a replacement when cows are at or near maintenance feed requirements. High ME means a lower volume of supplement can be fed to achieve the same level of maintenance, and low CP% means there is less N available to be lost through urine. Current supplement includes hay (54 tn DM) from good quality pasture (9 MJ ME per kg DM & 14% CP). A commonly used high ME low CP% supplement is maize silage (10.5 MJ ME per kg DM & 8% CP). 46.3 tonnes of DM from maize provides the same energy as 54 tonnes of hay DM (*i.e.* 48,6000 MJ ME).

Proposal: Replace winter hay supplements with maize silage.

Effectiveness: Switching to maize silage **reduces modelled N-loss by 2 kg N ha^{-1} yr^{-1}**.

Implications & cost: In principle there should be little if any change in production if cows are receiving the same energy from maize as they were getting from hay. Assuming maize silage can be purchased at $0.35 per kg DM, and good quality hay can be purchased at $0.30 per kg DM, then total cost is $16,205 and $16,200 for maize silage and hay respectively. Using these prices, there would be no appreciable cost to the farm business by switching to maize silage.

Recommendation: To consider using maize silage over hay as the winter supplement, depending on seasonal prices.

Note 1: It is assumed that storage facilities for maize silage already exist, and that those facilities are designed to capture any silage leachate. If not, constructing these extra facilities will represent an extra cost.

Note 2: There may be other losses associated with maize such as increased wastage during feeding, and reduced DM content from the fermentation process (i.e. DM tonnage should not be estimated from standing maize).

Note 2: Interest in palm kernel was expressed as an alternative supplementary feed. At 11.5 MJ ME per kg DM, 42.3 tonnes of palm kernel DM would be necessary to maintain existing ME requirements. However, feeding this amount would have no effect on N-loss (as modelled by *Overseer*), probably because palm kernel has a high crude protein content (18%).

TABLE 6: Relevance of common N-loss mitigation options (+ P-loss & faecal microbes)

MITIGATION OPTIONS	Issue & ranking***	Relevance or opportunity	NOTES
Mitigations captured by Overseer			
Avoid winter (May, June or July) N-applications	N	LOW	Apparently no urea-N is applied during winter months.
Ensure effluent application area is large enough to keep loading <150kg N/ha/yr	N, bugs, P	LOW	Currently receives 34 kg N ha^{-1} yr^{-1} from effluent.
Avoid winter effluent applications	N, bugs, P	LOW	Already practiced.
Use supplements with N-concentrations that are lower than pasture (or higher energy content - e.g. maize)	N	HIGH	Used previously but farm manager has reservations. Willing to consider, so worth evaluating further.
Replace fertiliser N with equivalent supplement-N	N	LOW	Cannot be used strategically to target periods of growth when N is most needed.
Ensure other nutrients are non-limiting (optimal) for max yield per kg N input	N	LOW	Soil tests indicate levels for major nutrients are at optimum or above. pH varies.
Decrease use of N-fertiliser	N	MEDIUM	Depends on other factors. May be considered if production can be maintained.
Decrease stocking rate	N, bugs	LOW	Already running a low stocking rate (2.65 cows/ha).
Change stock type or class	N	LOW	Not suitable.
Reduce imports of supplementary feed	N	LOW	Depends on other factors. May be considered if production can be maintained.
Graze cattle off during winter (May, June, July)	N, bugs, P, sed	HIGH	Manager is willing to consider.
Use a sealed wintering/standing pad with effluent collection and storage system	N, bugs	LOW	Not a preferred option, although it is an alternative to off-farm winter grazing.
Increase supplement exports off farm	N	LOW	Not financially prudent at current time.
Recycle effluent to land rather than pond treatment & disposal to waterways	N, bugs, P	LOW	Already practiced.
Other mitigation activities			
Time N-fertiliser application for periods when N demand is greatest*	N	LOW	Already practiced.
Avoid high-rate, single dressings of N-fertiliser. Use split dressings (20-50kg N/ha per dressing)	N	LOW	Already practiced.
Adjust N-fertiliser rates & timings seasonally to respond to actual or expected production demand (seasonal variations)	N	LOW	Already practiced.
Use an N-fertiliser product with an N-uptake efficiency that is better than the current N-product	N	LOW	Pasture may preferentially uptake ammonium-N cf. nitrate-N. However, research has only demonstrated small differences in pasture yield (e.g. Ball & Field, 1982).
Avoid N-applications when soils are saturated (leaching/runoff & low plant activity).	N	LOW	Already practiced.
Avoid N-applications during excessive dry periods (plant N-uptake low)	N	LOW	Low relevance for the greater part of farm (irrigated).
Consider timing N-fert using a water balance on soils with high leach/runoff risk (shallow gravel soils, soils with high water tables, artificially drained soils)	N	LOW	Currently part of a scheme with regular soil water monitoring.
Delay N-applications directly after dry periods until pastures have started recovering	N	LOW	Low relevance for the greater part of farm (irrigated).
Ensure an adequate buffer distance from waterways when applying fertiliser**	N, P	LOW	Already practiced.
Use urea product treated with urease inhibitor	N	LOW	Already practiced.
Ensure you can actually use the extra grass grown when N-fertiliser is used	N	LOW	Already practiced.
Spray nitrification inhibitor according to manufacturer recommended rates and timings, particularly on highly stocked areas (e.g. camps)	N	LOW	Already practiced.
Use an irrigation schedule or soil-water monitoring to guide effluent application.	N, bugs, P	LOW	Currently part of a scheme with regular soil water monitoring.
Ensure effluent storage ponds do not overflow (part. winter)	N, bugs, P	HIGH	Has happened in the past. More investigation required.
Use adequate buffer distance from waterways when applying effluent (+20m)	Bugs, N, P	MEDIUM	There is one paddock in the effluent rotation with a stream.
Irrigation systems: Avoid N runoff & deep drainage losses by ensuring effective application rates & timings according to soil-water balance, irrigation scheduling, or soil-water monitoring	N	LOW	Currently part of a scheme with regular soil water monitoring.
Other best management works			
Ensure all paddocks are supplied with adequate troughs or dams	Bugs, N, P, sed	HIGH	Needs further investigation. Partial reliance on natural water (streams) would be less viable if streams were fenced.
Replace fords with bridges or culverts	Bugs, sed, N, P	HIGH	The main ford may require a bridge under the Clean Streams Accord. Likewise, at least a two stream crossings (K-Road paddocks) may require culverts.
Exclude stock from flowing waterways by fencing	Bugs, sed, N, P	HIGH	A sizeable area of streams network through 10 paddocks, most of which would possibly require fencing under the Clean Streams Accord, & some of which is already fenced.
Create wetland attenuation zones where runoff converges	Bugs, sed, N, P	LOW	Topography is generally unfavourable on this farm.
Create riparian attenuation zones wider than 10-30m	Bugs, sed, P, N	LOW	This mitigation is examined in greater detail (page 21) to demonstrate why it has low relevance.
Ensure runoff from tracks/lanes is not channelled into streams near crossings	Bugs, sed, N, P	LOW	There is one location where the lane dips down to a culvert crossing. However, the size of the dip negates a practical solution.
Ensure there are no major leaks in the effluent irrigation system (e.g pipe joins).	N	LOW	Already practiced.
Invest in a high efficacy effluent treatment/disposal system (e.g. digesters)	N, bugs, P	LOW	For this farm there are many other lower cost options.
Ensure runoff from yards, feed pads, etc. does not go directly into waterways	Bugs, N, P, sed	LOW	Already practiced.
Ensure effluent storage ponds are sealed	N, bugs	MEDIUM	There is reason to suspect leakage. More investigation required.
Ensure effluent storage ponds are of a sufficient size	N	LOW	More investigation required.
Store leakable supplementary feeds (e.g. silage) on a sealed base with an effluent collection/storage/disposal system	N	LOW	Not relevant unless supplementary feed programme alters.

** When pastures are higher than 25mm or 1000kg DM/ha, are actively growing, when soil temp >6degrees*

*** See formulas in Spreadmark code of practice*

**** **N**= nitrogen loss, **P**= phosphorus loss, **bugs** = faecal microbes, **sed** = sediment*

5.2.2 Off-farm winter grazing

Grazing off-farm during winter is a powerful N-mitigation option because it essentially removes urine-N contributions at a time when the leaching risk is greatest, and it takes away the need to use winter supplements and fertiliser-N by default. Currently 200 cows are wintered on-farm over winter (25 May to 20 August).

Proposal: Graze the herd off-farm from beginning of June to end of July (includes no winter N-fertiliser or supplement use).

Effectiveness: Grazing the cows off-farm during winter **decreases modelled N-loss by 9 kg N ha^{-1} yr^{-1}**

Implications & cost: At the time of writing (early spring) off-farm grazing costs were $18.00/cow/week. Eight weeks for 200 cows represents $28,800 plus $2,200 for cartage ($0.11/cow/km at a 50km radius x 2 trips). Total cost of grazing-off would be in the vicinity of $31,000.

The need to use supplements and winter-N is made redundant by off-farm grazing. Savings include $16,200 for supplements (54,000 tn hay DM @ $0.30/kg DM) and $1,550 for winter-N (10kg urea-N/ha x 94ha @ $1.65/kg urea-N). An extra $2,000 expenditure is required to cover the nutrients that would have been applied with the hay (270 kg P, 810 kg K, 162 kg S). Total tangible savings would be $15,750 ($16,200 - $2,000 + $1,550).

At first glance wintering-off could reduce N-loss by 9 kg N ha^{-1} yr^{-1}, but it would cost the farm business $15,250 in revenue. HOWEVER, few farmers would waste the extra pasture grown on-farm while the cows are grazed elsewhere. Three possible options to make use of the extra pasture include:

1. Increase next season's stocking rate. If an extra five cows were milked (2.7 cows/ha), then farm revenue could be expected to increase by $11,000 (assuming 400 kg MS per cow from current production). Likewise, increasing the herd by an extra 10 cows (~2.8 cows/ha) could result in $22,000 additional revenue, which is sufficient to offset the cost of winter grazing. **Modelled N-loss remains unchanged at both stocking rates**, presumably because most leaching occurs during the winter when cows are grazed off.
2. Extending the milking season by calving earlier or milking longer, or a combination of both. An additional two weeks of milking at the margins could represent an extra $28,000 in revenue (at a return of $2,000 for every extra day milked). **Modelled N-loss also remains unchanged** (note: lactation length was extended by 14 days in the Advanced Dairy Production option).
3. Making hay for sale off-farm. Assuming a late spring/early summer surplus of 3000 kg DM/ha (~170 conventional bales per hectare) across 15 ha (45 tn hay DM or 2550 bales), a farmgate price of $0.30 per kg hay DM ($13,500), and a harvesting cost of $2.30 per conventional bale equivalent (2550 x $2.30 = $5,865), less $1,200 for fertiliser to replace exported nutrients (45 tn hay = 225 kg P, 675 kg K, 135 kg S), then revenue generated from haymaking could be a somewhat uninspiring $6,435. **Modelled N-loss remains unchanged on a whole-of-farm basis**.

In summary, winter grazing decreases modelled N-loss by 9 kg N ha-1 yr-1, and it may represent an opportunity to increase farm returns in the vicinity of $7,000 to $13,000 per year. HOWEVER, the better returns are dependent on obtaining quality grazing in a low risk area (see notes below), and being able to utilise the extra pasture produced on-farm during the grazing off period.

Recommendation: Seriously consider off-farm winter grazing if quality grazing in a low N-loss risk area can be obtained, and the on-farm surplus winter feed can be utilised.

Note 1: Wintering off to achieve N-loss targets is only a valid practice if grazing can be sourced at a location where N-loss is not a concern (e.g. outside the Region, in a non-targeted catchment, or on a farm operating well within its own N-loss targets).

Note 2: Some farmers have incurred significant losses through off-farm winter grazing, either through stock misadventure (high risk landscapes) or dramatic loss of cow condition through poor feeding and grazier mismanagement. Finding quality grazing is not a straightforward proposition, and one that lessens the viability of off-farm winter grazing as an N-loss mitigation option.

5.2.3 Install bridge over the Oruakeretaki Stream

Bridges exclude direct defecation of cattle to water, provide all-weather access, and reduce sediment associated with stock induced stream bed and bank erosion/disturbance. A bridge over the Oruakeretaki Stream may not be required under the Clean Streams Accord (page 6), but it will definitely be required under the One Plan (page 23-24). There are examples in the local district where similar spans have been achieved at relatively low cost using train-wagon chasises.

Proposal: To construct a bridge across the Oruakeretaki Stream at least cost.

Effectiveness: A bridge would likely decrease estimated N-loss by **~0.6 kg N ha^{-1} yr^{-1}** (see page 5) and P-loss by <0.1 kg P ha^{-1} yr^{-1}. Reductions in faecal microbe contaminants would likely be much higher and more important, but these cannot be robustly quantified for the Barrow farm at the present time.

Implications & cost: Cost of constructing a bridge has been estimated at $73,000 by a local river engineering consultant (cost estimate appended). In production terms the only gain is all-weather access, which is minor given this is a manageable problem for only a few days each year.

Recommendation: A bridge represents a major investment, and one that challenges to viability of farming across the Oruakeretaki Stream. Given that the bridge may become a non-negotiable requirement, then the recommendation is to firstly explore alternatives in-depth, and secondly to construct the bridge only if there is no other viable alternative.

FENCING STREAMS (recommended)

Eligible streams, rivers and waterways

Existing fences

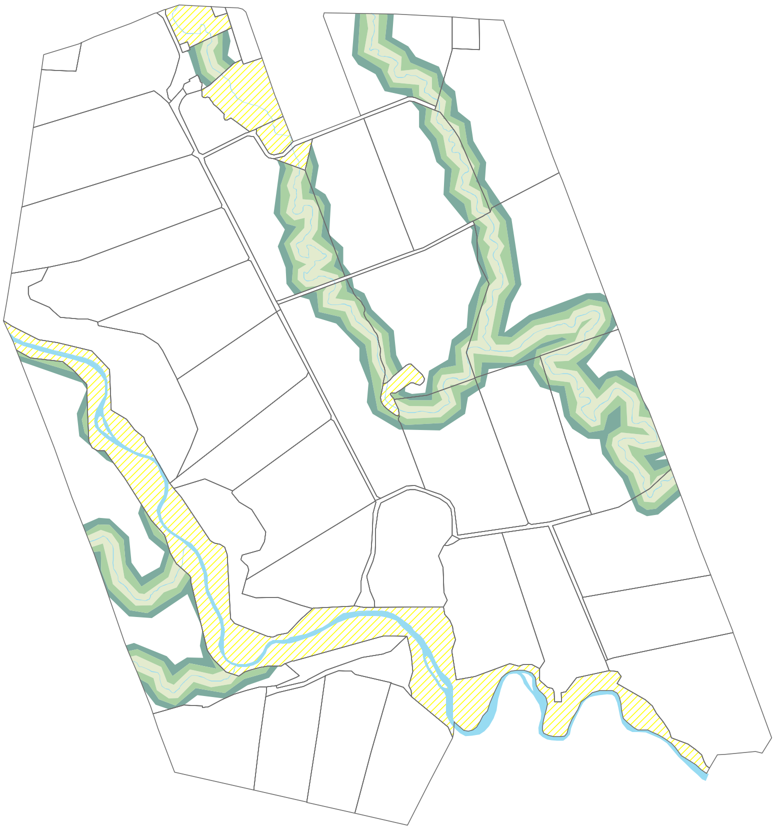
Areas excluded from the grazing rotation with streams (i.e. already protected)

Recommended new fences to tightly parallel waterways. Assuming a uniform 1m width for all streams and a 0.5m buffer to place fences, then total length of new fencing required is 5.9 km. Area of land that would be retired is 1.7 ha. Approximately 0.5 ha of this is grazed pasture.

Waratahs (minimum of 300)

Braced strainers or angle posts (minimum of 50)

Total length of waterways currently unfenced = 3.2 km



RIPARIAN BUFFER STRIPS

Eligible streams, rivers and waterways

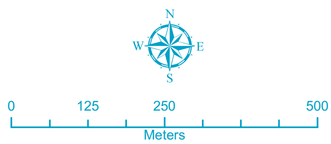
Existing fences

Areas excluded from the grazing rotation with streams (i.e. already protected)

10 metre wide buffer strip. Grazing reduced by 5 ha, but traps majority of contaminants.

20 metre wide buffer strip. Grazing reduced by 10 ha but trapping efficiency increased.

30 metre buffer strip. Grazing reduced by 15 ha. Generally traps all contaminants most of the time.



The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

WATERWAY PROTECTION

John & Debbie Barrow

Maharahara Road, Dannevirke

Rivers and waterways interpreted of orthophotography. Small streams assigned a uniform width of 1m. Recommended fencing and riparian zones created by buffering river and waterways. Results generalised using Douglas-Poiker alogorithm to approximate linearity associated with fencing practice. Recommended fences further edited to better align with high stream banks, existing fences, and low value land. Effect of slope was considered negligible for the buffer strip evaluation.

5.2.4 Fence waterways

Direct access of stock to waterways amplifies the risk of contamination by faecal microbes, and to a lesser extent, the contribution of nutrient to water. Further, liver fluke infection is possible in some areas, and a recent Government report has suggested waterways may be a source of leptospirosis. Both the dairy industry and Horizons Regional Council are aiming to have all appreciable streams on all dairy farms excluded from the grazing rotation. Currently there is 3.2 km of unfenced streams on the Barrow property.

Proposal: To fence all waterways using an electrified two-wire waratah fencing system that minimises the loss of productive land.

Effectiveness: Fencing all waterways **will likely decrease estimated N-loss by ~0.2 kg N ha^{-1} yr^{-1}** (see page 5) and P-loss by <0.1 kg P ha^{-1} yr^{-1}. These reductions are minor. The greater-gain would be reduced pathogen contamination. While this cannot be robustly quantified for the Barrow property (see page 5), research studies have demonstrated significantly lower faecal microbe contamination of waterways through stock-exclusion and fencing.

Implications & cost: Total fence length is estimated at 6.1 km, requiring at least 300 waratahs and 50 braced No.1 full round posts (to be used as cheap strainers and angle posts). This could be reduced substantially with straighter lines and a greater area retired from grazing. Cost for 6.1 km (excluding any gates) is estimated at $2.38/m or $14,500. Total area of retired land would be 1.7 ha (includes water, trees, etc). Loss of effective grazed area is 0.5 ha, which equates to 7375 kg DM/year less pasture, 520 kg less milksolids per year, and a loss of $2,860 in farm gate returns each year (see Table 6). Troughs would be required for 2 paddocks (see 5.2.9), costing an additional $2500. The Barrows have expressed an interest in flax or carex species to shade and suppress waterweed and bank weeds such as blackberry (estimated at $400 to cover ~0.5 ha). To summarise, **total expense is estimated at $17,400, while lost income is estimated at $2,860 per year**.

Recommendation: That stock be excluded from all waterways using a semi-permanent fencing system. While nutrient loss savings would be small, risks associated with faecal contamination of water would be much reduced. Further, these streams likely require fencing under the Clean Streams Accord (see page 7), and Rules under the One Plan (see page 23-24). Cost is high, but can be blunted somewhat by staggering the work over 4-5 years (Clean Streams Accord compliance target is year 2012). A consideration of suitable riparian species is included as Appendix 2.

5.2.5 Planted riparian buffers

Planted riparian buffers are considered here as the next step-up from fencing-off waterways. In a farm business context, the purpose of riparian buffers is to trap nutrients, sediment, and faecal microbes associated with runoff (in addition to excluding stock from waterways). Generally the first 10m is the most important, with effectiveness increasing with width out to 30m where most contaminants get trapped/attenuated most of the time. In short, planted riparian buffers are effective where runoff is a key contaminant transport mechanism.

Proposal: Create fenced and planted riparian buffer strips around waterways. Determine which width is likely to be most cost-effective (10m, 20m or 30m buffer widths - map on previous page 21).

Effectiveness: The trapping/attenuation effects of riparian buffer widths could not be robustly evaluated for the Barrow property. Specific research is currently being undertaken to build such effects into the next release of the *Overseer* model. Even so, many other studies have demonstrated planted buffers as being highly effective in trapping/attenuating sediment, phosphorus, and faecal microbes. Reductions in N-loss are generally lower, because leaching rather than runoff is considered the key N-loss transport factor on NZ dairy farms. However, it could be safely assumed that riparian buffers would benefit the farm's environmental performance in most cases.

Implications & cost: Main implications include establishment costs (planting, fencing) and lost production (Table 7). Herd number would be reduced by approximately 13, 26, and 39 cows for 10m, 20m and 30m buffer widths respectively (to maintain the 2.65 cows per hectare stocking rate).

Table 7: Production and financial implications of fencing and/or planting different width riparian buffers

Practice	Area retired (ha)	Establishment costs		Production change			
		Fencing[1] ($)	*Plants[2] ($)*	*Effective area retired (ha)*	*Pasture DM[3] (kg DM/yr)*	*Milksolids[4] (kg MS/yr)*	*Income[5] ($/yr)*
Fencing waterways	1.7	+ $14,500	$400	0.5	-7,375 kg/yr	- 520	- $2,860
10m buffer	6	+ $13,050	+ $4000	5.0	-73,750 kg/yr	- 5,200	- $28,600
20m buffer	11.4	+ $11,600	+ $7920	9.9	-146,025 kg/yr	- 10,400	- $57,200
30m buffer	16.5	+ $10,150	+ $11,760	14.7	-216,825 kg/yr	- 15,600	- $85,800

1 At $2.38/m and a 10% reduction in cost as the buffer gets wider to account for fewer angles, less materials, and less fencing time
2 Native species at $800/ha targeting the retired effective area. Note that this is an extremely conservative value ($10,000 - $20,000 per ha has been cited elsewhere)
3 Based on an average 14,750 kg DM ha^{-1} yr^{-1} (See page 8. Note that using the distributed values had little effect on total annual yield).
4 Based on current production figures (100,000 kg MS per year).
5 At $5.50 per kg MS

Recommendation: Not to establish planted riparian buffers at this stage. Other recommendations in this report will help improve environmental performance considerably, which may be sufficient for achieving catchment water quality targets. Over-investment in environmental mitigations is not recommended when there is uncertainty about necessity. If it comes to pass that all intensive farms in the Upper-Manawatu Catchment comply with the One Plan but water quality remains below target, then there may be sufficient justification to revisit riparian buffers.

5.2.6 Install culverts at stock crossings (small waterways)

Culverts achieve the same outcomes as bridges but on a smaller scale (i.e. for smaller streams). In the main, the Barrow property is well served with culverts, although several have outfall heights that are higher than those recommended by guidelines[1]. There are at least two locations where new culverts are required under the One Plan (page 23-24), and possibly the Clean Streams Accord also.

Proposal: Install two concrete culverts in the eastern K-Road block paddocks.

Effectiveness: Under the current system losses of N & P from direct defecation would be minor. Reduction in faecal contaminants would be higher, but still small on a whole-farm basis. However, this would change considerably if the bridge was installed.

Implications & cost: Cost of purchasing and installing the two culverts has been estimated at $3,400. Resource consent may cost a further $1000 under the current consent process.

Recommendation: That the culverts be installed. Environmental enhancements would be minor at the present time, but installing the culverts may become a non-negotiable requirement under the One Plan and possibly the Clean Streams Accord also.

[1] *Culvert and Bridge Construction: Guidelines for Farmers. Ministry for the Environment, 2004. Available: www.mfe.govt.nz/publications/land/culvert-bridge-oct04/*

5.2.7 Ensure all paddocks have adequate stock water

Troughs decrease the number of cows entering riparian and stream areas to obtain a drink. Clean trough water can also be a more healthy stock-watering option. Currently one paddock in the grazing rotation does not have a trough. If all streams were fenced, then two troughs would be required. Both would be located in the west K-Road Block. New reticulation would also be necessary.

Proposal: To install two new troughs.

Effectiveness: The effect of new troughs cannot be robustly predicted for the Barrow property.

Implications & cost: Improvement in stock health and production (if any) is difficult to speculate. Cost is more tangible. Two troughs ($300/trough) plus 600 metres of 32mm medium density pipe ($120 per 100m coil) plus installation and fittings would cost an estimated $2500.

Recommendation: To install the two troughs. This recommendation is made on the basis that all streams will need to be fenced (either because of the Clean Streams Accord or One Plan Rules), and the herd will therefore require a reliable water source other than the stream.

5.2.8 Effluent application area

A commonly used upper-limit loading for nitrogen application is 150 kg N/ha/yr. Overseer can calculate the area of land required to keep N-loading from effluent within the 150 kg N/ha/yr guideline. The current area of land receiving effluent is 15 ha. However, the actual 'effective area' of the effluent block is 13 ha when One Plan discharge restrictions are accounted for (see Section 6.3.3).

Proposal: Optimise the size of the effluent application area according to an upper loading limit of 150 kg N/ha/yr.

Effectiveness: Overseer calculates the optimal area of land for effluent application at 16 ha. This is 3 ha larger than the current effective area. Modelled N-loss does not change (possibly because of the small amounts being considered when averaged over the farm and then rounded to the nearest whole number).

Implications & cost: Enlarging the effluent application area will not incur any substantial cost, other than a minor increase in labour requirements for the year. The existing pump and irrigation system is capable of reaching the neighbouring paddock (the front to rear of the farm follows a downward elevation gradient).

Recommendation: Expand the effluent application area into closest paddock of the Top River Block.

Note 1: Under the intensification scenario discussed on page 16, the size of the effluent block would need to increase to 18ha, 21ha, and 26ha for the years 2016, 2021, 2031 respectively.

5.3 Achieving 2011 N-targets

The difference between current N-loss and N-targets for 2011 is quite small (1 kg N/ha/yr), and the Barrow operation has many mitigation options available to comply with One Plan N-limits. Response can therefore be flexible. However, in the short term, fencing waterways and bridging the Oruakeretaki Stream are the two most strongly recommended actions. They would combine to reduce N-loss by the required 1 kg N/ha/yr for 2011. Further, each can be considered as a non-negotiable requirement under the One Plan, the Clean Streams Accord, or both (i.e. they have to be done anyway). Undertaking these activities may cost upwards of $90,000 if all associated services had to be contracted, and lost production could amount to approximately $3,000 revenue drop per year.

5.4 Achieving 2031 N-targets

Longer term targets require the adoption of additional mitigations. Assuming the farm can remain operational without any future N-loss gains (however, see predicted N-loss from an intensification scenario on page 16), then the farm must reduce the current level of N-loss by 7 kg N/ha/yr over 20 years to remain compliant with the One Plan in 2031.

For the Barrow farm, the single most effective mitigation is wintering the herd off farm. Coupled with the requirement to fence streams and bridge the Oruakeretaki Stream, total reduction in N-loss could be as much as 10 kg N/ha/yr. This would allow the 2031 N-target to be achieved comfortably, while retaining a small margin (3 kg N/ha/yr) for future farm development and intensification. There would be no additional cost relative to the 2011 N-targets. At 2007 prices there may even be an opportunity to increase returns by $7,000 to $13,000 per year.

However, winter grazing is only a valid option if quality grazing can be sourced continuously, at a reasonable price, and located within a catchment where N-loss is not a concern (e.g. a low priority catchment, or on a farm operating well within its own N-targets).

6.0 ONE PLAN REQUIREMENTS

Controlled and permitted activities relevant to the Barrow farm have been assessed to identify current levels of compliance under the One Plan (Table 9 overleaf). Note that the list and terminology only applies to the Barrow property. Non-compliant activities are further evaluated to identify actions or options required to become compliant (Section 6.3). There is an unavoidable degree of overlap with recommended N-loss mitigations (previous section) and recommendations to become fully compliant under One Plan rules.

6.1 Existing consents

Currently there are three active consents; one for discharge to land, and two regarding surface water takes (Table 8).

Table 8: Active resource consents for the Barrow property, 2007

Consent reference	*Consent Type*	*Max Daily (m^3/d)*	*Max Rate (l/s)*	*Started*	*Expires*	*Water Body*
101496	Discharge to Land	6.8	-	17/01/01	30/11/25	-
102482	Surface Water Take	1000	-	17/03/03	24/02/08	Oruakeretaki Stream
102722	Surface Water Take	2240	45	28/01/04	17/12/08	Mangapuka-Kakahu Stream & a tributary

Note that existing consents will be replaced by a Whole Farm Consent associated with this FARM Strategy, except for consents concerning large ground water takes, construction of bores, and any other type of consent not covered in the FARM Strategy workbook.

6.2 Planning period

This FARM Strategy is designed for a 5-year planning period. However, it is recognised that the viability of some mitigation practices are strongly dependent on seasonal factors (cost, payout, climate, etc), and it is conceivable that the most suitable options for mitigating environmental impact will fluctuate annually. It is therefore recommended that the nutrient budget be reassessed each year, and mitigation practice adjusted accordingly.

TABLE 9: Barrow's status of controlled and permitted activities under the One Plan (2007)

CONSENTABLE ACTIVITY	REQUIREMENTS	STATUS 07	NOTES
Farming within N-loss target?	1. Farm N-loss must be within N-loss targets	Requires attention	1 kg N/ha/yr above N-loss limit
Produce animal effluent?	1. No direct discharge of effluent to water from yards or pads	Compliant	
Store animal effluent?	1. No direct discharge of effluent to water from ponds & sumps	Requires attention	Effluent pond overflows occasionally during winter - requires further assessment
	2. Ancillary storm water must not discharge into pond or sump	Requires attention	Most storm-water from milking parlour roof is discharged to ponds
	3. Effluent storage must be sealed and not leaking	?	Difficult to evaluate within project limits
	4. Effluent pond or sump must have capacity to hold 2-days of effluent between applications (if applied to land)	Compliant	
Apply effluent to land?	1. No substantial leaks in irrigation pipes or equipment	Compliant (assumed) *	Difficult to evaluate at present time (winter).
	2. Spray application must be > 20m from surface water bodies, bores, or the CMA	Compliant (assumed) *	A stream runs through the area designated as the effluent block. Avoiding the 20m restricted zone is readily achieved by irrigator/spreader positioning.
	3. Spray application must be > 20m from public areas & roads, or residences	Compliant (assumed) *	Restricted zones can be readily avoided by irrigator/spreader positioning.
	4. Spray application must be > 50m from protected archaeological or biodiversity areas	na	No rare/threatened/at risk habitats or archaeological/cultural sites on the farm
	5. Must have a nutrient budget (emphasis on N)	Compliant	
	6. Must not apply on days when drift will cause problems for neighbours	Compliant (assumed) *	Difficult to evaluate within project limits
	7. Annual N-loadings of the effluent block should not be in excess of 150 kg N ha^{-1} yr^{-1}	Requires attention	Requires 16.3 ha. Currently effluent block is 13.3 ha effective (see map p.25).
	8. Surface ponding longer than 5hrs after application must be avoided	Compliant (assumed) *	Difficult to evaluate within project limits
Active farm dump or offal hole?	1. Only organic waste & dead animal matter. No dumping of chemicals, metal, plastic, household rubbish, animal remedies, sprays, fuel, poisons, sewage, plastic twine, silage wrap.	Compliant (assumed) *	
	2. No discharge to water	Compliant	
	3. Must not be sited within 150m from residences or public areas	Compliant	
	4. Must not be sited within 10m of the farm boundary or river floodplain	Requires attention	Located within 10m of the flood plain
	5. Must not be sited within 50m from protected archaeological or biodiversity areas	na	No rare/threatened/at risk habitats or archaeological/cultural sites on the farm
	6. Must not be sited within 100m from bores, surface water bodies, or CMA	Requires attention	Located within 100m of river.
	7. Must manage pests	Compliant (assumed) *	Pests managed as required
	8. There will be no objectionable smell	Compliant	No objectionable smell noted when evaluated
Stock have direct access to waterways?	1. Stock must have adequate (reticulated) trough water available in each paddock (ideally to meet peak demand)	Requires attention	Requires two troughs in the west K-Road paddock (+ new reticulation)
	2. Waterways that qualify under the Clean Streams Accord must be fenced	Requires attention	3.7 km of stream requires fencing
	3. Stock crossings must have a bridge or culvert	Requires attention	One bridge and two major culverts required
	4. Runoff from bridges and culverts must be directed to land rather than water	Compliant	Runoff is redirected to land where practicable
Apply fertiliser?	1. No application of fertiliser directly to water bodies	Compliant (assumed) *	
	2. No application into protected biodiversity areas	na	No rare/threatened/at risk habitats or archaeological/cultural sites on the farm.
	3. Must be applied in accordance with industry Code of Practice	Compliant (assumed) *	
	4. N-fertiliser use requires a nutrient budget	Compliant	
	5. Must not apply on days when drift will cause problems beyond the farm boundary	Compliant (assumed) *	
Surface water take?	1. Total take must be <15m3 per day	Compliant	
	2. Total take rate must be <0.5 litres per second	Compliant	
	3. Total farm water take must be below local Allocation Limits	Compliant	
	4. Take must not affect wetland water levels	Compliant	
	5. Take must not be from protected wetland	Compliant	
	6. Water intake must have a screen	Compliant	
	7. Intake velocity must be low enough to avoid harming small fish	Compliant (assumed) *	
	8. Water take must not adversely affect legal water takes of existing users	Compliant	
	9. Extracted water must be used efficiently	Compliant (assumed) *	Efficiency of one irrigator tested by Bloomer & Assoc.
	10. Must report take particulars to Horizons RC	Compliant	

* Level of compliance cannot be assessed conclusively within project limits. Full compliance is assumed until proven otherwise.

6.3 Five-year strategy to achieve One Plan compliance

6.3.1 Maintaining existing mitigations

Existing mitigations have been reported in Section 5.1. Change with any of the listed activities may affect N-loss, and would therefore necessitate a nutrient budget reassessment. Accordingly, existing best-practice activities should be maintained for the first year, and reassessed with a new nutrient budget in the second year.

Objective 1: Maintain current use of urease-treated urea at 200 kg N ha^{-1} yr^{-1} for 2007/2008. Record where, when and how much urea is applied during the season (for improved nutrient budgeting in the following year).

Objective 2: Continue to avoid winter applications of urea and other N-fertilisers.

Objective 3: Continue to spray nitrification inhibitors to pasture at provider-recommended rates and timings for 2007/2008. Record where, when and how is applied (this may become important for future nutrient budgeting).

Objective 4: Maintain the same stocking rate, lactation period, supplements, and grazing strategies for 2007/2008.

6.3.2 Operating within N-targets

The farm is required to operate within an N- target of 24 kg N ha^{-1} yr^{-1} starting year 2011. Currently the Barrow operation is 1 kg N ha^{-1} yr^{-1} above the target. While no change is required until 2011, it is recommended some of the mitigation works are initiated early (e.g. fencing streams), and that low or nil cost N-mitigating activities are adopted. Objectives concerning fencing waterways and the bridge are covered in more detail under Sections 6.3.6 and 6.3.7.

Objective 5: Reduce N-loss by 0.2 kg N ha^{-1} yr^{-1} by fencing all waterways that qualify under the Clean Streams Accord before 2011 (see Section 6.3.6).

Objective 6: Reduce N-loss by 0.6 kg N ha^{-1} yr^{-1} by installing a bridge over the Oruakeretaki Stream before 2011 (see Section 6.3.7).

Objective 7: Install two stock-crossing culverts in the western K-Road paddock by 2011.

6.3.3 Effluent application area

Area of land that currently receiving effluent is 14.9 ha (effective grazed area). This is reduced to 13.3 ha when One Plan separation distances are factored in (see map page 26). Further, Overseer modelling indicates that the Barrow's require an area of 16.3 ha to achieve the generally accepted upper-limit of 150 kg N ha^{-1} yr^{-1} application loading. In short, the effluent application area needs to expand by 3 ha to be compliant. The Barrows have indicated that expanding the application area into the neighbouring southern paddock (2.5 ha) would be readily achievable without additional cost. Running the irrigator close to the next neighbouring paddock would create an overlap sufficient to accommodate the extra 0.5 ha.

Objective 8: Avoid effluent application onto non-permissible areas and expand the application area beginning 2007/2008.

6.3.4 Farm dumps and offal holes

One Plan separation distances for farm dumps and offal holes are very restrictive for the Barrow farm. Further, the current dump site is non-compliant due to its proximity to the flood plain and river. A new site and resource consent is required for future disposal of organic waste and 'dead animal material'. Consent and installation cost is estimated at $1,500.

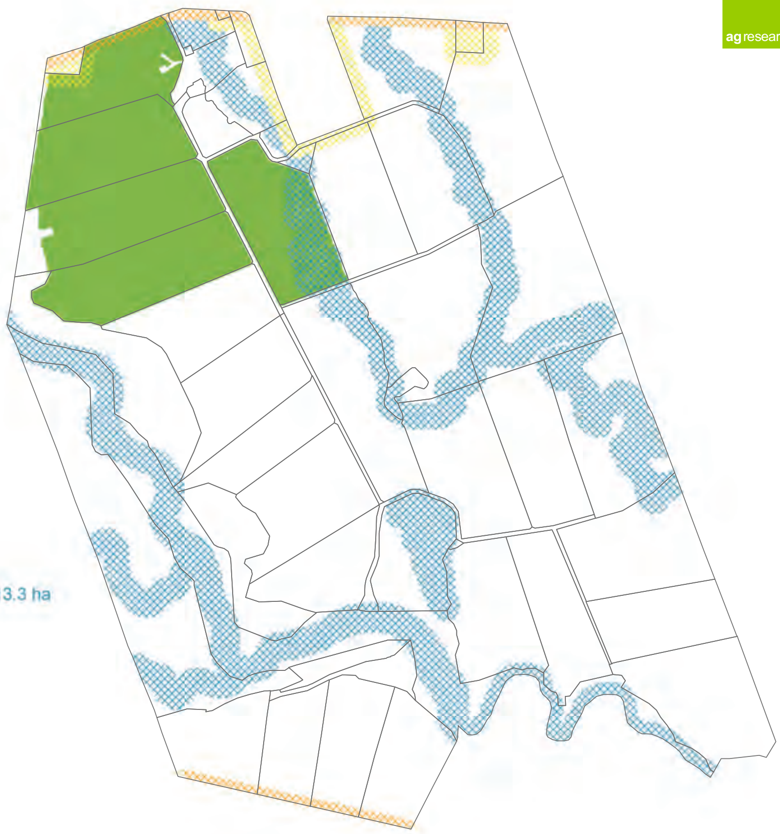
Objective 9: Initiate a new dump site within a permissible area as soon as possible, beginning with the application of a resource consent before December 2007.

6.3.5 Availability of trough water in all paddocks

Two troughs will be required in the western K-Road paddock if all streams are to be fenced.

Objective 10: Install two troughs in the western K-Road paddock before 2011.

EFFLUENT APPLICATION AREAS



ONE PLAN separation distances

No discharges of dairy effluent permitted within 20 m of a public road.

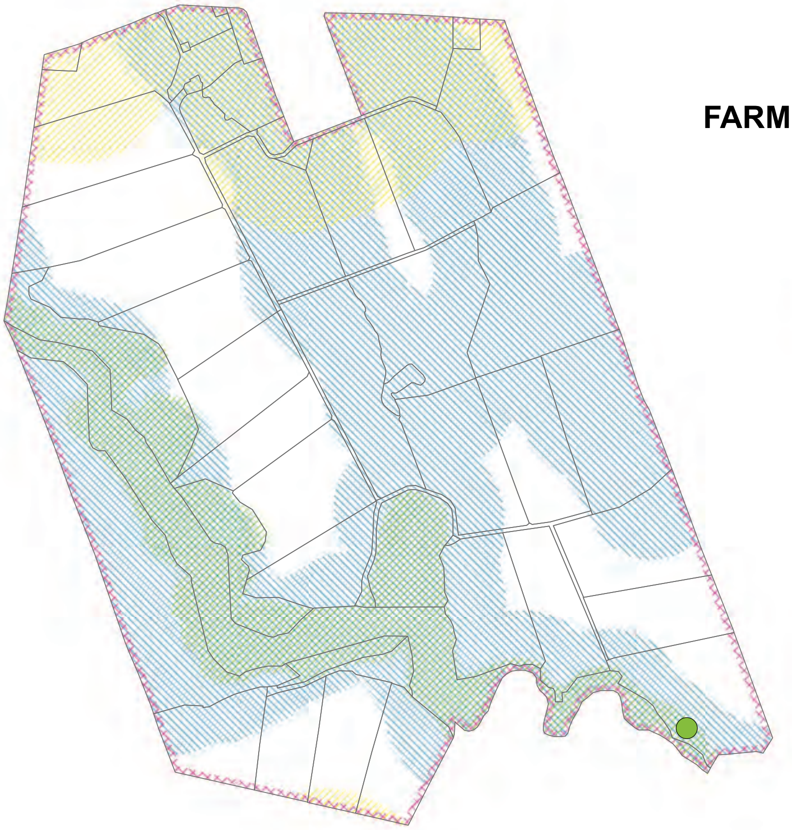
No discharges of dairy effluent permitted within 20 m of residences, marae, schools, public buildings and public recreation areas.

No discharges of dairy effluent permitted within 20 m of bores or surface water bodies.

Existing effluent application area

Existing effluent application block (14.9ha).
Restricted proportion = 1.6 ha (11%).
Actual 'effective' area of effluent application block = 13.3 ha

FARM DUMPS & OFFAL HOLES



ONE PLAN separation distances

No farm dump or offal hole is permitted within 10 m of the property boundary.

No farm dump or offal hole is permitted within 150 m of residences, marae, schools, public buildings and public recreation areas.

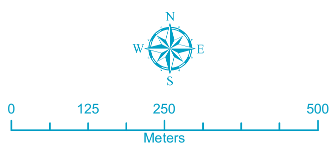
No farm dump or offal hole is permitted within 10 m of the first floodplain terrace of rivers*.

No farm dump or offal hole is permitted within 100 m of bores or surface water bodies.

** Presumably the One Plan specification is also meant to include the flood plain itself.*

Active farm disposal sites

Farm dump



The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

AREAS WITH RESTRICTIONS

John & Debbie Barrow

Maharahara Road, Dannevirke

Separation distances taken from Rule 13x of the One Plan. Note that specifications have been reworded for clarity, and as such, only apply to the Barrow farm. Does not include all specifications for effluent recycling/disposal, farm dumps, or offal holes. Please refer to the One Plan for full specifications. Location of relevant features are shown on the Property Map (page 5).

6.3.6 Fencing streams

Currently 3.2 km of waterway should be fenced as a requirement of both the Clean Streams Accord and the One Plan. Given that several developments will be directed in the western K-Road paddock (bridge, trough, culverts), then there may be some advantage in starting the stream fencing programme on this block.

Objective 11: Achieve Clean Streams Accord and One Plan requirements by fencing waterways with an electrified two-wire waratah fencing system before 2012.

11a: Erect 800m of fencing around western K-Road streams during the 2007/2008 season (~400m of stream) and plant with preferred riparian species.

11b, 11c, 11d, 11e: Aim to erect 1.3km, 0.9km, 1.5km, and 1.3km of fencing over four years (2008-2012) to achieve the Clean Streams target.

6.3.7 Bridging the Oruakeretaki Stream

Ford access to 14ha of grazing across the Oruakeretaki Stream does not currently comply with the One Plan. Continued stock crossing requires the construction of bridge.

Objective 12: Achieve One Plan requirements before 2011 by installing a stock bridge across the Oruakeretaki Stream.

12a: Initiate the resource consent process early to find out if a bridge will be permitted within current cost estimates. Aim to submit a consent application before December 2007.

12b: Aim to construct the bridge during the 2009/2010 season.

6.3.8 Effluent storage and storm water runoff

The effluent storage system does not comply with One Plan requirements because it has overflowed during winter and directly discharged to water. Subsurface water recharge is a suspected cause. Further, rain water from half the milking shed roof (~80m^2) flows onto yard and into the holding ponds. This rates as non-compliant under the One Plan, and it may also be contributing to effluent pond overflow during winter.

It is recommended that options to minimise subsurface recharge be delayed in favour of: (a) installing guttering on the milking shed, and (b) redirecting storm water from the yard area (~300 m^2) onto land rather than into the holding ponds during winter. Assuming 28% of annual rainfall falls in the winter months (estimated from Dannevirke weather data), then 335 mm (28% of 1200mm) of winter rain on a 380m^2 surface area represents 127 m^3 or 127,000 litres. Installing guttering alone would divert 27 m^3 over the winter period (96 m^3 over the entire year), at an estimated cost of $300.

Objective 13: Evaluate if storm-water diversion will stop holding-pond overflow during winter.

13a: Install guttering on the yard side of the milking shed (with down-pipe discharging to land) before April 2008.

13b: Construct a mechanism to divert storm-water runoff from the yards before April 2008.

13c: If the proposed diversions do not reduce pond overflow risk, then winter application to land is required in the short term, and further investigation for a more permanent solution is required over the longer term.

6.3.9 Existing consents

Requirements for existing resource consents are not covered here, other than recognising that the conditions should be adhered to alongside the objectives recommended in this report. However, the two water-take consents are due for renewal in 2008. It is highly important to reapply for these consents at least 6-months prior to expiry dates **to ensure 'existing use rights' are retained**.

Objective 14: Continue to observe conditions set by the three existing resource consents.

Objective 15: Apply for renewal of the two existing *surface water take* resource consents six-months before each expiry date.

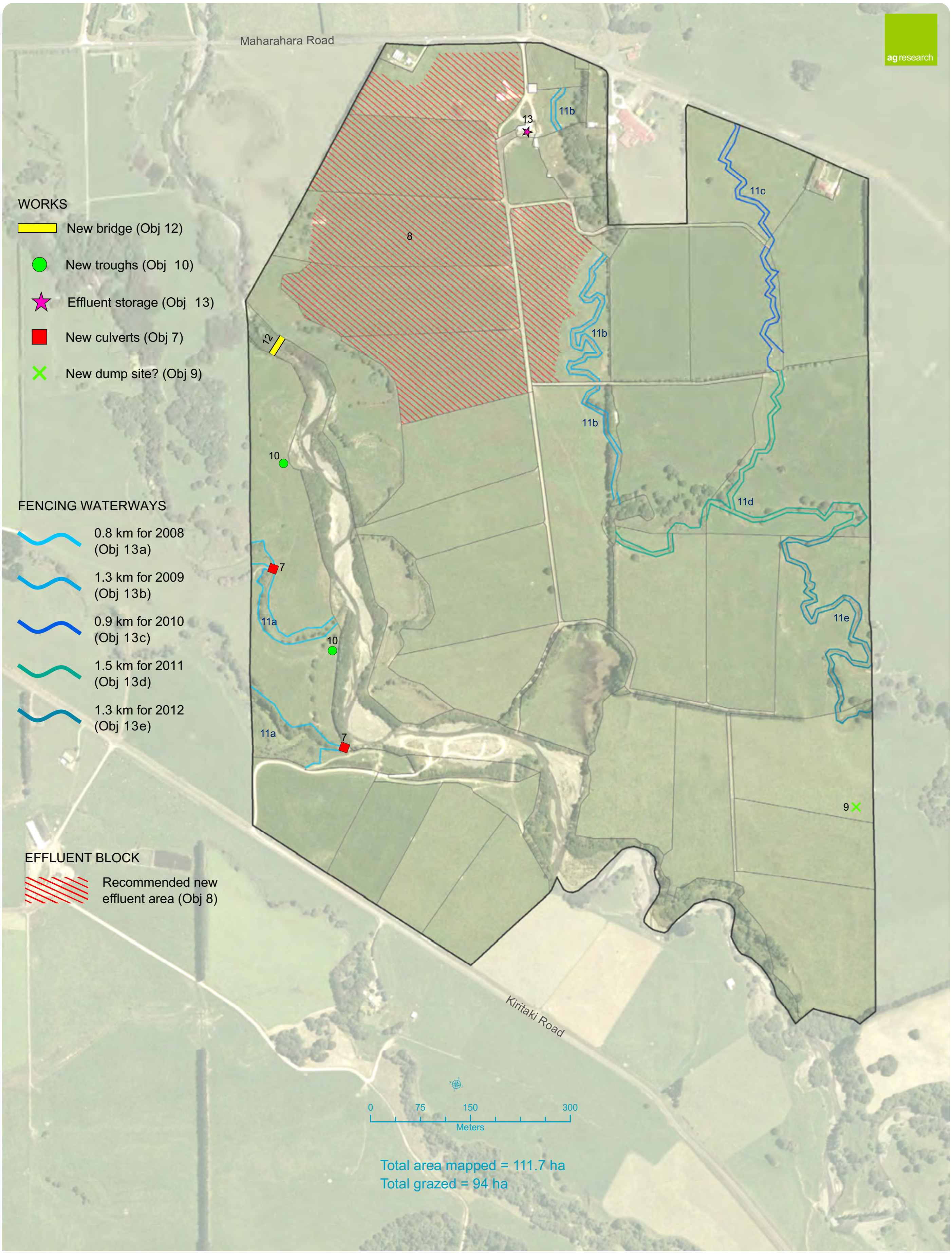
15a: Submit a reapplication for the Oruakeretaki Stream take BEFORE **24th August 2007**.

15b: Submit reapplication for the Mangapuka-Kakahu Stream take BEFORE **June 17th 2008**.

TABLE 10: Five-year strategy for compliance with One Plan requirements

OBJECTIVES	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Maintain existing mitigations					
1. Maintain urease treated urea use*	200 kg N/ha/yr*	200 kg N/ha/yr*	200 kg N/ha/yr*	200 kg N/ha/yr*	200 kg N/ha/yr*
2. Continue to avoid winter applications of N-fertiliser	-	-	-	-	-
3. Continue N-inhibitor spraying*	Spray May & August, within 7 days of grazing*	Spray May & August, within 7 days of grazing*	Spray May & August, within 7 days of grazing*	Spray May & August, within 7 days of grazing*	Spray May & August, within 7 days of grazing*
4. Maintain current policies for stock, feeding & fertiliser*	→	→	→	→	→
Operate within N-loss targets					
5. Reduce N-loss by 0.2 kg N/ha/yr by fencing all streams that qualify under the Clean Streams Accord	*See objective 11*				
6. Reduce N-los by 0.6 kg N/ha/yr by installing a bridge over the Oruakeretaki Stream	*See objective 12*				
7. Install two culverts in western K-Road paddock			Purchase x2 H-type culverts.	Install culverts	
Effluent area and N-loading					
8. Expand the effluent application area	Start including the extra paddock in the effluent application round.	→	→	→	→
Farm dump					
9. Initiate a new dump site within permitted zones	Close existing dump. Apply for resource consent. Construct new dump site.	Manage pests	Manage pests	Manage pests	Manage pests
Availability of trough water in all paddocks					
10. Ensure trough water in all (future) paddocks	Purchase x2 troughs & 6 coils of 32mm pipe. Install in the same year.				
Fencing streams					
11. Exclude stock from waterways by fencing streams	800m fencing (11a) in western K-Road paddock.	1.3km fencing (11b)	900m fencing (11c)	1.5km fencing (11d)	1.3km fencing (11e)
Bridging the Oruakeretaki Stream					
12. Install a bridge over the Oruakeretaki Stream	Initiate the resource consent process.	Look to purchase main materials.	Look to purchase main materials.	Construct bridge	
Effluent storage and storm water runoff					
13. Evaluate options to minimise risk of pond overflow during winter	Install guttering on the yard side of milking parlour & discharge to land. Divert winter storm water runoff from yards onto land.	If winter overflow continues, evaluate sealing ponds with clay or synthetic liner.			
Existing consents					
14. Continue to observe conditions under existing consents	→	→	→	→	→
15. Reapply for surface water take consents	Reapply for surface water takes before 24/08/07 and 17/06/08				

* Objectives depend on maintaining existing farm management strategies. Any substantial change in stock policy, feeding policy, irrigation, inhibitor application, or N-use will require a reassessment of farm N-loss against N-targets (i.e. a new nutrient budget).



The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

REQUIRED WORKS

John & Debbie Barrow

Maharahara Road, Dannevirke

Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

6.4 Summary of compliance cost estimates

6.4.1 Direct costs

Cost estimates are generated from local prices at time of writing (Aug 2007) and are therefore subject to change. Most have been compiled through John Simmonds from DairyTeam and David Veale from Wai Waste Environmental Consultants (cost estimate for the bridge). Full cost could not be established in all cases (particularly secondary costs), and it is likely that a canny farmer could make substantial savings (cost of services is based on contract rates).

Several requirements and recommendations made in this report will carry a low or nil cost (e.g. enlarging the effluent area), or may even represent a saving.

Total cost to become compliant with the One Plan in 2011 is estimated at $99,100 (Table 10). Constructing a bridge represents the most significant cost at $73,000. Achieving Clean Streams obligations would cost $24,000 (fencing streams, troughs, culverts, pond overflow).

Table 10: Direct costs 2011

Install x2 culverts (obj 7)	$4,400
Relocate farm dump (obj 9)	$1,500
Install x2 troughs (obj 10)	$2,500
Fencing streams (obj 11)	$17,400
Bridge (obj 12)	$73,000
Pond overflow (obj 13)	$300
TOTAL	**$99,100**

6.4.2 Revenue implications

Most of the recommended mitigations will have little impact on revenue earnings. The exception is fencing waterways, which represents a loss of production land. Approximately 0.5 ha of grazing would be removed, which represents a loss of 520kg MS/year, or one whole cow dropped from the milking herd. Financially, **revenue would be decreased by $2,860 each year, for every year** (at $5.50/kg MS). At $6.40/kg MS the loss would be $3330 annually.

6.5 Longer term costs and implications

It is difficult, and perhaps even irresponsible, to predict the cost and revenue implications of farming within N-targets over long timeframes. While a recommendation has been made to consider off-farm wintering as a mitigation out to 2031, long term costs and implications cannot be estimated with any hint of confidence. At the time of writing, winter grazing appears to be an attractive mitigation, but in 10 or 20 years it may be a completely unviable option.

6.6 Other considerations

6.5.1 Monitoring and recording

Recording and reporting irrigation particulars is already a condition of the Surface Water Take consents. Monitoring and recording urea use (where, when & how much) and effluent application (when, how much, nutrient analysis) is also recommended. While this monitoring/recording is not required, the information it provides is invaluable for future nutrient budgets, efficient use of water, optimal use of effluent nutrient, and minimisation of N-leaching risk from the effluent block.

6.5.2 Whole farm consent

At the time of writing the idea of 'whole of farm consents' was still being developed.

6.5.3 Council assistance

Fencing and planting waterways will be eligible for consideration of an environmental grant from Horizons Regional Council. Grants are available for enhancing 'water quality by retiring and planting stream banks'. Costs for fencing, plants and labour are all eligible under the grant scheme. Further, the Barrow farm would likely attract a higher grant rate (30% to 40% of costs) because this FARM Strategy is, for all intensive purposes, an 'environmental farm plan'. Contact for a local HRC representative is provided at the end of this section.

6.5.4 Follow up

Contacts for follow-up and further information include your Horizons Regional Council representative, and the farm business development consultant involved in this project

Grant McLaren
Horizons Regional Council
Corner Vogel & Tay Streets
Woodville
Phone 06 9522 800
Mobile 021 227 7107
Email: grant.mclaren@horizons.govt.nz

horizons regional council

John Simmons
DairyTeam Consultant
348A Ruahine St
Palmerston North
Ph/fax 06 3533598
Mobile 0274 519 456
Email: john.s@dairyteam.co.nz

DairyTeam

APPENDIX 1: BRIDGE ESTIMATE

Cost estimate for constructing a bridge to span the Oruakeretaki Stream. Compiled by David Veale, engineering consultant, Wai Waste Environmental Consultants Ltd., P.O. Box 73, Dannevirke, (06) 374 8592, Mobile 027 3111 938.

Cost Estimate for Farm Bridge based on a single span of 13 meters (ie 2 x 44' railway carriage as superstructure)

Item	*Description*	*Unit*	*Rate*	*Quantity*	*Total*
1.0	Resource Consent Application (Horizons)	LS			$2,500
				Sub Total	**$2,500**
2.0	Test Drive Piles	LS			$1,000
2.1	Bridge Design	LS			$3,000
2.2	Purchase of Railway Wagons (if available)	Ea	$5,000	2	$10,000
2.3	Purchase Piles (2x6x8m)	Per m	$30	96	$2,880
2.4	Transport Materials to Site	LS			$2,500
2.5	Drive Piles	Ea	$150	12	$1,800
2.6	Concrete Abutments	m^3	$1,000	20	$20,000
2.7	Decking Materials (400x200x5mx13m)	Per m	$10	325	$3,250
2.8	Side Rails & Post Materials	LS			$1,000
2.9	Place Superstructure	LS			$1,500
2.10	Secure Superstructure	LS			$5,000
2.11	Plant and Labour	LS			$7,000
				Sub Total	**$58,930**
3.0	River Protection Works	LS			$2,000
				Sub Total	**$2,000**
	Total Estimate of Works				$63,430
	+ 15% Contingency				$9,515
				Total Estimate for Works	**$72,945**

Notes:
It is difficult to place an accurate estimate on a farm bridge of this type without a detailed design to work to. This cost estimate is on the basis of the farm bridge being constructed to a high safe standard that is insurable. Some farmers will believe that they can construct a bridge far cheaper than this, however safety should not be jeopardised by cost savings. The design component is slightly higher to allow for the increased work around establishing the safe working load for this type of bridge.
Some assumptions have been made around the depth piles would need to be driven and also the height of the bridge above water level, all of which would need to be confirmed from detailed site investigations and design phase.
This cost estimate is for a single span farm bridge, if multiple spans are required all costs will increase.

Other Cost Estimates

Emmetts
If landowners are wanting to use the bridge for heavy vehicles they may have to look towards an Emmett type bridge. A single span Emmett's bridge for the above (i.e. single span of 13 metres) would likely cost between $90,000 - $125,000 depending on site specific conditions, and excluding resource consent costs.

Te Rimu Station
Following the February 2004 flood event Te Rimu Station replaced two bridges each with a span of 22m. The bridges were constructed of concrete abutments, a second hand crane gantry for the superstructure, wooden decking and side rails. Both these bridges cost on average $100,000.

APPENDIX 2: RIPARIAN CONSIDERATIONS

Practical concern was expressed over the fencing of streams. Current stock access helps control the proliferation of waterweed, associated sediment build-up, and the risk of culvert 'blow out' when clumps of weed/sediment become dislodged during flooding and dam culvert entrances. Planting with riparian species would eventually minimise these problems through shading the slower flowing portions of the streams. However, from previous experience, the gravel rock types characterising the Barrow farm do not reliably support larger woody species, which in the past have caused bank collapse, damming, and stream diversion (all of which incur a substantial clean up cost). Chris Phillips, a senior scientist at Landcare Research, was approached for advice. We gratefully acknowledge the recommendations and suggestions he provided.

Species for riparian zone 1: Lower areas immediately adjacent to the stream, particularly the marshy areas

- Sedges such as *Carex secta* (known as Pukio or niggerhead), *Carex virgata* (Swamp sedge), or more grazing-tolerant species like *Carex maorica* or *Carex geminate* (Cutty grass, rautahi).
- Any type of rushes such as *Juncus pallidus* (Giant rush).
- Perhaps some flaxes, but a smaller species like *Phormium cookianum* (Mountain flax) rather than *Phormium tenax* (common flax).

Species for riparian zone 2: Higher banks with freer draining soils

- Any type of flax such as *Phormium cookianum* (Mountain flax) or *Phormium tenax* (common flax).
- Liberal plantings of *Cortaderia richardii* (toe toe).
- Perhaps some *Anemathele lessoniana* (Wind grass, Gossamer grass) to add a degree of diversity (a big clumped grass that grows to about the same dimensions as toe toe).
- A few occasional Cabbage trees (Cordyline australis) to add a bit more interest.

Purchase price of native riparian species can be quite high (some publications have cited costs of $10,000 to $20,000 per hectare planting costs). Wholesale prices are available from nurseries such as Matatoa Trees and Shrubs (P.O.Box 31, Engles Road. Shannon, 06 362-7477). On that note it would be well worth investigating the Environmental Grants offered by Horizons Regional Council (see previous Section 6.5.3), or perhaps even considering growing your own. Native seeds are low cost (see www.nzseeds.co.nz), and most of the recommended species can be propagated from 'cuttings' of a primary parent plant.

Mature sedges providing shading and riparian habitat. Photo provided by Chris Phillips, Landcare Research.

Sedges and Giant rushes with a few toe toe and flax in the background. Picture supplied by Stephen Moore and Chris Phillips, Landcare Research.

APPENDIX 3: INFORMATION CHECK

Assessment of current N-loss through Overseer Nutrient Budgets can only be as robust as the information used in the model. This appendix is provided as an assurance that the best information available was used for the Barrow property at the time of assessment. Most information collected by farmer interview and a review of accounts by the farm consultant. Fertiliser receipts have been sighted. For this particular farm, set up of the Overseer model has been assessed by Massey University scientists.

Production inputs

- 250 FxJ cows (peak) producing 100,000kg MS/yr.
- 50 replacements grazed off at weaning.
- Main herd is wintered on-farm.
- 54 tonne (dry weight) of good quality pasture hay sourced off-farm and feed out during the winter months (all paddocks).

Effluent management

- Two pond system + land application (14.9 ha).
- Effluent mechanically stirred. No sludge is applied to land.

Resource information

- Farm located 57 km from coast.
- Annual rainfall is 1,200mm (supplied by Horizons Regional Council).
- All blocks are classed as FLAT according to Overseer topography categories.

Block	Ha	Soil	Soil test results May 2007							
			Olsen P	Qt K	OrS	TBK	Qt Ca	Qt Mg	Qt Na	PR
Back block	22.7	Well drained Ashhurst silt loam	22	6	15	0.7	13	30	4	48 %
House block	19.5	Well drained Ashhurst silt loam	40	8	18	0.7	11	35	5	78 %
K-Road (irrigated)	8.3	Imperfectly drained Ohakea silt loam	22	10	15	0.8	14	25	6	50 %
No fertiliser block[1]	1.0	Well drained Ashhurst silt loam	30.6	12.6	10.8	0.7	10.8	27.9	4.5	48 %
Top river block	15.1	Well drained Ashhurst silt loam	34	14	12	0.7	12	31	5	55 %
Bottom river block[2]	6.2	Mod.well drained Rangitikei sandy loam	34	14	12	0.7	12	31	5	8 %
Hay shed block	14.9	Imperfectly drained Ohakea silt loam	53	12	12	0.7	11	29	5	48 %
K-Road (no irrigation)[3]	5.7	Well drained Ashhurst silt loam	22	10	15	0.8	14	25	6	50 %
Shed block no effluent or irrigation[4]	0.6	Well drained Ashhurst silt loam	34	14	12	0.7	12	31	5	55 %
Trees & non grazeable	17.9									

[1] No soil test information available. Assumed values from Top River Block less 10% (to account for nil fertiliser).
[2] No soil test information available. Assumed values from Top River Block. Phosphate Retention (PR) set at the Overseer default for Recent soils.
[3] No soil test information available. Assumed values from K-Road (irrigated) Block.
[4] No soil test information available. Assumed values from Top River Block.

Nitrogen fertiliser and inhibitors

- 200 kg N/ha/yr as Quinphos Sustain urea over all fertilised blocks (93ha).
- No winter application of urea (May, June, July).
- 52 ha is fertigated with urea through the irrigation system. This was not modelled through Overseer.

Pasture management & irrigation

- Assumed DEVELOPED status (extensive sowing of tetraploid ryegrasses).
- Pasture utilisation estimated at 80% based on local information.
- Clover levels set to MEDIUM as a long term representation of clover status.
- 80.5ha is irrigated for approximately 14 weeks during the warmer months at a calculated rate of 350mm per year. Includes K-Line and travelling irrigators.
- Blocks not irrigated include the Shed Block, K-Road (non-irrigated), Bottom River and the No Fert Block..

Other fertiliser inputs

- 4 tn 'CLOVER KING LS/MS' for Hayshed Block.
- 41tn 'CLOVER KING LS/MS & 7K' for rest of the farm.
- Applied by ground spreader in late spring (Oct & Nov) and early autumn (Mar & April). Phosphorus applied as RPR.

Fertiliser nutrient applied (kg nutrient/ha/yr)							
Area (ha)	N	P	K	SO_4-S	E-S	Ca	Mg
Whole farm	0.0	55.9	35.2	33.6	28.1	149.6	3.9
Hayshed Block	0.0	32.9	0.0	20.4	16.9	88.6	2.3

Assurance statement:

To the best of our knowledge, the information provided above is true and correct at the time the Overseer analysis was undertaken (October 2007).

Farm owner, operator or manager

Name: John Barrow

Date:

Signed:

Nutrient management consultant

Name: Andrew Manderson

Date:

Signed:

ACKNOWLEDGEMENTS

Key people involved in the preparation of this report include:

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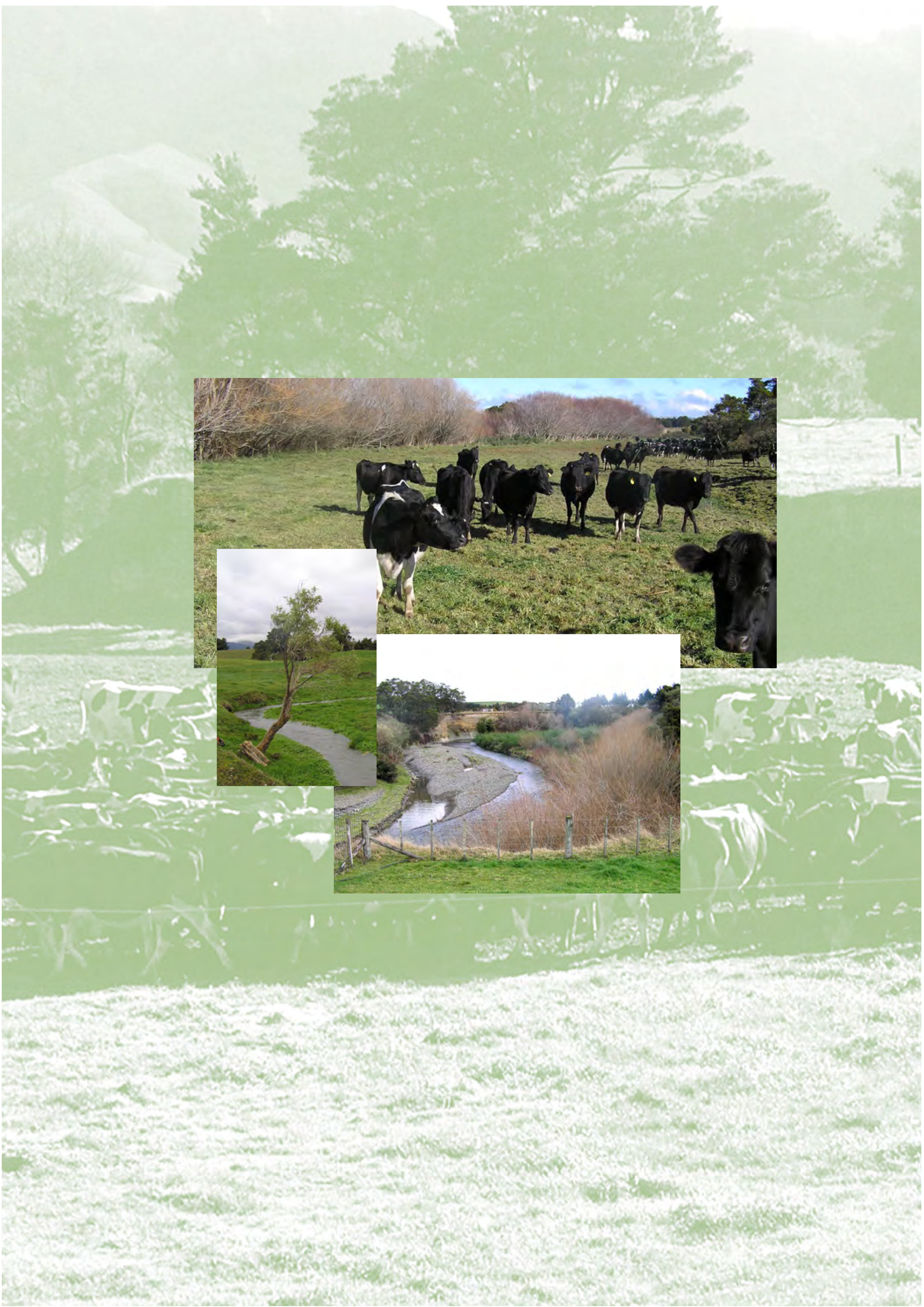
Massey University

FARMS

farmer applied
resource mgt
strategies



7.16 CASE STUDY 2 REPORT (HUKANUI DAIRY FARM, RAINFED)

26 kg N/ha/yr Glenbrook Farm N-loss (2007)

20 kg N/ha/yr N-loss target 2010

16 kg N/ha/yr N-loss target 2030

RESOURCE MANAGEMENT STRATEGY

Glenbrook Farm
Hukanui Road, Eketahuna

FARMS
farmer applied resource mgt strategies

Reference: FARMS/2007/RMS#002
Catchment: Mana_8b
Prepared by: AgResearch Ltd.
Date: 10/07/06

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BACKGROUND

THE ONE PLAN & RULE 13*x*: At present eleven important catchments in the Manawatu-Wanganui Region have nutrient levels far in excess of what is desirable. To help address this issue Horizons have proposed a Rule in the One Plan that aims to lessen the nutrient-impact from activities associated with intensive farming. Resource consents concerning irrigation takes, fertiliser, stock feed, biosolids, soil conditioners, dumps, offal holes, and effluent, will be necessary for dairy farming, cropping, market gardening, and intensive sheep and beef farming. The Rule will come into effect at different times for each of the eleven catchments.

ONE FARM; ONE CONSENT: A new consent process will be available under the One Plan. The traditional approach of having several separate consents for a farm is replaced with a single whole-farm consent. This means only one consent – not many – is needed for the entire farm. This promises to make the process simpler, quicker and considerably less expensive. A *FARM Strategy* is a necessary prerequisite for a whole-farm consent.

FARM STRATEGY: A FARM Strategy (Farmer Applied Resource Management Strategy) represents an assessment of permitted and controlled activities for a farm, and a strategic plan to ensure those activities comply with One Plan specifications and water quality targets. It combines a nutrient budget, a comparision of farm nutrient-loss against catchment water-quality targets, an evaluation and recommendation of mitigation options (if the farm is operating outside of catchment water-quality targets) including cost and effectiveness, an assessment of eligibility for relevant consents, and a farm plan of works that spells out the where, when and how much of achieving sustainable land use within the given catchment of interest.

This report summarises an exploratory FARM Strategy for Glenbrook Farm; a 188 ha dairy property located at near Hukanui settlement. The farm is situated within the Middle Mangatainoka sub zone (Mana_8b) of the larger Mangatainoka Water Management Zone (Mana_8), which in turn is part of the Manawatu Catchment. Rule 13x is due to come into effect on the 1st April 2010 for the Mangatainoka WM Zone. Glenbrook Farm represents the second application of the FARM Strategy framework.

1.0 PLAN SUMMARY

- **Purpose:** Purpose is to identify how Glenbrook Farm can remain compliant under Rule 13*x* of the proposed One Plan. Emphasis is on identifying best options that achieve requirements without placing unnecessary strain on farm performance.

- **Farm overview:** A 188 ha (166 ha effective) seasonal-supply dairy farm growing 9,500 kg pasture DM/ha/yr and milking 368 predominantly Friesian cows (2.22 cows/grazed hectare) and producing ~830 kg MS/ha/yr under a 50:50 sharemilking agreement. Production performance is above average. Topography is mostly flat with stony shallow soils located in the former Mangahao River bed (80 ha), bordered by various terraces with Kopua silt loam soils (108 ha). Average rainfall is 1865 mm.

- **Clean Streams Accord:** 4.5 km of farm waterways qualify under the Accord. Cows are excluded from 1.4 km, leaving 3.1 km of meandering streams that need stock exclusion. An unusually low discharge permission (9m^3 effluent per day) is considerably lower than the farm's current rate of discharge (124 m^3 effluent/day via the siphon-tube application system). Consequently, under the farm's current consent condition, the effluent-application-to-land system requires attention to be compliant with the Accord.

- **Nutrient loss and water quality:** Nutrient loss calculated using the Overseer Nutrient Budget model and ancillary calculations for direct deposition of excreta to waterways and effluent discharge losses. **Current N-loss is calculated at 26 kg N/ha/yr**.

- **Permissible N-loss: Permissible N-loss is calculated at 20 kg N/ha/yr for the first year (2010)**, and becomes gradually tighter over the 20-yr implementation period (permissible N-loss by 2030 is 16 kg N/ha/yr). Compared with current N-loss (26 kg N/ha/yr), **a reduction of 6 kg N/ha/yr is necessary for the farm to achieve catchment water quality targets for 2010.**

- **Mitigations evaluation:** A wide range of mitigation options were assessed and rated in terms of relevance to the farming operation. Highly relevant options were evaluated further to identify likely effectiveness, cost, and future impact on farm revenue.

Option	N & bug effectiveness	Cost	Practicality	Suitability
N-inhibitors	N-loss ↓ **5kg N/ha/yr**	Only 6% yield response needed to break even; potentially considerably more profitable	High	✓✓✓
Reduce urea 10%	N-loss ↓ **1kg N/ha/yr**	Modelled $22,750 reduction in gross revenue	Low	×
Reduce cows, supplement & urea scenario	N-loss ↓ **1kg N/ha/yr** & bug risk↓	Potentially +$50,000 in gross revenue but requires development investment (drainage, etc.)	Medium	✓✓
Fence waterways	Bug risk↓ & N-loss ↓ **0.2kg N/ha/yr**	$11,200 cost and $6,400/yr lost revenue (gross)	Low	✓
Planted riparian buffers	Bug risk↓ & N-loss risk↓	$20,500-$23,700 cost and $33,800 to $42,300/yr lost gross revenue depending on buffer width (10-30m).	Extremely low	×
Travelling irrigator effluent system	Bug risk↓ & N-loss ↓ **1.6 kg N/ha/yr on average** (highly variable)	$31,500 cost (but would require pond capacity to double to be compliant) and requires high labour cost	Medium	✓✓
Larall effluent system	Bug risk↓ & N-loss ↓ **2.6 kg N/ha/yr**	$49,360 cost (maybe less depending on pasture yield increases) but low labour costs	High	✓✓✓
Wetland effluent system	Bug risk↓ & N-loss ↓ **0.9 kg N/ha/yr**	$15,000 cost	Low	×

✓ *Non-negotiable. Required under Clean Streams Accord and/or One Plan.*

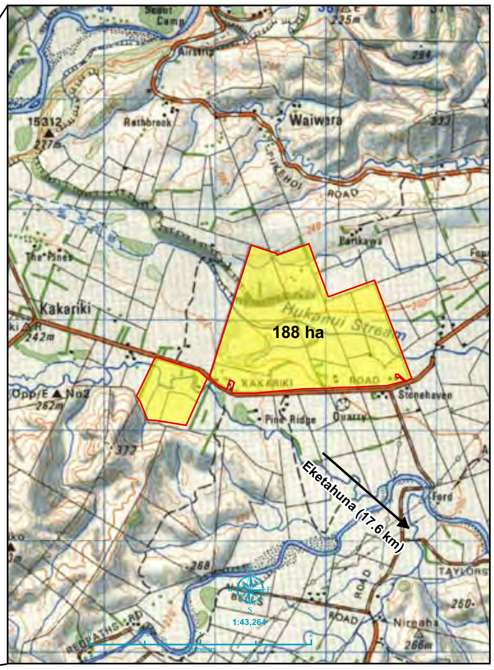
- **Mitigations to achieve 2010 N-targets**: A reduction of 6 kg N/ha/yr is required before 2010. Fencing waterways and a shift to a more effective effluent application system is estimated to reduce N-loss by 3 kg N/ha/yr. Both are required under the Clean Streams Accord. Further N-reductions could readily be achieved by switching to a urease-urea product and adopting nitrification inhibitors. Fencing waterways, upgrading the effluent application system, and using N inhibitors would not only achieve the 2010 N-target, but it would likely put it in credit by 2 kg N/ha/yr. These and other mitigations, plus advances in technology, mean longer term targets (2030) are similarly achievable.

- **Cost of achieving N-targets**: Estimated cost of fencing waterways ($11,200) and upgrading the effluent application to the Larall system ($49,360) could both be considered as existing compliance costs under current obligations (resource consent + Clean Streams Accord). Combined cost of fencing waterways and upgrading effluent application is $60,560. Adopting N-inhibitors ($53,240 cost) is likely to result in a net return to offset any cost at a modest 6% pasture response (i.e. +$53,240 return). A 7.2% response would easily offset any lost production associated with fencing off waterways (equivalent to+$6,400). Even higher pasture responses from N-inhibitors could be expected. In short, depending on your viewpoint, achieving One Plan 2010 N-targets will either cost nothing, or it will cost upwards of $60,560.

- **Other One Plan requirements:** Other considerations requiring attention under the One Plan include: redirecting stormwater discharge from part of the milking shed roof away from the effluent ponds and onto land ($500 cost); installing 3 additional culverts ($1,050 cost); and enlarging the effluent application area to 20 hectares. Combined cost of these requirements is $1,560.

- **Full compliance cost: Total cost of achieving One Plan requirements and N-loss targets (irrespective of what obligation they fall under) is estimated at $62,120**.

- **Compliance strategy:** Recommendations to achieve full compliance are made as 13 specific objectives for successive implementation over a five-year period. Any appreciable change in stock policy, feeding policy, or fertiliser will require a reassessment of farm N-loss against N-targets (i.e. a new nutrient budget).



This property is located 17.6 km north east of Eketahuna township.

(Distances calculated by road between farm boundary edge and town centre).

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

FARM LOCATION & ACCESS

Glenbrook Farm, Hukanui Road, Eketahuna

Prepared for Horizons Regional Council by AgResearch Ltd, as part of the FARMS initiative.
September 2007.

agresearch

ID	LEGAL DESCRIPTION	AREA
1	WN26D/607, LOT 1 DP 55781	26.273 ha
2	WN46A/61, SECT 160 Blk I Mangaone Survey District	32.6767 ha
3	WN25A/134, SECT 161 Blk I Mangaone Survey District	48.5623 ha
4	WN89/198, SECT 110 Blk I Mangaone Survey District	40.6557 ha
5	Pt SECT 111, Blk I Mangaone Survey District	40.014 ha
		188.1817 ha*

* The precision and accuracy of legal land parcels for rural areas can contain appreciable errors. However, for this farm, the legal area (188.2 ha) is very similar to the area obtained by physical mapping (188.0 ha).

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LEGAL TITLES AND PARCELS

Glenbrook Farm, Hukanui Road, Eketahuna

Prepared for Horizons Regional Council by AgResearch Ltd, as part of the FARMS initiative.
July 2007.

agresearch

2.0 FARM DESCRIPTION

2.1 Existing farm business

2.1.1 The physical resource

- The farm is located near Hukanui settlement 17.6 km north east of Eketahuna township. This places it within the One Plan's *Middle Mangatainoka subzone* (**Mana_8b**) of the *Mangatainoka Water Management Zone* (**Mana_8**). These are priority-targeted catchments for nutrient management.
- Geologically the farm encompasses part of the former Mangahao River bed (80 ha) and the Hukanui Aggregation Surface (108 ha). This attributes the farm with shallow bouldery soils on the former river bed with a high water table, which grade up through stoney Kopua silt loam soils on the lower terraces, and through to deep Kopua silt loams on the mid and upper terrace systems. Topography is mostly flat to gently undulating, although there are several areas of steep terrace scarps. Lowest point above sea level is 195 m and highest point is 265 m.
- Total length of <u>perennial streams</u> is estimated at 4.5 km. This includes the Hukanui Stream (1.8 km), Mangaraupiu Stream (1.1km), and significant feeder streams (1.6 km). The former river bed has a high water table flowing through gravels and stones, which means flow-pathways can be just above or below the surface (or a combination of both). This report includes all flowing surface water within the definition of stream (even though the 'stream' may either emerge from, or disappear into, the gravels). Two small and shallow lakes have also been constructed by damming the Hukanui Stream.
- Annual rainfall is 1865 mm (supplied by Horizons) although proximity to the Tararua Ranges (< 4km) causes a steep rainfall gradient across the farm (435 mm apparent difference between the eastern and western ends of the farm).
- Total area of the property has been mapped at **188 ha** with an estimated **166 ha** in pasture (all non-pastoral vegetation mapped out at a high level of detail – see property map over the page). This is considerably less than the 125 hectares effective currently used for farm calculations (several low-producing paddocks are excluded). This report considers all pastoral land as effective even though it may vary in productivity.

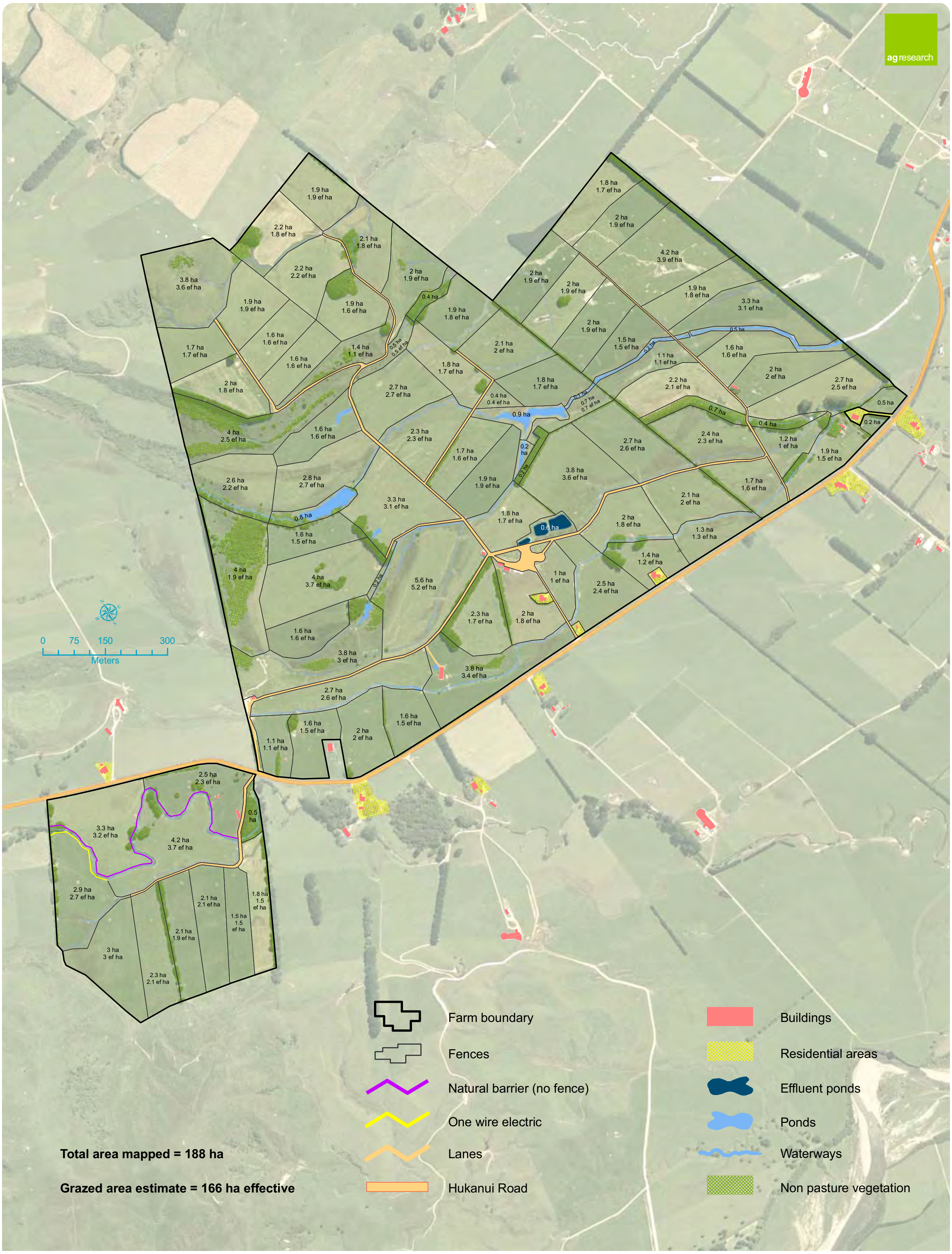
2.1.2 Infrastructure

- The property has 5.5 km of laneways most of which are separately fenced and have a crushed lime surface.
- Farm buildings, yards and other structures are in good serviceable condition. The milking shed is a modern 35-aside herringbone shed with a large capacity yard.
- The farm is well subdivided with 63 paddocks in the milking round and six paddocks that are intermittently grazed (or not at all) because of bush, swampiness, or very stony poor producing land. Average paddock size is generally around 2-3 ha. Total length of fencing for the farm is **41 km** (boundary fencing = 8.0 km, internal fencing = 32.8 km).

2.1.3 Farm system

- Farm ownership is under a partnership between A & E Billington and M & P Gleeson. Farm operation is under a 50:50 sharemilking agreement between the owners and B & M Webb.
- Seasonal supply dairy-farming system running 368 predominantly Friesian cows and producing between 113,000 to 138,000 kg of milksolids (680-830 kg MS ha^{-1} yr^{-1}). Stocking rate for the nutrient budget is 2.22 cows per grazed hectare.
- All replacement young stock grazed off-farm from weaning (late Nov), until calving (late July). Surplus calves sold at 4 days old in August-September, and cull cows sold throughout late Feb to late May. Herd losses during winter are generally less than 4%.

Cattle	2005 (as a representative year)
Breed	Friesian
Live weight	490 kg
Peak numbers milked	368 cows
Replacements	92 heifers
Wintered on farm	All cows and heifers grazed off
Stocking Rate	2.22 cows/ha



FARMS

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PROPERTY MAP

Glenbrook Farm

Hukanui Road, Eketahuna

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

2.1.3 Farm system (continued)

- Dairy shed effluent is managed through a two-pond system with an additional receiving pond (total effluent holding capacity ~3835 m^3). Treated effluent is applied to land through a 75mm siphon pipe. Discharge to land from the siphon outlet is alternated between two points (generally). Pond sludge is evacuated every two years and spread over the adjacent paddock.
- Average amount of net effluent (excludes sludge) generated each year is estimated at 8,863 m^3 (see Appendix 1). Approximately 25% of the final pond's volume is emptied during a single siphoning event, with an event lasting 3 days. Each event would deliver 373 m^3 over three days or 124 m^3/day. At 373 m^3 it would take 24 siphoning events each year to deliver the full 8863 m^3 of pond effluent to land.

2.1.4 *Clean Streams Accord* and Fonterra's *Effluent Indicator System*

The dairy industry entered into the *Clean Streams Accord* in 2003. Under the Accord, dairy farms are obligated to:

- Exclude cattle from perennial streams deeper than a "Red Band" (ankle depth) and "wider than a stride".
- Ensure farm races include bridges or culverts where stock regularly cross a watercourse.
- Manage dairy effluent appropriately according to regional council specifications.
- Manage nutrients using a nutrient budget.
- Protect regionally important wetlands.

The aim is to have 90 to 100% of dairy farms compliant by year 2012 (only five years away). Fonterra has also recently introduced the *Effluent Indicator System* for the 2007/08 season. Regional councils are invited to notify Fonterra about farmers who are "persistently and critically" non-compliant with effluent management. Failure to remedy non-compliance in the short term may result in payout reductions, or refusal to pick up milk over the longer term (3yrs).

- The farm has 4.5 km of perennial waterways (including two small lakes) that qualify as 'Clean Streams' streams or lakes. Approximately 1.4 km is already protected. The remainder (3.1 km) has no stock exclusion fencing (although part is already fenced on one side). This includes 200 m of one-wire electric along the Mangaraupiu Stream that requires maintenance (a one wire electric will not always exclude young stock, which can carry elevated faecal pathogen burdens). **Total length of waterway that requires attention under the Accord is 3.1 km.**
- The system used to manage dairy effluent is unlikely to be compliant with existing consent conditions. Under the current resource consent daily application is limited to a maximum 9 m^3 of effluent per day, and effluent runoff is not permitted to enter drains or waterways. If a single siphoning event drained 25% of the last pond over three days, then approximately 124 m^3/day would be applied to land (see Appendix 1). To remain compliant the event would need to span a continuous 41 days to achieve a 9 m^3/day application rate. Further, it is highly likely that the rate of discharge from the pipe outlet exceeds soil infiltration capacity, particularly during wet periods, and there was visual evidence of effluent reaching a nearby drain via runoff. **Under current conditions specified in the farm's discharge to land resource consent the system would be considered non-compliant and therefore requires attention under the Accord.**
- The property is well served with culverts. All lanes and access ways are culverted or bridged where they cross waterways.
- The farm has an existing nutrient budget prepared by Terry Roberts of Ravensdown.
- There are several small patches of wetland on the farm, none of which are considered to be of regional importance or significance.

Effluent discharge to land system

Mangaraupiu Stream

2.1.5 Pasture and grazing management

- Grazing rotation of the main herd is 40 days in August to September, 20 days from late October to January/February, and gradually up to 26-30 days in April/May (averages out as a 27 day rotation over the whole season). Heifer replacements are grazed as a separate herd.
- The herd is grazed off farm during winter (mostly on land located in a different water management zone). A proportion of cows will be moved off farm in May, with the majority leaving from mid June until the end of July (~6 weeks). Cows are brought back to the farm proportionally according to calving groups, with later calving cows (50) returning in mid to late August.
- In two of the past four seasons, up to 8 hectares of turnips were grown but yields were poor. Approximately 15 ha of the farm was regrassed over the same period. However, a high proportion of paddocks appear to have lower quality pasture relative to many dairy farms in the district.
- Supplement use for the 2005/06 season included (74 tn DM), hay (23 tn DM), palm kernel (135 tn DM), maize silage (43 tn DM), and *Starch Pro* (10 tn DM).
- Current pasture production is estimated at **9,500 kg DM/ha/yr** using Overseer Nutrient Budgets. At a pasture utilisation rate of 80% (as an average for the entire year), this equates to 7,600 kg DM/ha/yr consumed, which is below the 8,800 kg DM/ha/yr harvested calculated by the Udder simulation model using local pasture growth rates (Mary Lund, Tararua Veterinary Services).
- Pasture production estimate is distributed across the farm (map opposite) using Land Use Capability units (map on page 14) and carrying-capacities for different units reported in LRG (1981). Similarly, potential carrying capacities have been used estimate potential levels of pasture production, if all manageable limitations were overcome (e.g. optimal pH, soil nutrient status, drainage condition, etc.). Upper limit of potential pasture yield is estimated at **13,900 kg DM/ha/yr**. Many generalisations have been made to produce these maps, so they should be used for comparative or indicative purposes only. However, they do suggest that Glenbrook Farm has a degree of scope for increasing annual pasture yield into the future.

2.1.6 Farm performance

- The farm has been benchmarked for the 2005/06 using the Red Sky Farm Performance Analysis system and an effective area of 125 ha. Results on financial indicators were not supplied. Production indicators that could readily be adjusted to the 166 ha effective used in this report are reported in Table 1. Adjustment distorts the comparison so emphasis should be placed on total numbers or performance per cow.
- In general the indicators suggest above average production performance (on a per cow basis). Nitrogen fertiliser use is below average.

Table 1: Adjusted Red Sky farm performance indicators 2005/06

	Glenbrook Farm	Top 10% NZ 50/50	NZ average 50/50	Regional average*
General Production Indicators				
Area (ha) effective	166	120	133	143
Peak cows milked	368	398	394	408
Stocking Rate (cows/ha)	2.2	3.3	3.0	2.9
Total milksolids (kg)	136591	144918	132177	139119
Kg MS/cow	371	364	335	341
Kg MS/ha	823	1208	994	973
Milk fat %	4.67%	5.01%	5.07%	4.86%
Protein %	3.48%	3.77%	3.81%	3.68%
Pasture & supplements				
Pasture harvested (tn DM/yr)	1487.36	1740	1649.2	1558.7
Pasture harvested per cow (tn/cow/yr)	4.0	4.4	4.2	3.8
Pasture harvested per ha (kg DM/ha/yr)	8960	14500	12400	10900
Total N-fertiliser used (tn/yr)	17.4	23.6	21.4	22.2
Kg N applied per kg MS (kg/MS kg)	0.13	0.16	0.16	0.16
Kg N applied per hectare (kg/ha)	105	197	161	155
Pasture cost (cents/MJ ME utilised)**	0.41	0.38	0.45	1.87
Forage cost (cents/MJ ME utilised)**	2.81	1.53	1.72	3.12
Concentrate cost (cents/MJ ME utilised)**	1.56	1.64	2.12	3.22

** Regional = Manawatu Wanganui*
*** Not fully sure if these particular indicators are affected by differences between effective area*

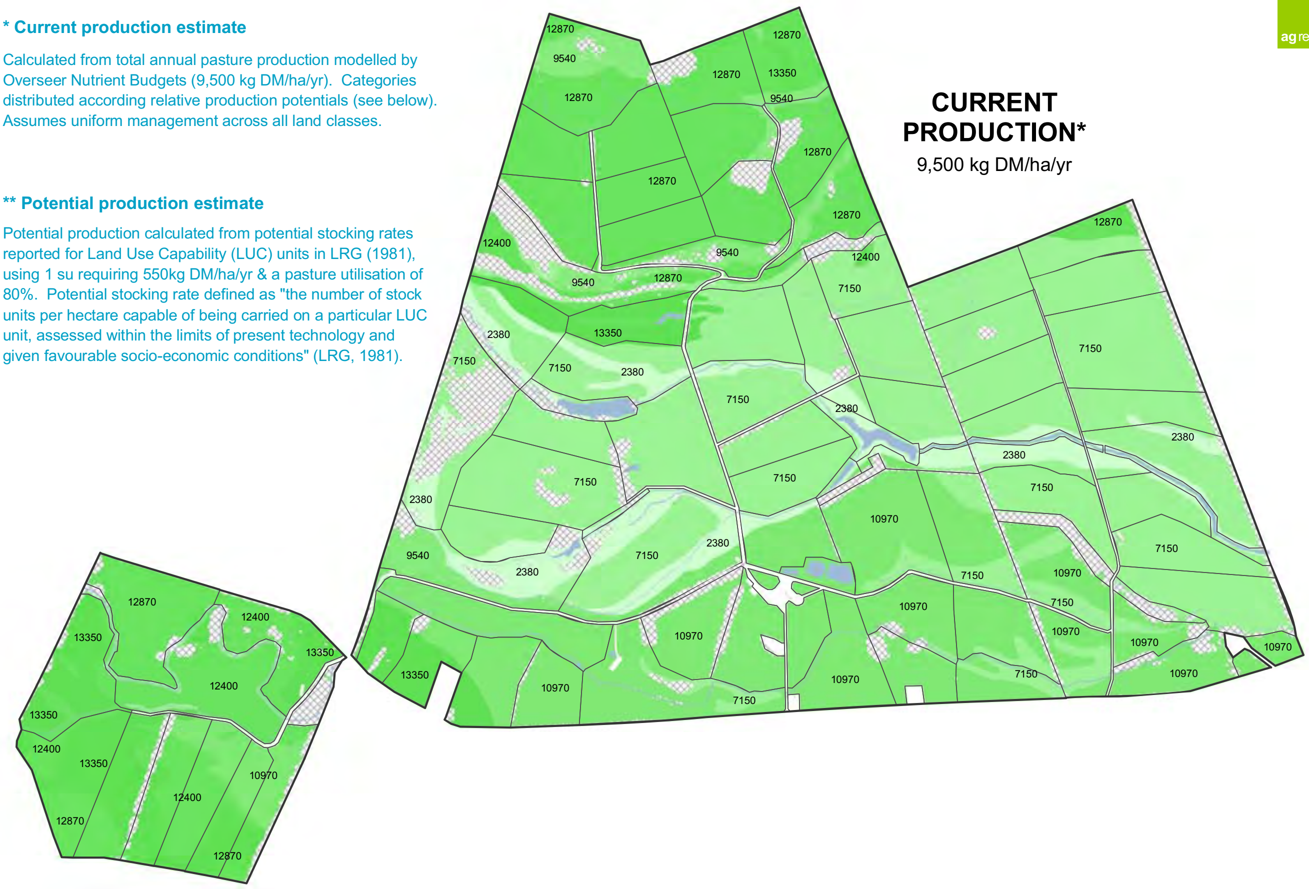
ag research

*** Current production estimate**

Calculated from total annual pasture production modelled by Overseer Nutrient Budgets (9,500 kg DM/ha/yr). Categories distributed according relative production potentials (see below). Assumes uniform management across all land classes.

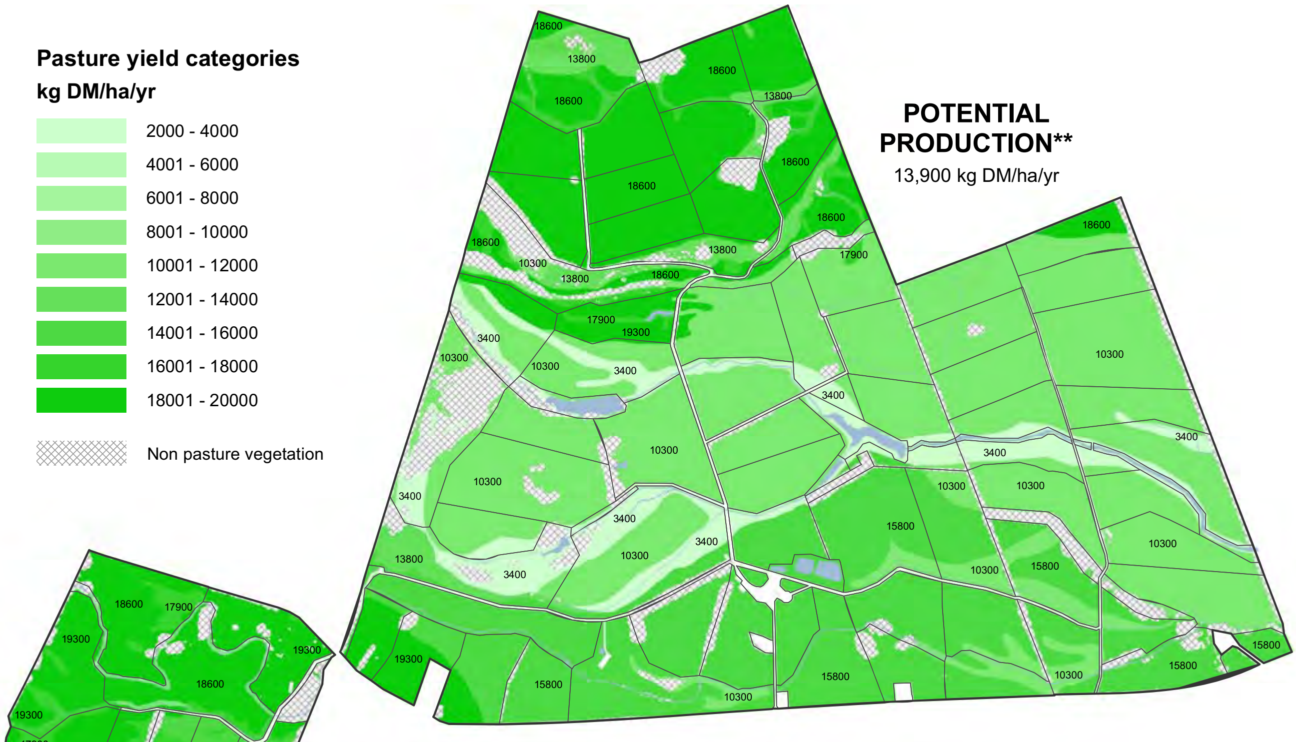
**** Potential production estimate**

Potential production calculated from potential stocking rates reported for Land Use Capability (LUC) units in LRG (1981), using 1 su requiring 550kg DM/ha/yr & a pasture utilisation of 80%. Potential stocking rate defined as "the number of stock units per hectare capable of being carried on a particular LUC unit, assessed within the limits of present technology and given favourable socio-economic conditions" (LRG, 1981).

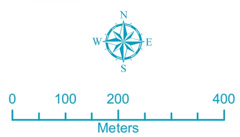


Pasture yield categories
kg DM/ha/yr

- 2000 - 4000
- 4001 - 6000
- 6001 - 8000
- 8001 - 10000
- 10001 - 12000
- 12001 - 14000
- 14001 - 16000
- 16001 - 18000
- 18001 - 20000
- Non pasture vegetation



Reference
Land Resources Group, 1981. Stock carrying capacities and fertiliser data for the North Island. Internal report No.22. Aokautere Science Centre, Ministry of Works & Development, Palmerston North, New Zealand.



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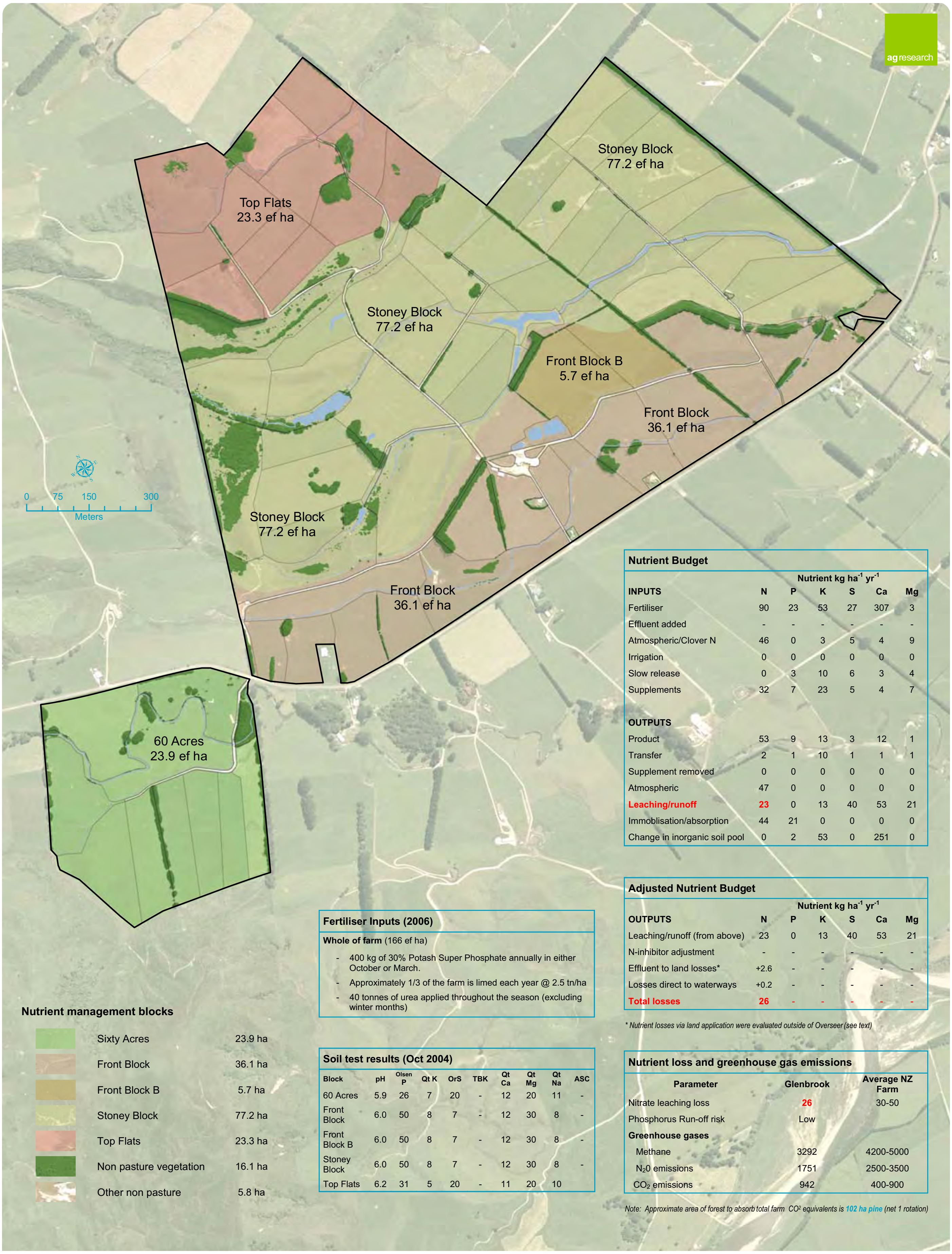
PASTURE YIELD GAP

Glenbrook Farm

Hukanui Road, Eketahuna

FOR COMPARITIVE PURPOSES ONLY. Current production estimated from Overseer Nutrient Budgets and distributed according to Land Use Capability (LUC) classes for the property. Potential production estimated from carrying capacities reported in LRG (1981), using 1 su requiring 550 kg DM/ha/yr and utilisation at 80%. Calculations assume a uniform management regime across all land units (i.e. does not account for differences in fert, stock mgt, etc).



Nutrient Budget

	Nutrient kg ha^{-1} yr^{-1}					
INPUTS	**N**	**P**	**K**	**S**	**Ca**	**Mg**
Fertiliser	90	23	53	27	307	3
Effluent added	-	-	-	-	-	-
Atmospheric/Clover N	46	0	3	5	4	9
Irrigation	0	0	0	0	0	0
Slow release	0	3	10	6	3	4
Supplements	32	7	23	5	4	7
OUTPUTS						
Product	53	9	13	3	12	1
Transfer	2	1	10	1	1	1
Supplement removed	0	0	0	0	0	0
Atmospheric	47	0	0	0	0	0
Leaching/runoff	23	0	13	40	53	21
Immoblisation/absorption	44	21	0	0	0	0
Change in inorganic soil pool	0	2	53	0	251	0

Adjusted Nutrient Budget

	Nutrient kg ha^{-1} yr^{-1}					
OUTPUTS	**N**	**P**	**K**	**S**	**Ca**	**Mg**
Leaching/runoff (from above)	23	0	13	40	53	21
N-inhibitor adjustment	-	-	-	-	-	-
Effluent to land losses*	+2.6	-	-	-	-	-
Losses direct to waterways	+0.2	-	-	-	-	-
Total losses	26	-	-	-	-	-

** Nutrient losses via land application were evaluated outside of Overseer (see text)*

Fertiliser Inputs (2006)

Whole of farm (166 ef ha)

- 400 kg of 30% Potash Super Phosphate annually in either October or March.
- Approximately 1/3 of the farm is limed each year @ 2.5 tn/ha
- 40 tonnes of urea applied throughout the season (excluding winter months)

Nutrient management blocks

Sixty Acres	23.9 ha
Front Block	36.1 ha
Front Block B	5.7 ha
Stoney Block	77.2 ha
Top Flats	23.3 ha
Non pasture vegetation	16.1 ha
Other non pasture	5.8 ha

Soil test results (Oct 2004)

Block	pH	Olsen P	Qt K	OrS	TBK	Qt Ca	Qt Mg	Qt Na	ASC
60 Acres	5.9	26	7	20	-	12	20	11	-
Front Block	6.0	50	8	7	-	12	30	8	-
Front Block B	6.0	50	8	7	-	12	30	8	-
Stoney Block	6.0	50	8	7	-	12	30	8	-
Top Flats	6.2	31	5	20	-	11	20	10	

Nutrient loss and greenhouse gas emissions

Parameter	Glenbrook	Average NZ Farm
Nitrate leaching loss	26	30-50
Phosphorus Run-off risk	Low	
Greenhouse gases		
Methane	3292	4200-5000
N_2O emissions	1751	2500-3500
CO_2 emissions	942	400-900

Note: Approximate area of forest to absorb total farm CO^2 equivalents is 102 ha pine (net 1 rotation)

FARMS

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

NUTRIENT MANAGEMENT

Glenbrook Farm

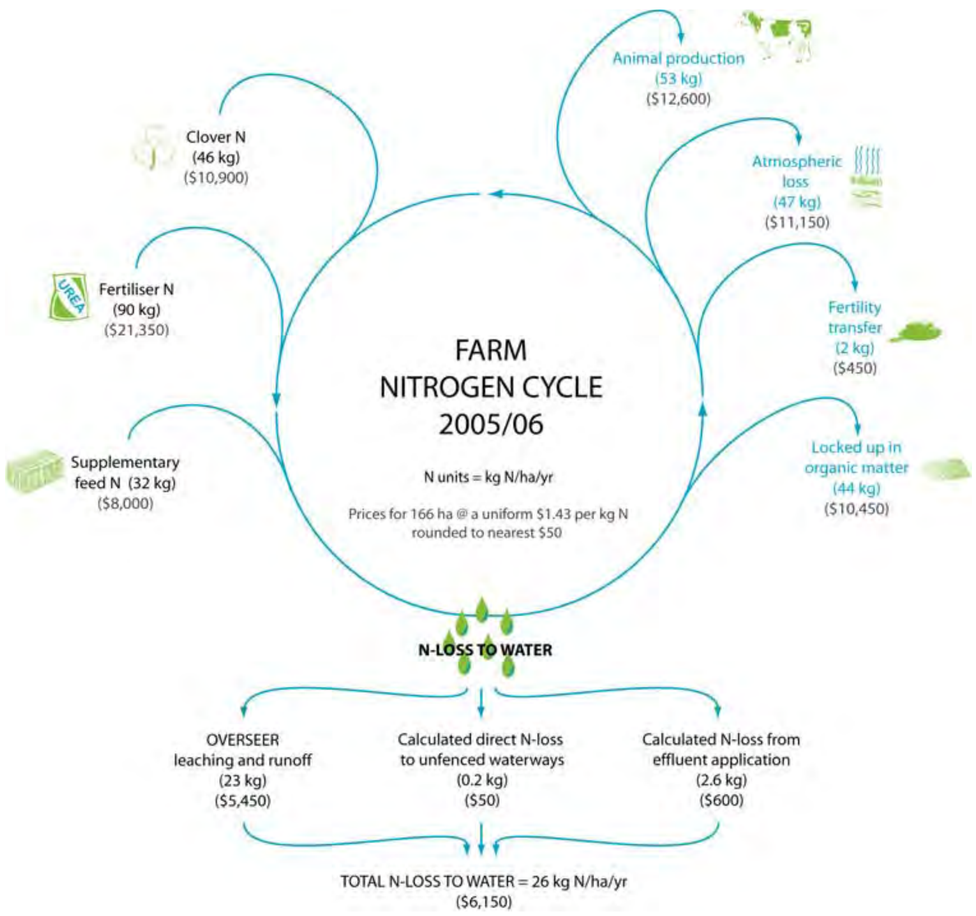
Hukanui Road, Eketahuna

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

3.0 FARM NUTRIENT BUDGET AND WATER QUALITY

3.1 Nitrogen budget and N-losses

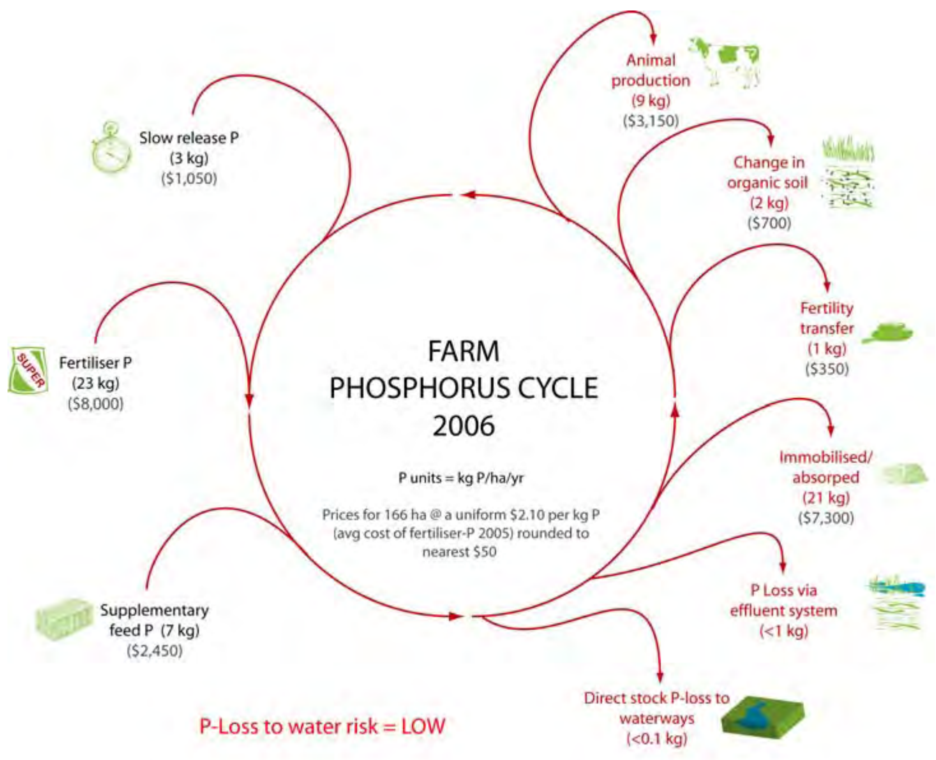
- The farm was divided into seven nutrient management blocks for analysis using *Overseer Nutrient Budgets* (v 5.2.6.0). Key inputs and Overseer outputs are summarised in the Nutrient Management Map opposite.
- Assumptions, settings and inputs for the Overseer model have been signed-off as being true and correct to the best of the farmers' and consultant's knowledge at the time this report was prepared (see Appendices).
- Overseer on its own calculates N-loss for Glenbrook Farm at 23 kg N ha^{-1} $year^{-1}$ (as N loss via runoff or leaching). However, this value does not include N-losses associated with stock voiding directly into waterways, or N-losses associated with the effluent application-to-land system. When these additional loss pathways are included (see below), **whole farm N-loss is estimated to be 26 kg N ha^{-1} $year^{-1}$**. Compared with other dairy farms this is still quite low (NZ average for dairy is 30-50 kg N ha^{-1} yr^{-1}).
  - *Direct N-loss to waterways assessment:* There are 10 paddocks with unfenced waterways. On an average 27 day rotation over a 271 day milking season, each paddock is grazed ~10 times per year (some more, some less). This equates to 3855 cows in each paddock over the entire year. Assuming a cow produces 12 pats and 10 urine spots per day, and given that around 80% of dung and urine is returned to pasture, then each paddock could receive up to 30,830 urine spots and 37,000 pats each year. Assuming 0.4% of these pats and spots are made directly to water (see interim report), then cows could be urinating 123 times and defecating 148 times directly into each paddock's stream. Fresh Friesian excreta contains around 8 g N per pat and 14.4 g N per spot, which equates to 30 kg N voided to streams in the 10 paddocks. Averaged across 188 ha, **direct N-loss to unfenced streams on Glenbrook Farm is estimated to be 0.2 kg N ha^{-1} $year^{-1}$**. This is a conservative estimate.



  - *Effluent application to land assessment:* A sample of treated effluent from above the siphon inlet at 0.5m depth was analysed by Massey University. Total nitrogen was 70 mg/L and total phosphorus was 16.3 mg/L, both of which align well with reported concentrations for treated effluent (see Appendix 1). Annual amount of nitrogen discharged from the last pond is therefore in the order of 620 kg N/yr. The proportion lost to water via runoff and drainage is estimated at 80% based on a single application event to dry soil (see Appendix 1). Eighty-percent is probably a conservative estimate. If 80% of pond discharge is lost to water, then N-loss would be 496 kg N/yr. **On a per hectare basis, N-loss associated with the effluent system is therefore estimated to be 2.6 kg N/ha/yr**.

3.2 Phosphorus budget and P-loss

- Overseer calculates total P-loss to for Glenbrook Farm at 0.8 kg P ha^{-1} yr^{-1}. Losses include those from soil and runoff, and fertiliser type and application. This figure gives the whole farm an overall LOW P-loss rating.



- **Stock P-loss directly to waterways**: Following the methods used to calculate direct N-loss to water (but using dung-P and urine-P concentrations of 2 g P/pat and 0.13 g P/spot), then direct P-loss to unfenced streams on Glenbrook Farm is estimated to be less than 0.04 kg P ha^{-1} yr^{-1}.
- **Effluent P-loss**: A sample of treated effluent had a Total P content of 16.3 mg P/L and a Dissolved Reactive P (DRP) content of 7.3 mg P/L. At these concentrations P-loss associated with effluent is estimated at 0.3-0.6 kg P/ha/yr.
- **Total P-loss is for Glenbrook Farm is estimated at 1.1 – 0.14 kg P/ha/yr** (as the sum of Overseer, waterway and effluent discharge losses).

3.3 Faecal microbes and waterway contamination

- Risk of faecal microbes entering water was not assessed for Glenbrook Farm due to gaps in research understanding. While there is a body of research on the effectiveness of mitigation practices, the preliminary methods and models of quantifying pathogen risk are still in an early stage of development.
- Direct deposition of dung to streams can represent a disproportional and large source of faecal contaminants to surface water (cf. nitrogen). Excluding stock from waterways is therefore widely recommended as a chief mitigation option. Based on stock access to streams, and an assumed 10 billion *E. coli* bacteria per cow pat, then it is conceivable that the Glenbrook operation contributes 5400 billion *E. coli* bacteria per year, or 20 billion per day, to *E. coli* loadings in fresh water streams. However, given our current state of understanding, this can only be considered as an indication of potential risk.
- Effluent application to land and artificial drainage are two indirect mechanisms linked to waterway contamination. Both involve water transporting pathogens to water bodies (either as runoff or drainage). Key mitigations known to be effective include planted riparian buffers, deferred effluent application, and strategic cattle access to poor draining soils (i.e. essentially any practice that minimises runoff or drainage, or avoids land contamination when runoff or drainage is likely to occur). Note that the current effluent-application-to-land system will likely carry a very high risk for contaminating surface water with *E. coli* and other pathogens.

4.0 RESOURCE ASSESSMENT AND NUTRIENT LOSS TARGETS

4.1 Principles

Annual nitrogen loads for the Mangatainoka Catchment have been measured by Horizons Regional Council at **518,000 kg N yr^{-1}**. This is more than two-times greater than the community's water quality standards for this particular catchment (target is **238,000 kg N yr^{-1}**). There is general agreement that nutrient loads need to be reduced, but there is much disagreement over how it should be done.

An easy option is to apply a blanket N-cap to every farm in the catchment. However, this fails to recognise farm-to-farm differences in land use, the quality of land (productive potential), and the current use of mitigation practices. Through the FARM Strategy approach, a more equitable approach is proposed. At its heart is the identification of farm-particular nutrient-loss targets based on the capability and productivity of land, and the fact that **better land has a higher capacity to sustain high levels of production (i.e. it is more sustainable), relative to attempting comparable levels of production from low quality land by using excessive inputs inefficiently.**

Water quality targets have been related to land production-potentials using the Land Use Capability (LUC) system of land classification. This ranks land according to eight classes, where class 1 represents the most elite land, and class 8 land has very low productive value (e.g. bluffs, swamps, river beds, etc.). Nitrogen-loss targets by LUC class are included in the One Plan (table below), designed to be phased in over a twenty-year period. A farm's relative area of different LUC units will determine the level of N-loss that the farm needs to operate within to achieve catchment water quality targets.

Table 2: One Plan N-loss targets for LUC classes

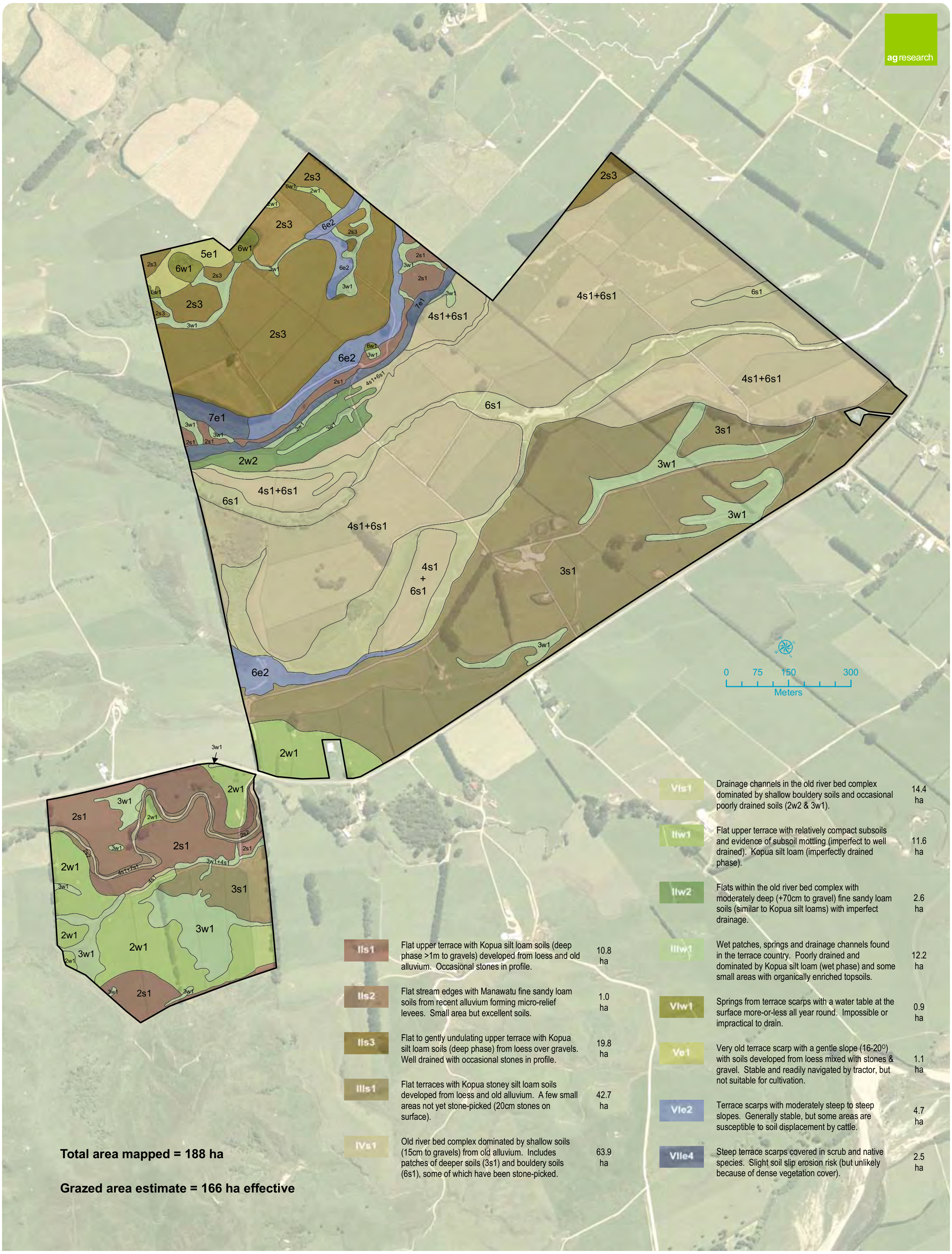
LUC	*N-loss targets (kg N ha^{-1} yr^{-1})*			
	YEAR_01	YEAR_05	YEAR_10	YEAR_20
I	32	27	26	25
II	29	25	22	21
III	22	21	19	18
IV	16	16	14	13
V	13	13	13	12
VI	10	10	10	10
VII	6	6	6	6
VIII	2	2	2	2

4.2 Land resource assessment

Land resources of Glenbrook Farm have been described and evaluated according to the Land Resource Inventory (LRI) and Land Use Capability (LUC) Classification. Survey was undertaken at a 1:8,000 scale. The LRI system involves mapping landscape units according to five inventory factors (rock type, soil unit, slope class, erosion type & severity, and vegetation).

LRI is then classified as LUC, which further groups similar units according to their capacity for sustainable production under arable, pastoral, forestry or conservation uses. The LUC code (e.g. 6e7) indicates *general capability* (1-8 classes), the *major limitation* (4 subclass limitations of **w**etness, **e**rosion, **s**oil and **c**limate), and the *capability unit* to link with units with similar management requirements and production opportunities. Note that the capability units used in this report are specific to Glenbrook Farm. A correlation with regional equivalents is presented in Table 3 in the *rLUC* column.

Land Use Capability is presented over the page. Description of the land resource by LUC is summarised as Table 3. N-loss targets for Glenbrook Farm have been calculated and presented on page 16.



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LAND USE CAPABILITY

Glenbrook Farm

Hukanui Road, Eketahuna

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

TABLE 3: Land resource description by LUC unit

	FARM LUC	Ha	DESCRIPTION	rLUC	ROCK	SOIL	SLOPE	VEGETATION	EROSION	TARGET N-LIMIT**
	IIs1	10.8	Flat terrace with deep soils from loess. Floods occasionally with evidence of minor alluvial deposits directly adjacent to stream.	2s1	Deep loess and old alluvium on gravels. Localised colluvial influence near hills.	Kopua silt loam (deep phase)	$0-3^0$	Pasture	Nil. Potentially slight to moderate wind erosion under cultivation.	**21 kg N/ha/yr** (227 kg N per LUC area)
	IIs2	1.0	Small areas adjacent to stream where historical stream meandering has been infilled with deep and fine alluvial deposits.	2s1	Alluvium	Manawatu fine sandy loam	$0-3^0$	Pasture	Slight streambank erosion.	**21 kg N/ha/yr** (21 kg N per LUC area)
	IIs3	19.8	Flat to gently undulating upper terrace.	2s1	Deep loess over gravels	Kopua silt loam (deep phase)	$0-7^0$	Pasture	Nil. Potentially slight wind erosion under cultivation.	**21 kg N/ha/yr** (416 kg N per LUC area)
	IIIs1	42.7	Flat stoney terrace with gravels at 30-60cm and stones in topsoil. Most has been stone picked although small areas remain with stones on the surface.	3s1	Loess and old alluvial deposits over gravels	Kopua stoney silt loam	$0-3^0$	Pasture	Nil. Potentially moderate wind erosion under cultivation.	**18 kg N/ha/yr** (769 kg N per LUC area)
	IVs1	63.9	Old river complex with flat topography lightly dissected by old and existing water channels. High water table and stoney soils.	4s1	Old alluvial deposits	Complex of silt loams & fine sandy loams intermixed with gravely/stoney soils	$0-3^0$	Pasture	Nil. Potential slight wind erosion where it can be cultivated.	**13 kg N/ha/yr** (831 kg N per LUC area)
	VIs1	14.4	Drainage channels in old river complex dominated by bouldery soils and occasional poorly drained fine-textured soils.	7s1*	Old alluvial deposits	Tukituki?	$0-3^0$	Pasture	Nil.	**10 kg N/ha/yr** (144 kg N per LUC area)
	IIw1	11.6	Flat terrace land with compact and mottled subsoil (imperfectly drained).	2w1	Deep loess and old alluvium on gravels	Kopua silt loam (imperfectly drained phase)	$0-3^0$	Pasture	Nil.	**21 kg N/ha/yr** (244 kg N per LUC area)
	IIw2	2.6	Small flat area with fine sandy loam soils from old alluvium	2w1	Old alluvium on gravels (70cm)	Similar morphology & colour to Kopua soils but slightly more coarse texture	$0-3^0$	Pasture	Nil.	**21 kg N/ha/yr** (55 kg N per LUC area)
	IIIw1	12.2	Wet patches, springs and terrace drainage channels. Water table at or near the surface for most of the year.	3w1	Mostly loess & old alluvial material	Kopua silt loam (wet phase)	$0-3^0$	Pasture & rushes	Nil.	**18 kg N/ha/yr** (220 kg N per LUC area)
	VIw1	0.9	Poorly drained areas associated with springs from the terrace scarps. Difficult or impractical to drain.	6e1*	Mostly loess	Kopua silt loam (wet phase)	$7-20^0$	Pasture, rushes, scrub	Nil.	**10 kg N/ha/yr** (9 kg N per LUC area)
	Ve1	1.1	Old, stable scarps with rolling to strongly rolling slopes.	6e1*	Loess mixed with stones & gravel over sandstone	Kopua silt loam (hill phase)?	$16-20^0$	Pasture	Nil.	**12 kg N/ha/yr** (13 kg N per LUC area)
	VIe2	4.7	Moderately steep to steep terrace scarps ($20-35^0$).	6e1*	Loess mixed with stones & gravel	Kopua silt loam (hill phase)?	$20-35^0$	Pasture with occasional scrub or native shrubs	Nil. Some areas with notable soil displacement caused by cattle.	**10 kg N/ha/yr** (47 kg N per LUC area)
	VIIe4	2.5	Steep terrace scarp.	7e4	Sandstone	Mangamahu silt loam	35^0	Scrub, native shrubs & pasture	Nil. Potential slight soil erosion.	**15 kg N/ha/yr** (37.5 kg N per LUC area)

** rLUC represents the closest correlation to the regional Land Use Capability classification described by Noble (1985). Units identified at detailed mapping scales* are not always explicitly identified in the regional classification. An asterisk denotes the closest equivalent.

** Permissible N-loss limits proposed in the One Plan for Year 20 (see Table 1). Refers to N-losses from leaching and runoff. Farming within these values is necessary to achieve catchment water quality standards.

4.3 N-TARGETS for Glenbrook Farm

To remain compliant under the One Plan, Glenbrook Farm is required to operate within the N-loss limits described below (Table 4). They represent the maximum permissible N-loss from leaching and runoff beginning April 2010. N-targets will not change over the 20 year period unless Land Use Capability changes (unlikely). When Rule 13 of the One Plan first comes into effect for the Mangatainoka Catchment (April 2010), N-loss for Glenbrook Farm must be no greater than 20 kg N/ha/yr.

Table 4: Permissible N-loss limits for Glenbrook Farm (N-targets)				
Year	*2010*	*2015*	*2020*	*2030*
N-target (kg N/ha/yr)	**20**	**19**	**17**	**16**

4.4 Implications

4.4.1 Uniform N-loss over 20 years

Current N-loss for Glenbrook Farm has been calculated at 26 kg N/ha/yr. A reduction of 6 kg N/ha/yr is required by 2010, and a further 4 kg N/ha/yr is required by 2030 (Table 5). Accordingly, management needs to aim at reducing N-loss by 10 kg over 20 years, which works out at 0.5 kg required decrease each year on average. Note this assumes no change in existing N-loss, such that the current 27 kg N/ha N-loss remains constant for the twenty year period.

Table 5: Reduction required at a uniform N-loss				
Year	*2010*	*2015*	*2020*	*2030*
Current N-loss (kg N/ha/yr)	26	26	26	26
N-target (kg N/ha/yr)	**20**	**19**	**17**	**16**
Difference (required reduction)	*6*	*7*	*9*	*10*

4.4.2 Predicted intensification N-loss over 20 years

The current loss of 26 kg N/ha/yr can legally increase under the One Plan provided sufficient mitigation options are available to offset any increase. Further, industry trends suggest farm production will change significantly over the next 20 years, and these changes will likely impact on N leaching and runoff losses. A scenario for change has been constructed for Glenbrook Farm. Reliable predictions cannot be made for such a long time period, so the results are at best a 'considered approximation'. They have been included solely to demonstrate how current production trends may impact on future N-loss.

The dairy industry has recommended farms should be aiming to achieve 4% productivity growth. Using total milk solid production as an indicator, Glenbrook Farm would need a 20-year target of 228,800 kg MS (1,380 kg MS/ha) using a baseline increase (i.e. 4% of 130,000 kg MS = 5,200 kg MS gain per year) or 273,890 kg MS using a compound increase. Some sectors are already aiming for 500 kg MS/cow, based on current genetic gains reported by the LIC (+3.6 kg MS/cow/yr), ongoing improvements in technology and management, and levels of production currently being achieved by top farmers (++400 kg MS/cow). Using 20-year targets of 228,800 kg MS and 500 kg MS/cow (20 years is quite a long time), the herd would need to increase to 457 cows or 2.75 cows/ha. A linear relation between cow numbers and inputs such as fertiliser and supplementary feed was assumed (a big assumption but one that errs on the side of being conservative). These predicted changes were modelled through Overseer Nutrient Budgets, and used to simulate how N-loss may change over the next 20 years (Table 6).

Table 6: Predicted N-loss reduction required under an intensification scenario				
Year	*2010*	*2015*	*2020*	*2030*
Predicted N-loss (kg N/ha/yr)	26	30	32	37
N-target (kg N/ha/yr)	**20**	**19**	**17**	**16**
Difference (required reduction)	*6*	*11*	*15*	*21*

An N-loss of 37 kg N/ha/yr is not unrealistic considering the current average for dairy is 30-50 kg N/ha/yr. Under this scenario Glenbrook Farm would need to aim at reducing N-loss by 21 kg over 20 years, or around 1 kg each year on average.

5.0 MANAGEMENT OPTIONS FOR MITIGATING N, P AND BUGS

The previous section reported N-targets for Glenbrook Farm, and the level of reduction required to achieve those targets. This section proposes and evaluates different options for mitigating N-loss.

5.1 Existing practice

Glenbrook Farm is already implementing a variety of environment-improving practices, some of which include:

- Capture of effluent from a proportion of laneway nearest to the shed. This is a zone of high animal concentration, and effluent is diverted into the ponds rather than washing down the lane or concentrating onto pasture.
- All small streams where lanes cross have culverts.
- No winter application of urea or effluent.
- A sizeable proportion of waterbodies are already fenced (1.4 km of 'Clean Streams' streams/lakes and a further 0.7 km of smaller streams or drains).
- Stock grazed off in winter.

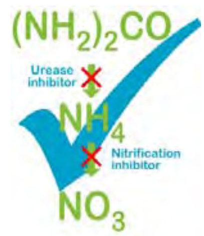
Existing practices that mitigate N-loss, P-loss or faecal microbe contamination of water, will need to continue as part of this FARM Strategy (see Section 6.3.1).

5.2 Additional mitigation options

A range of recognised mitigation options have been listed and rated in terms of relevance to the operation of Glenbrook Farm (Table 8). Those with the highest relevance are evaluated further according to potential effectiveness and cost. Note that the listed mitigation practices are generally geared towards nitrogen, but with a recognition that many also affect P-loss, faecal microbes, and sediment loss. "Effectiveness" is evaluated by rerunning the *Overseer* model under the proposed mitigation where possible. Note that the implementation of one practice can have implications for other mitigation practices (e.g. wintering cows off farm may negate the need for N-applications during winter, feeding of supplements on-farm, etc.). Also note that practices have been evaluated individually, so the effectiveness of each cannot simply be added together to provide a summed total.

5.2.1 Urease and nitrification inhibitors

Inhibitors interrupt urea-nitrogen transformation processes. Urease inhibitors work on the first part of the transformation by restricting the conversion of urea to ammonium (thereby restricting the amount of ammonium available for the second key transformation). Nitrification inhibitors operate on the second transformation by interrupting the microbial conversion of ammonium to nitrite then to nitrate. In effect both inhibitors reduce the amount of nitrate-N in soil, which is the main type of N associated with leaching. Recent studies report significant leaching-loss reductions of 30-80%, and improved pasture yields of around 5-20%.



Proposal: To replace the current urea fertiliser product with a urease inhibitor urea-product, and to spray pasture with a nitrification inhibitor according to manufacturer recommended rates and timings.

Effectiveness: While there is a rapidly growing body of research on the effectiveness of inhibitors, it is difficult to predict with any certainty how well they will perform on any given farm at any point in time. For the interim, and for Glenbrook Farm given its location and climate, we suggest a conservative 20% reduction in the leaching/runoff calculated by Overseer as an approximation of inhibitor effectiveness. Accordingly, adopting the use of inhibitors is **estimated to decrease N-loss by by 5 kg N ha^{-1} yr^{-1}.**

Implications & cost: Current on-the-ground cost for normal urea at 103 kg N/ha/yr is $24,450 ($1.43/kg N x 103 kg x 166ha), while a shift to urease treated urea would cost $54,900 ($1.67/kg N x 103 kg N x 166ha). The increase is $4,100/yr. Cost of spraying with nitrification inhibitor twice per year at $148/ha (applied) equates to $49,136/yr ($148 x 166ha x 2 applications). Accordingly, total on-the-ground cost of adopting urease and nitrification inhibitors is estimated at $53,240 per year ($321/ha). Potential increases in pasture and gross revenue are estimated at different response rates (Table 7). Only a 6% yield increase is required break even (6% response = $53,340 gross revenue).

Table 7: Potential returns at increasing inhibitor response rates

Yield % increase	Extra kg DM/ha[a]	Kg DM/farm	Extra Kg MS[b]	Gross revenue[c]
5%	475	78850	6913	$ 44,450
10%	950	157700	13826	$ 88,900
15%	1425	236550	20739	$ 133,350
20%	1900	315400	27652	$ 177,800

a Using 9.5 tn/ha/yr for current pasture production
b From ratio of current pasture yield to current MS production
c At a MS payout of $6.43 per kg

Recommendation: That urease and nitrification inhibitors be adopted into the farm system. Coupled with N-loss reductions associated with fencing waterways and effluent disposal, using inhibitors would readily allow the Glenbrook Farm to achieve N-targets for 2010. The required level of pasture response to break-even is small relative to responses reported elsewhere (up to 20%). Note that both N-loss and pasture yield estimates are conservative, and it is possible that reductions and yields could be considerably higher. However, also note that the use of supplements was not factored into calculating the value of extra dry matter produced.

TABLE 8: Relevance of common N-loss mitigation options (+ P-loss & faecal microbes)

MITIGATION OPTIONS	Issue & ranking[1]	Relevance or opportunity	NOTES
Mitigation options captured by Overseer			
Avoid winter (May, June or July) N-applications	N	LOW	Does not use urea in the winter months.
Ensure effluent application area is large enough to keep loading <150kg N/ha/yr	N, bugs, P	HIGH	Current effluent area is less than 0.2 hectares
Avoid winter effluent applications	N, bugs, P	UNCERTAIN	If the siphon system is left on 'automatic' then the risk is high
Use supplements with N-concentrations that are lower than pasture (or higher energy content - e.g. maize)	N	MEDIUM	There may be an opportunity to reconfigure supplement amounts and ratios alongside other mitigation practices.
Replace fertiliser N with equivalent supplement-N	N	LOW	Cannot be used strategically to target periods of growth when N is most needed. Further, reducing the use of supplement is a management objective.
Ensure other nutrients are non-limiting (optimal) for max yield per kg N input	N	LOW	Soil tests indicate levels for major nutrients are near optimum or above.
Decrease use of N-fertiliser	N	MEDIUM	May conflict with other farm strategies (e.g. reducing use of supplements).
Decrease stocking rate	N, bugs	LOW	Already running a low to medium stocking rate (2.2 cows/ha).
Change stock type or class	N	LOW	Not suitable.
Reduce imports of supplementary feed	N	HIGH	Managers are concerned about current levels of supplement but needs to be balanced against production implications.
Graze cattle off during winter (May, June, July)	N, bugs, P, sed	LOW	All ready practiced.
Use a sealed wintering/standing pad with effluent collection and storage system	N, bugs	LOW	Unnecessary investment given size of the N-loss deficit. Maybe a longer term consideration.
Increase supplement exports off farm	N	LOW	Not financially prudent at current time.
Recycle effluent to land rather than pond treatment & disposal to waterways	N, bugs, P	HIGH	Considerable improvements are available for the disposal to land system.
Other mitigation activities			
Time N-fertiliser application for periods when N demand is greatest[2]	N	LOW	Already practiced[4].
Avoid high-rate, single dressings of N-fertiliser. Use split dressings (20-50kg N/ha per dressing)	N	LOW	Already practiced[4].
Adjust N-fertiliser rates & timings seasonally to respond to actual or expected production demand (seasonal variations)	N	LOW	Already practiced[4].
Use an N-fertiliser product with an N-uptake efficiency that is better than the current N-product	N	LOW	Urea is currently the most cost effective source of fertiliser-N. However, see note on urease treated urea below.
Avoid N-applications when soils are saturated (leaching/runoff & low plant activity).	N	LOW	Already practiced[2]. However, there is scope for an improved drainage programme in the 60 acre block to reduce periods of saturation.
Avoid N-applications during excessive dry periods (plant N-uptake low)	N	LOW	Already practiced[2].
Consider timing N-fert using a water balance on soils with high leach/runoff risk (shallow gravel soils, soils with high water tables, artificially drained soils)	N	LOW	Represents an extra workload difficult to justify without irrigation.
Delay N-applications directly after dry periods until pastures have started recovering	N	LOW	Already practiced[4].
Ensure an adequate buffer distance from waterways when applying fertiliser[3]	N, P	LOW	Already practiced[4].
Use urea product treated with urease inhibitor	N	MEDIUM	Given the local climate and proximity to the Tararua Ranges, our estimation is that inhibitors may be moderately effective.
Ensure you can actually use the extra grass grown when N-fertiliser is used	N	LOW	Already practiced[4].
Spray nitrification inhibitor according to manufacturer recommended rates and timings, particularly on highly stocked areas (e.g. camps)	N	MEDIUM	Our estimation is that inhibitors are likely to be moderately effective for Glenbrook Farm.
Ensure effluent storage ponds do not overflow (part. winter)	N, bugs, P	LOW	
Use adequate buffer distance from waterways when applying effluent (+20m)	Bugs, N, P	LOW/HIGH	Low relevance with existing system. High relevance under proposed new system.
Other best management works			
Ensure all paddocks are supplied with adequate troughs or dams	Bugs, N, P, sed	LOW	Farm owner has assured that all paddocks have reticulated stock water
Replace fords with bridges or culverts	Bugs, sed, N, P	LOW	All lane crossings of waterways are either bridged or culverted.
Exclude stock from flowing waterways by fencing	Bugs, sed, N, P	HIGH	A sizeable area of streams network through 10 paddocks, most of which would possibly require fencing under the Clean Streams Accord, & some of which is already fenced.
Create wetland attenuation zones where runoff converges	Bugs, sed, N, P	LOW	Efforts over the past 25 years have been to drain wet convergence zones.
Create riparian attenuation zones wider than 10-30m	Bugs, sed, P, N	LOW	This mitigation is examined in greater detail (page 20) to demonstrate why it has low relevance.
Ensure runoff from tracks/lanes is not channelled into streams near crossings	Bugs, sed, N, P	LOW	Generally adequate to good lane & drainage designs, especially near the shed (effluent is captured). Possibly one or two spots on 60 acres block (see page xyz).
Ensure there are no major leaks in the effluent irrigation system (e.g pipe joins).	N	LOW	Not really relevant to the existing system.
Invest in a high efficacy effluent treatment/disposal system (e.g. digesters)	N, bugs, P	LOW	For this farm there are many other lower cost options.
Ensure runoff from yards, feed pads, etc. does not go directly into waterways	Bugs, N, P, sed	LOW	Already practiced.
Ensure effluent storage ponds are sealed	N, bugs	UNCERTAIN	There are wet patches adjacent to the pond walls. It is not clear if these patches are caused from pond seepage. It may be natural seepage associated the higher water table of the slightly elevated terrace next to the ponds.
Ensure effluent storage ponds are of a sufficient size	N	MEDIUM	Ponds of sufficient size for current land disposal system but half the capacity required for successful deferred irrigation using a travelling irrigator
Store leakable supplementary feeds (e.g. silage) on a sealed base with an effluent collection/storage/disposal system	N	LOW	

[1] ***N**= nitrogen loss, **P**= phosphorus loss, **bugs** = faecal microbes, **sed** = sediment*

[2] *When pastures are higher than 25mm or 1000kg DM/ha, are actively growing, when soil temp >6degrees*

[3] *See formulas in Spreadmark code of practice*

[4] *Based on farmer assurance. Cannot be assessed conclusively within project limits. Assumed compliant until proven otherwise.*

5.2.2 Reduced urea-N use

Current urea use (102 kg urea-N/ha/yr) can be considered low relative to some other dairy operations, but there is scope for reduced application. The upside is less dependence on a somewhat costly source of N, and the potential increase of 'free' nitrogen from greater clover N-fixation activity. The downside is reduced opportunity to use a source plant-available N when it is most advantageous.

Proposal: To evaluate N-loss and financial implications of reducing Urea-N by 10 kg N/ha/yr.

Effectiveness: Reducing current N-use by 10 kg N/ha/yr **decreases modelled N-loss by 1 kg N/ha/yr**.

Implications & cost: Production and financial implications were evaluated by Mary Lund of Tararua Veterinary Services by setting up a farm scenario in Udder. Total milksolid production was reduced by 3,960 kg MS. At a payout of $6.43, gross revenue would decrease by $25,120. Applying 1.7 tn less urea-N equates to a saving of $2,375 (at a cost of $1.43 per kg urea-N applied). From these results the farm could stand to lose $22,750 per year by reducing urea applications by 10% (note: gross margin difference reported by Udder was $22,650).

Recommendation: The recommendation is not to reduce current N-use by 10%. While N-loss would likely be reduced by 1 kg N/ha/yr, the saving would come at a high cost financially ($22,750). Other more cost-effective options are available for reducing N-loss.

5.2.3 Less cows, less supplement and less urea

Evaluating individual mitigations is acceptable when only small N-loss reductions are required. However, when required N-loss reductions are high, it becomes more practical to evaluate compound mitigations. N-loss from Glenbrook Farm is not particularly high, but because the farm was set up in Udder, it was considered both practical and useful to assess the implications of a compound mitigation involving reduced cow numbers, supplement input, and reduced urea application. Specific reductions were researched and modelled by Mary Lund of Tararua Veterinary Services for the purpose of optimising gross margin. Key Udder inputs were transferred to Overseer to model N-loss.

Proposal: Reduce cow numbers by 8%, urea-N use by 5%, and supplement use by 33%.

Effectiveness: Less cows, urea and supplement **reduces modelled N-loss by 1 kg N ha^{-1} yr^{-1}**. While the same reduction is achievable by reducing N-use alone (see above), making the reduction alongside less supplements and cow numbers has significant financial implications.

Implications & cost: Udder suggests the gross margin could increase by $51,480 (11% increase) due to major reductions in feed costs (-$35,000 or a 21% reduction) and variable costs (-$56,000 or 13% reduction), while only a relatively minor decrease in milksolid production (<1% as -626 kg MS) and gross returns (-$4,520 at $6.43/kg payout or 1% decrease). In short, modelling suggests less cows, urea and supplement could gross $50,000 more income. However, consider Note 1 below.

Recommendation: To consider this compound mitigation in more detail. From an N-loss perspective the gain is small, but reduced stocking rate has other positive environmental and animal health orientated benefits, and from a purely financial perspective, the promise of greater returns from reduced inputs would make for a more efficient and effective farming operation. However, see Note 1 below.

Note 1: For the Udder scenario to be realised, the amount of feed from pasture would need to increase by 10% (i.e. 10% more pasture grown and harvested). There are several options available to make this happen (e.g. improved drainage of 60 Acres block, a more aggressive pasture renewal programme, irrigation), but most would involve a capital investment not factored into the Udder gross margin above.

Note 2: Modelled N-loss is only 1 kg N/ha/yr because when production outputs are maintained (i.e./e.g. milksolid yield), the model appears to balance N assuming greater N sourced from the atmosphere.

5.2.4 Effluent application area

Current effluent application area is optimistically estimated at 0.2 ha which is well below the 20 hectare area required to achieve a recommended maximum 150 kg N/ha per year loading.

Proposal: Enlarge the area of land currently receiving effluent to 20 hectares.

Effectiveness: Effectiveness is dependent on the choice of effluent irrigation system (Sections 5.2.7 and 5.2.8). It is strongly recommended that the effluent area be located on the mid-terraces rather than the old river bed (very low water holding capacity and high water table). The area suggested for effluent disposal is presented on page 27.

Implications & cost: There is an indirect cost associated with having to purchase an irrigation system to cover the 20 hectares (see Sections 5.2.7 and 5.2.8). However, there is also benefits. Improved utilisation of effluent nutrients would be worth approximately $1,342/yr (Appendix 3), and because effluent-N induces pasture responses similar to urea-N, then increased pasture yields could be worth $1,750 to $6,990 depending on response rates.

Recommendation: To adopt the effluent-application area proposed on page 27.

FENCING STREAMS (recommended)

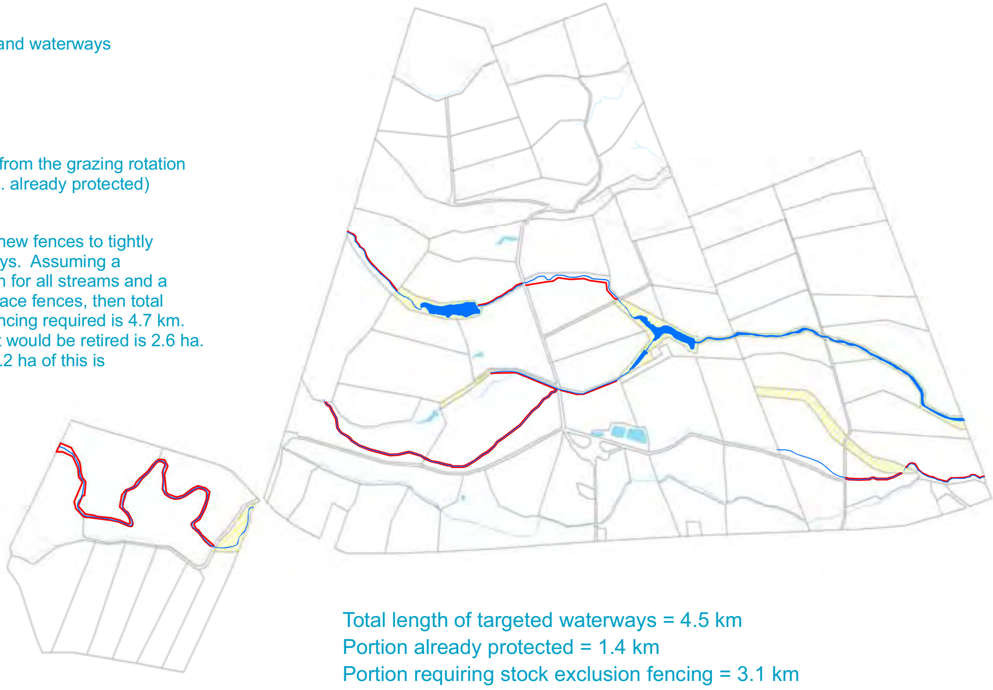
agresearch

Streams, rivers and waterways

Existing fences

Areas excluded from the grazing rotation with streams (i.e. already protected)

Recommended new fences to tightly parallel waterways. Assuming a uniform 1m width for all streams and a 0.5m buffer to place fences, then total length of new fencing required is 4.7 km. Area of land that would be retired is 2.6 ha. Approximately 1.2 ha of this is grazed pasture.



Total length of targeted waterways = 4.5 km
Portion already protected = 1.4 km
Portion requiring stock exclusion fencing = 3.1 km

RIPARIAN BUFFER STRIPS (not recommended)

Targeted streams (3.1 km)

Existing fences

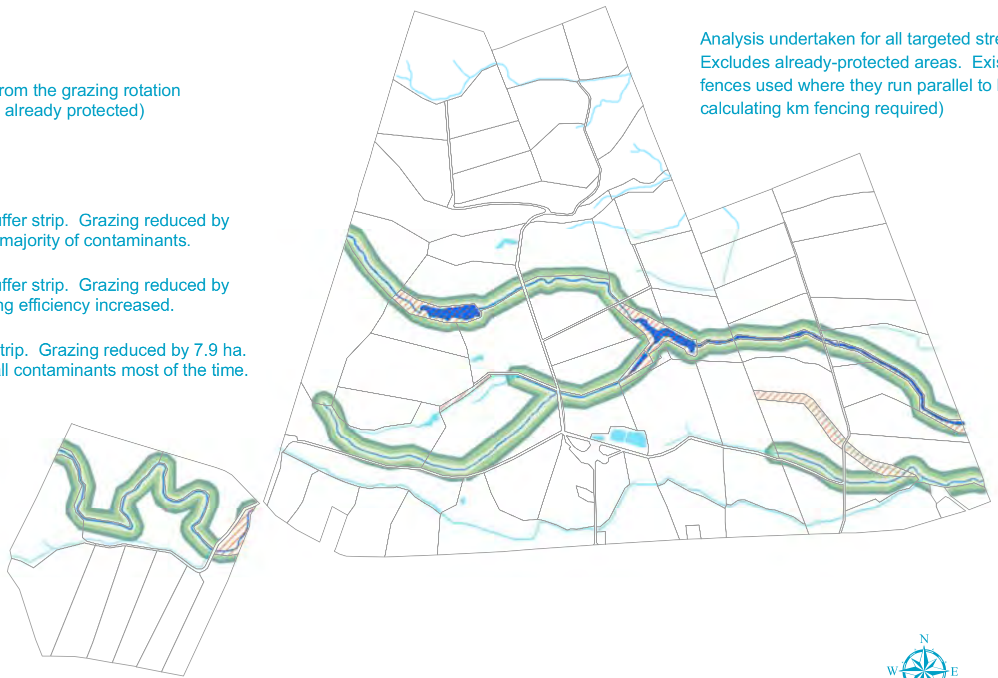
Areas excluded from the grazing rotation with streams (i.e. already protected)

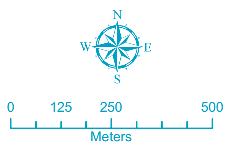
10 metre wide buffer strip. Grazing reduced by 6.3 ha, but traps majority of contaminants.

20 metre wide buffer strip. Grazing reduced by 7.8 ha but trapping efficiency increased.

30 metre buffer strip. Grazing reduced by 7.9 ha. Generally traps all contaminants most of the time.

Analysis undertaken for all targeted streams. Excludes already-protected areas. Existing fences used where they run parallel to buffers (for calculating km fencing required)





The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

WATERWAY PROTECTION

Glenbrook Farm

Hukanui Road, Eketahuna

Rivers and waterways interpreted of orthophotography. Small streams assigned a uniform width of 1m. Recommended fencing and riparian zones created by buffering river and waterways. Results generalised using Douglas-Poiker alogorithm to approximate linearity associated with fencing practice. Recommended fences further edited to better align with high stream banks, existing fences, and low value land. Effect of slope was considered negligible for the buffer strip evaluation.

5.2.5 Fence waterways

Direct access of stock to waterways amplifies the risk of contamination by faecal microbes, and to a lesser extent, the contribution of nutrient to water. Both the dairy industry and Horizons Regional Council are aiming to have appreciable streams on all dairy farms excluded from the grazing rotation. Currently there is 3.1 km of waterways that requires stock exclusion.

Proposal: To fence all waterways using an electrified two-wire waratah fencing system that minimises the loss of productive land.

Effectiveness: Fencing all waterways **will likely decrease estimated N-loss by ~0.2 kg N ha^{-1} yr^{-1}** (see page 11) and P-loss by <0.1 kg P ha^{-1} yr^{-1}. These reductions are minor. The greater-gain would be reduced pathogen contamination. While this cannot be robustly quantified for Glenbrook Farm, research studies have demonstrated significantly lower faecal microbe contamination of waterways through stock-exclusion and fencing.

Implications & cost: Total required fence length is estimated at 4.7 km. Local fencing costs for erecting a two-wire waratah fencing system are estimated at $2.38/m. Excluding gates and other peripherals, cost of fencing waterways would be approximately $11,200. Fence design should keep culverted crossings as part of the paddock to negate the need for extra troughs. Total area of retired land would be 2.6 ha (includes water, trees, etc). Loss of effective grazed area is 1.2 ha, which could result in 1000 kg less milksolids (@ current 832 kg MS/ef ha), and a loss of $6,400 in farm gate returns each year (see Table 9). The herd would need to be reduced by 3 cows to maintain the current stocking rate.

Recommendation: That stock be excluded from all waterways using the recommended fencing system. While nutrient loss savings would be small, risks associated with faecal contamination of water would be much reduced. Further, these streams likely require fencing under the Clean Streams Accord, and Rules under the One Plan. Cost is high, but can be blunted somewhat by staggering the work over 4-5 years (Clean Streams Accord compliance target is year 2012).

5.2.6 Planted riparian buffers

Planted riparian buffers are considered here as the next step-up from fencing-off waterways. Purpose would be to trap nutrients, sediment, and faecal microbes associated with runoff (in addition to excluding stock from waterways). Generally the first 10m is the most important, with effectiveness increasing with width out to 30m where most contaminants get trapped/attenuated most of the time. Planted riparian buffers can be effective where runoff is a key contaminant transport mechanism.

Proposal: Create fenced and planted riparian buffer strips around waterways. Determine which width is likely to be most cost-effective (10m, 20m or 30m buffer widths).

Effectiveness: The trapping/attenuation effects of riparian buffer widths could not be robustly evaluated for Glenbrook Farm. Specific research is currently being undertaken to build such effects into the next release of the *Overseer* model. Even so, many other studies have demonstrated planted buffers as being generally effective in trapping/attenuating sediment, phosphorus, and faecal microbes. Reductions in N-loss tend to be lower, because leaching rather than runoff is considered the key N-loss transport factor on NZ dairy farms. However, it could be safely assumed that riparian buffers would benefit the farm's environmental performance in most cases.

Implications & cost: Main implications include establishment costs (planting, fencing) and lost production (Table 9). Herd number would be reduced by approximately 14, 17, and 18 cows for 10m, 20m and 30m buffer widths respectively (to maintain the 2.2 cows per hectare stocking rate).

Table 9: Production and financial implications of fencing and/or planting different width riparian buffers

Practice	Area retired (ha)	New fence[1] (km)	Establishment costs		Production change		
			Fencing[2] ($)	*Plants[3] ($)*	*Effective area retired (ha)*	*Milksolids[4] (kg MS/yr)*	*Income[5] ($/yr)*
Fencing waterways	2.6	4.7	$11,186	-	- 1.2	- 999	- $6,426
10m buffer	7.7	7.2	$15,422	$5,040	- 6.3	- 5247	- $33,739
20m buffer	8.7	7.9	$16,922	$6,240	- 7.8	- 6496	- $41,772
30m buffer	8.8	8.1	$17,350	$6,320	- 7.9	- 6580	- $42,308

1 Required length of fencing generally decreases with increasing buffer width (less angles)
2 At $2.38/m and a 10% reduction in cost as the buffer gets wider to account for fewer angles, less materials, and less fencing time (plus greater use of existing fences)
3 Native species at $800/ha targeting the retired effective area. Note that this is a conservative value ($10,000 - $20,000 per ha has been cited elsewhere)
4 Based on current production figures (830 kg MS per hectare).
5 At $6.43 per kg MS

Recommendation: Not to establish planted riparian buffers at this stage. Other recommendations in this report will help improve environmental performance considerably, which may be sufficient for achieving catchment water quality targets.

5.2.7 Effluent treatment system – travelling irrigator

Travelling irrigators are a common option for applying treated effluent to land. Further, purchase of a travelling irrigator system is currently being considered by the farm owner. Dave Horne from Massey University has evaluated the potential of using a travelling irrigator in place of the siphon pipe system.

Proposal: Use a travelling irrigator system and deferred irrigation to apply treated effluent to land at a maximum accumulated N-loading of 150 kg N/ha/yr.

Effectiveness: Overseer suggests the effluent application area needs to be at least 20 hectares in size to operate effectively within the 150 kg N/ha/yr N-loading recommendation. A soil water balance was calculated to identify (a) when effluent can be applied, and (b) how much effluent can be applied per event. The calculation was run each year for a ten-year period (1994-2004) using official rainfall data collected on the neighbouring farm (supplied by Horizons), and a generous 30mm available water holding capacity for the Kopua silt loam soil type (from Landcare's National Soils Database). The smallest depth that travelling irrigators can apply to is typically 8mm, so a minimum 8mm soil-water deficit was used to trigger an irrigation event. Each event would allow two daily runs of the irrigator (i.e. two shifts) and the application of 100m^3 of effluent to 1.24 hectares. Results suggest that it will be extremely difficult to achieve deferred irrigation successfully on Glenbrook Farm with a travelling irrigator (Table 10). In five of the ten years there was a risk that 25-30% of annual effluent volume would have exited the soil as runoff or drainage.

Relative to the 2.6 kg N/ha/yr N-loss under the current siphon-tube system, **switching to a travelling irrigator could result in an average N-loss reduction of 1.6 kg N/ha/yr**. HOWEVER, this is an average value subject to much variation, and it is unlikely that Horizons would ever issue a consent that permits the application of effluent to wet soils in most years. **To achieve an effective deferred irrigation programme using a travelling irrigator (for most years) would require double the current pond storage capacity (*i.e.* 8000 m^3).**

Table 10: Assessment of travelling irrigator effectiveness

Season	Net effluent[a] generated (m^3/yr)	Unsafe irrigation days in lactation season[b]	Effluent that would be applied to wet soil because pond was full (m^3/yr)	Potential N-loss (kg N/ha/yr)[c]
94-95	9306	175	1272	0.5
95-96	9088	174	5013	1.9
96-97	8997	172	2857	1.1
97-98	8627	159	192	0.1
98-99	8901	146	3754	1.4
99-00	8424	123	0	0
00-01	8889	133	1594	0.6
01-02	8575	146	0	0
02-03	8469	137	3033	1.1
03-04	9353	173	278	0.1
10-yr mean	8863	154	1799	1

(a) Liquid effluent (excludes sludge) *(b) Days when irrigation cannot be applied* *(c) At an effluent concentration of 70 mg N/L*

Implications & cost: Travelling irrigators are often the cheapest land application system to purchase but they can have very high operating costs (particularly with labour inputs). Set up cost would be at least $26,500 (quote obtained by farm owner), which is relatively inexpensive compared with some systems. However, to be a viable option the ponds would need to be enlarged to double their current capacity. This is estimated to cost $4500, which when added to the irrigator purchase, would bring total investment cost to $31,000. Further, a travelling irrigator often requires a much higher degree of commitment and work than many seem to appreciate. Having to move the irrigator twice per day – often on inconvenient days decided by the weather – represents a high ongoing labour commitment that needs to be built into the day-to-day operation (on top of everything else).

Recommendation: To adopt a travelling irrigator system only if other options are unsuitable (see below), and only if pond storage capacity can be doubled and the extra work commitment can be accommodated.

5.2.8 Effluent treatment system – Larall system (Low Application Rate & Low Labour system)

The 'Larall system' is based on multiple interconnected sprinkler heads similar in concept to K-Line systems but larger (see Appendix 4). It is considered here because of its ease of operation, low application rate, and capacity to irrigate a large area over short time periods.

Proposal: Use the Larall system and deferred irrigation to apply treated effluent to land at a maximum accumulated N-loading of 150 kg N/ha/yr.

Effectiveness: Potential effectiveness was evaluated in the same manner as the travelling irrigator, but using a soil-water deficit trigger of 4mm rather than 8mm (application rate of the Larall system is typically 3.6 mm/hr). This permits an application of 210m^3 (at a depth of 3.6mm) onto 6 hectares using 20 sprinklers per irrigation event.

The Larall system would achieve deferred irrigation in all but one of the ten years considered (Table 11). Accordingly, **N-loss would be reduced by and estimated 2.6 kg N/ha/yr** (i.e. all N-loss associated with the current siphon-tube system) on average. For the one year where effluent had to be applied to a wet soil (1995-96), there are options available with the Larall system that would have allowed management to achieve a nil wet-soil application record for the year.

Table 11: Assessment of Larall system effectiveness				
Season	Net effluent[a] generated (m^3/yr)	Unsafe irrigation days in lactation season[b]	Effluent that would be applied to wet soil because pond was full (m^3/yr)	Potential N-loss (kg N/ha/yr)[c]
94-95	9306	150	0	0
95-96	9088	137	854	0.3
96-97	8997	133	0	0
97-98	8627	122	0	0
98-99	8901	106	0	0
99-00	8424	89	0	0
00-01	8889	99	0	0
01-02	8575	106	0	0
02-03	8469	103	0	0
03-04	9353	139	0	0
10-yr mean	8863	118	85	0.03

(a) Liquid effluent (excludes sludge) *(b) Days when irrigation cannot be applied* *(c) At an effluent concentration of 70 mg N/L*

Implications & cost: The Larall system is relatively expensive to purchase. It is estimated that a system with 20 sprinklers would cost Glenbrook Farm approximately $53,500 (estimate for a 20ha system) to establish (includes pump, pipe, etc.). Savings expected from improved pasture response and the fertiliser value of effluent nutrient is estimated to reduce cost to $49,360 (see Appendix 3). Further, operating costs for a Larall system are considerably lower than that of a travelling irrigator (labour requirements are much less – see Appendix 4). The system is also expandable (just add more sprinklers) if herd size – and effluent generation – grows in the future.

Recommendation: Consider the Larall system as the preferred option for applying effluent to land. While initial financial outlay is relatively high, it can achieve a successful deferred irrigation programme that is compliant with One Plan requirements. Further, it represents a less labour-demanding option that would be easier to introduce to the current operation.

5.2.9 Effluent treatment system – wetland treatment post oxidation ponds

Well designed and maintained wetlands can be used as an additional treatment step for effluent discharged from oxidation ponds. Site characteristics below the effluent ponds suggest the area may have been an extensive wetland prior to drainage, and may therefore be suitable for conversion to an effluent treatment wetland.


EFFLUENT RECEIVING WETLAND

Proposal: To treat oxidation pond effluent through a receiving wetland designed to achieve Treatment Level 1 specifications* (potentially suitable for indirect discharge to streams via farm drains and natural wetlands).

Effectiveness: Guidelines for the design of effluent treatment wetlands suggest a minimum wetland size of 780 m^2 for a herd of 368 cows. There is scope for an area considerably larger than this (see Appendix 1: Wetland Option #1 = 6594 m^2). If built and maintained according to specifications, then the wetland has the potential to decrease suspended sediment (40-65%), nitrogen (15-35%), phosphorus (5-15%), and faecal coliforms (70-85%). Accordingly, **this particular effluent-receiving wetland has the potential to reduce N-loss by 1 kg N/ha/yr**. A larger wetland with a gravel bed (Treatment Level 2) has the potential to remove up to 50% of nitrogen, which would reduce N-loss by 1.3 kg N/ha/yr (Table 12).

Table 12: Potential effectiveness of wetland treatment of effluent				
Pollutant	Reported effectiveness (% removed)*		Potential effectiveness forGlenbrook Farm	
	Level 1 Treatment	Level 2 Treatment	Level 1 Treatment	Level 2 Treatment
Suspended sediment	40-65	70-75	-	-
Total nitrogen	15-35	40-50	0.9 kg N/ha/yr	1.3 kg N/ha/yr
Total phosphorus	5-15	10-25	0.09 kg P/ha/yr	0.15 kg P/ha/yr
Faecal coliforms	70-85	85-95		-

Implications & cost: Building an effective wetland requires considerably more investment than simply plugging a drain and erecting a fence. Based on recommended guidelines* minimum cost would be in the order of $15,000 for Treatment Level 1 and $30,000 for Treatment Level 2. Area lost from the grazing rotation would be minor, and because it is low quality land (dominated by rushes, wet, very stony), impact on production would also be minor.

Recommendation: Not to construct a receiving wetland for the purpose of treating effluent. While wetland treatment would be an improvement over the current siphon-tube system, the N-mitigation gains are not likely to be as substantial as those that may be achieved under other options (i.e. the Larall system).

** Guidelines for constructed wetland treatment of farm dairy wastewaters in NZ (Tanner & Kloosterman, 1997).*

5.3 Achieving 2010 N-targets

Glenbrook Farm would need to reduce N-loss by 6 kg N/ha/yr to be compliant under the One Plan when Rule 13x comes into effect for the Mangatainoka Water Management Zone in 2010. Fortunately, in having assessed the farm early, Glenbrook Farm has a two-year grace period to achieve the 2010 N-targets. There is a variety of mitigation options available for this farm, and therefore a degree of flexibility in how the N-targets are achieved. However, in the short term, fencing waterways and upgrading the effluent system are the two most strongly recommended actions. Together, they would reduce N-loss by an estimated 3 kg N/ha/yr. Further, the effluent system upgrade appears to be needed for compliance with the existing resource consent, and both actions would be required under the Clean Streams Accord. The shortfall (3 kg N/ha/yr) would readily be accommodated by adopting the use of inhibitor products. This would put the farm N-balance in credit (+2 kg N/ha/yr) and carries the promise of increasing farm gate returns.

5.4 Achieving 2030 N-targets

Longer term targets require the adoption of additional mitigations. Assuming the farm can remain operational without any future N-loss gains (however, see predicted N-loss from an intensification scenario on page 16), then the farm must reduce the current level of N-loss by 10 kg N/ha/yr over 20 years to remain compliant with the One Plan in 2030. Factoring in the mitigations mentioned above, a further reduction of 2 kg N/ha/yr would be required. This is not insurmountable given the current development rate of N-mitigation technologies.

It would be irresponsible to speculate if these developments can match current intensification trends in the dairy industry. It is conceivable that ongoing intensification could result in a required N-loss reduction of 21 kg N/ha/yr by 2030. However, this is a long time frame, and it can be argued equally that downturn in commodity prices plus increased consumer demand for produce from low intensity systems could result in a net decrease in Glenbrook Farm's predicted N-loss. Twenty-years is just too long for reliable predictions.

6.0 ONE PLAN REQUIREMENTS

Controlled and permitted activities relevant to Glenbrook Farm have been assessed to identify current levels of compliance under the One Plan (Table 14 opposite). Note that the list and terminology is a summary and only applies to Glenbrook Farm. Refer to the One Plan for a full list of controlled and permitted activities. Non-compliant activities are further evaluated to identify actions or options required to become compliant (Section 6.3). There is an unavoidable degree of overlap with recommended N-loss mitigations (previous section) and recommendations to become fully compliant under One Plan rules.

6.1 Existing consents

Currently there is one active consent for discharge to land (Table 13). Note that existing consents will be replaced by a Whole Farm Consent associated with this FARM Strategy, except for consents concerning large ground water takes, construction of bores, and any other type of consent not covered in the FARM Strategy workbook.

Table 13: Active resource consents for Glenbrook Farm, 2007

Consent reference	*Consent Type*	*Max Daily (m^3/d)*	*Max Rate (l/s)*	*Started*	*Expires*	*Water Body*
101496	Discharge to Land	9	-	21/01/99	21/01/19	-

6.2 Planning period

This FARM Strategy is designed for a 5-year planning period. However, it is recognised that the viability of some mitigation practices are strongly dependent on seasonal factors (cost, payout, climate, etc), and it is conceivable that the most suitable options for mitigating environmental impact will fluctuate annually. It is therefore recommended that the nutrient budget be reassessed each year, and mitigation practice adjusted accordingly.

TABLE 14: Summary of controlled and permitted activities under the One Plan (2007)

CONSENTABLE ACTIVITY	REQUIREMENTS	STATUS 07	NOTES
Farming within N-loss target?	1. Farm N-loss must be within N-loss targets	Requires attention	Currently above 2010 N-targets
Produce animal effluent?	1. No direct discharge of effluent to water from yards or pads	Compliant	
Store animal effluent?	1. No direct discharge of effluent to water from ponds & sumps	Compliant	
	2. Ancillary storm water must not discharge into pond or sump	Requires attention	A proportion of storm-water from milking parlour roof is deposited on the yards and then into the ponds
	3. Effluent storage must be sealed and not leaking	Uncertain but assumed to be compliant	Seepage noted around base of pond walls but may be from natural drainage and water table fluctuations. Difficult to evaluate within project limits so assumed compliant until proven otherwise.
	4. Effluent pond or sump must have capacity to hold 2-days of effluent between applications (if applied to land)	Compliant	
Apply effluent to land? **	1. No substantial leaks in irrigation pipes or equipment	Compliant	
	2. Discharge application must be > 20m from surface water bodies, bores, or the CMA	Compliant**	However, the nature of the siphon system discharge means there is a high risk of effluent reaching open water from runoff. Under the existing consent this would be non-compliant but under the One Plan it probably is compliant
	3. Discharge application must be > 20m from public areas & roads, or residences	Compliant	
	4. Discharge application must be > 50m from protected archaeological or biodiversity areas	Compliant	
	5. Must have a nutrient budget (emphasis on N)	Compliant	
	6. Must not apply on days when drift will cause problems for neighbours	Compliant (assumed) *	
	7. No surface ponding for more than 5hrs after application	Compliant (assumed) *	Highly unlikely given porous soils and surface runoff characteristics of the site
Surface or ground water take?	1. Surface or ground water takes require a consent	Compliant	No current surface or ground water takes in operation
Use biosolids or soil conditioners?	1. Application of biosolids and/or 'soil conditioners' requires a consent	Compliant	Biosolids and soil conditioners not used (other than lime)
Active farm dump or offal hole?	1. Farm dumps or offal holes require a consent	Compliant	Farm owner asserts there is no active farm dump or offal hole on the property. No dump or offal hole was sighted during the field survey.
Stock have direct access to waterways?	1. Stock must have adequate (reticulated) trough water available in each paddock (ideally to meet peak demand)	Compliant	
	2. Waterways that qualify under the Clean Streams Accord must be fenced	Requires attention	3.1 km of riparian fencing required
	3. Stock crossings must have a bridge or culvert	Requires attention	Farm well served with existing culverts and bridges but riparian fencing would necessitate 3 extra culverts
	4. Runoff from bridges and culverts must be directed to land rather than water	Compliant	Runoff is redirected to land where practicable
Apply fertiliser?	1. No application of fertiliser directly to water bodies	Compliant (assumed) *	
	2. No application into protected biodiversity areas	na	No rare/threatened/at risk habitats or archaeological/cultural sites on the farm.
	3. Must be applied in accordance with industry Code of Practice	Compliant (assumed) *	
	4. N-fertiliser use requires a nutrient budget	Compliant	
	5. Must not apply on days when drift or odour will cause problems beyond the farm boundary	Compliant (assumed) *	
Store and feed supplements?	1. Feed storage areas must be sealed to restrict effluent seepage (downwards percolation). Excludes silage pits <500m² and presumably hay sheds	Compliant	
	2. Feed storage areas must be protected from water runoff entry	Compliant	Applies mainly to silage pit in this case, which is compliant
	3. Runoff from feed storage areas must not enter surface water bodies	Compliant	Applies mainly to silage pit in this case, which is compliant
	4. Feed storage areas must not be sited within 50m of protected areas, or within 20m of bores, water bodies or the CMS	Compliant	
	5. Feeding out must not take place within 50m of protected areas, or within 20m of bores, water bodies or the CMS	Compliant	
	6. Feed storage and feeding out shall not result in objectionable odour, dust or drift beyond the farm boundary.	Compliant (assumed) *	

* Level of compliance cannot be assessed conclusively within project limits. Full compliance is assumed until proven otherwise.

** Oddly enough, it appears that the current land disposal system would be compliant under the One Plan. The closest condition is 13-6a, where 'there shall be no discharge of effluent into a waterbody…'. Technically there is no direct discharge – effluent reaching the drain comes via a discharge to land, and is therefore only an indirect discharge to water. Given the obvious inefficiency of the siphon pipe system this is quite surprising. However, because upgrading the effluent treatment system would be required under the current consent, it is considered a compliance requirement under the One Plan pending clarification.

6.3 Five-year strategy to achieve One Plan compliance

6.3.1 Maintaining existing mitigations

Existing mitigations have been reported in Section 5.1. Change with any of the listed activities may affect N-loss, and would therefore necessitate a nutrient budget reassessment. Accordingly, existing best-practice activities should be maintained for the first year, and reassessed with a new nutrient budget in the second year.

Objective 1: Maintain level of urea use at 102 kg N ha^{-1} yr^{-1} for 2007/2008. Record where, when and how much urea is applied during the season (for improved nutrient budgeting in the following year).

Objective 2: Continue to avoid winter applications of urea and other N-fertilisers.

Objective 3: Continue to graze the dairy herd off-farm during winter.

Objective 4: Maintain existing policies for stock, grazing and fertiliser. A significant deviation in these policies would require re-evaluation of the nutrient budget and N-targets.

6.3.2 Operating within N-targets

The farm is required to operate within an N-target of 20 kg N ha^{-1} yr^{-1} starting year 2010. Currently Glenbrook Farm is 6 kg N ha^{-1} yr^{-1} above the target. While no change is required until 2010, it is recommended some of the mitigation works are initiated early (e.g. fencing streams). Sub objectives concerning fencing waterways and the effluent system are covered in more detail under Sections 6.3.6 and 6.3.8.

Objective 5: Reduce N-loss by 0.2 kg N ha^{-1} yr^{-1} by fencing all waterways that qualify under the Clean Streams Accord before 2010 (see Section 6.3.6).

Objective 6: Reduce N-loss by 2.6 kg N ha^{-1} yr^{-1} by adopting a Larall system for the application of effluent to land (see Section 6.3.8).

Objective 7: Achieve a combined N-loss reduction of 5 kg N ha^{-1} yr^{-1} by switching to a urease-urea product starting 2008/09, and...

Objective 8: Spray pasture with a nitrification-inhibitor product starting 2008/09 season according to manufacturer recommended rates and timings.

6.3.3 Effluent application area

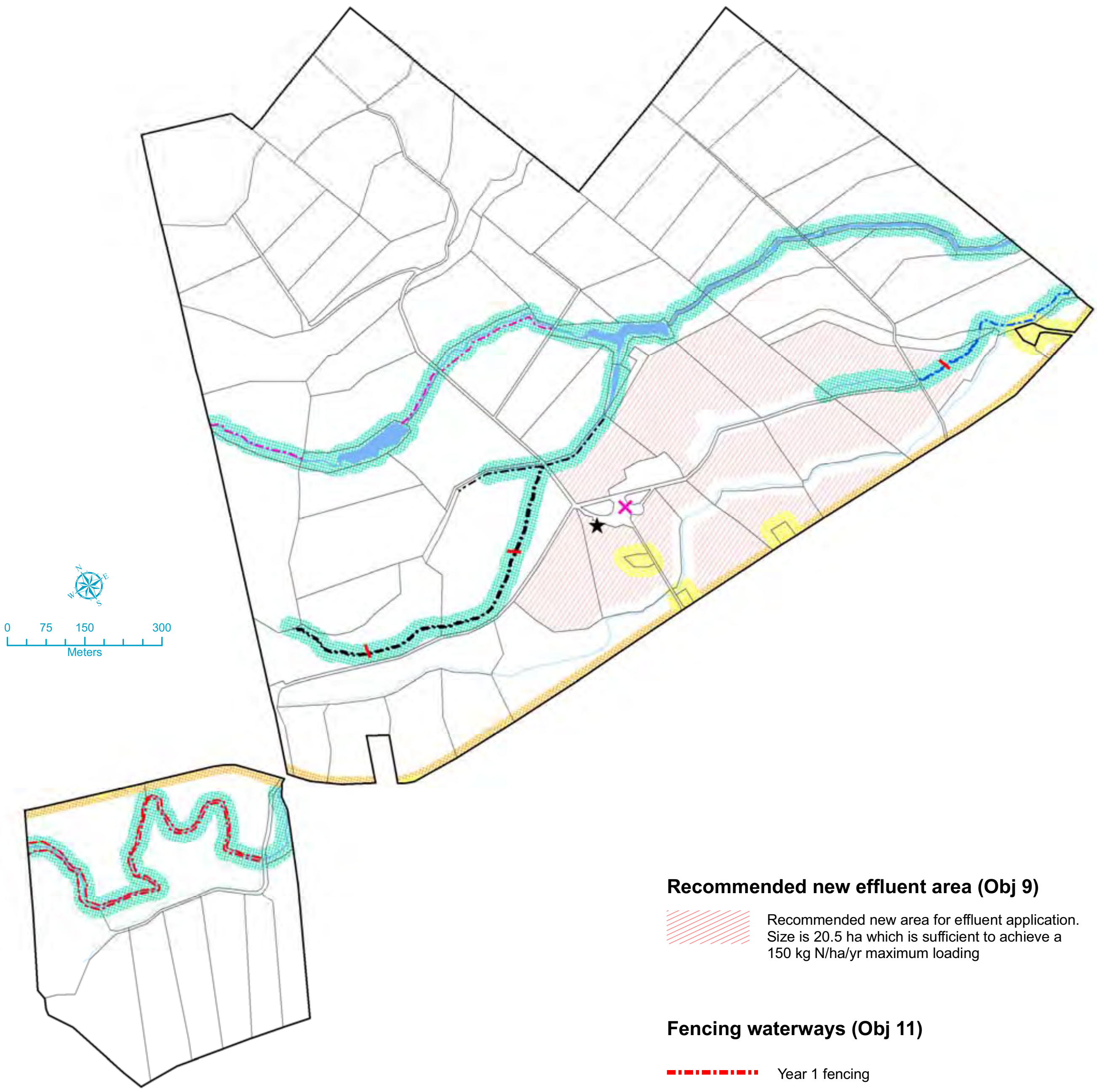
Overseer suggests a minimum effluent application area of 20 hectares is necessary to achieve a commonly recommended maximum loading of 150 kg N/ha per year. This is not an explicit compliance requirement under the One Plan. However, it would likely be written as a consent condition for both the travelling irrigator or Larall effluent application systems (depending on which system is chosen). It is strongly recommended that the effluent area be located on the mid-terraces rather than the old river bed (which has very low water holding capacity and high water table. Soil water balances would need to be recalculated). The area suggested for effluent disposal is presented on the Works Map opposite. Note that effluent application needs to be carefully managed to avoid sensitive areas that qualify as One Plan separation distances (no applications within 20m of boundary, water or residences).

Objective 9: Expand the effluent application area according to the Works Map for the 2008/09 season. Manage carefully to avoid applications onto sensitive areas.

6.3.4 Storm water runoff

Rainwater from a proportion of the milking shed roof (175 m^2) flows into the yard and then into the effluent ponds, thereby contributing to the liquid volume of effluent generated. At an annual rainfall of 1865 mm this small area would be collecting around 326 m^3 of water every year (3.7% of annual net-effluent volume). Roof stormwater discharge to effluent ponds is not permitted under the One Plan. Stormwater should either be collected in a tank or discharged to land. Cost of additional guttering and pipe to achieve the latter option is estimated at $500.

Objective 10: Install new guttering and pipe to direct stormwater runoff from the milking shed roof onto land.



Recommended new effluent area (Obj 9)

Recommended new area for effluent application. Size is 20.5 ha which is sufficient to achieve a 150 kg N/ha/yr maximum loading

Fencing waterways (Obj 11)

- Year 1 fencing
- Year 2 fencing
- Year 3 fencing
- Year 4 fencing

Other works

- Roof stormwater diversion (Obj 10)
- Additional culverts (Obj 12)

ONE PLAN separation distances (for effluent)

- No discharges of dairy effluent permitted within 20 m of a public road.
- No discharges of dairy effluent permitted within 20 m of residences, marae, schools, public buildings and public recreation areas.
- No discharges of dairy effluent permitted within 20 m of bores or surface water bodies*

One Plan 'waterbody' definitions are unclear. Effluent separation distances around targeted Clean Streams streams are shown in blue on the map. However, effluent area is calculated by considering all surface waterbodies in vicinity (just in case).

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

REQUIRED WORKS

Glenbrook Farm

Hukanui Road, Eketahuna

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

6.3.5 Fencing streams

The farm has 4.5 km of waterways that qualify as targeted under the One Plan and the Clean Streams Accord. Approximately 1.4 km is already protected. Total length of new fencing required is 4.7 km. This is broken down to a 4-year programme starting 2008 (Clean Streams target date is 2012).

Objective 11: Achieve Clean Streams Accord and One Plan requirements by fencing waterways with an electrified two-wire waratah fencing system before 2012.

11a: Erect 1.9 km of riparian fencing on the 60 Acre block during the 2007/2008 season.
11b, **11c**, **11d**: Aim to erect 0.6 km, 0.5 km and 1.8 km of fencing over three years (2009-2012) to achieve the Clean Streams target.

6.3.6 Additional culverts

Currently the farm is well served with culverts and bridges. However, at least three paddocks would be dissected under the riparian fencing programme described above. As a result, 3 new culverts will need to be installed to ensure connectivity between the bisected portions of these paddocks. Cost is estimated at $350 per culvert (450mm culvert) or $1,050 for the three culverts.

Objective 12: Install three new culverts in the paddocks shown on the Works Map (page 27).

6.3.7 Effluent irrigation system

The current method of applying effluent to land (siphon pipe) is unlikely to compliant under the existing consent. However, under the One Plan the system itself would be eligible provided there was no direct discharge to water. In our view this is an oversight, and it is probable that the current system would only be permitted to continue with a long list of new conditions that would make it difficult to operate. We therefore strongly recommend switching to the Larall system

Objective 13: Use a 20-sprinkler Larall system to apply treated effluent to a minimum area of 6 hectares at a maximum rate of 210 m^3 on days when soil moisture deficit is >4mm. Sprinklers would need to be shifted 3 times per day to achieve this rate.

6.4 Summary of compliance cost estimates

6.4.1 Direct costs

Cost estimates are generated from local prices at time of writing and are therefore subject to change. Full cost could not be established in all cases (particularly secondary costs), and it is likely that a canny farmer could make substantial savings (cost of services is based on contract rates). **Total cost to become compliant with the One Plan estimated at $62,120**. Note that fencing waterways and upgrading the effluent application system can both be considered as existing compliance costs rather than One Plan compliance costs.

Table 15: Cost estimate summary

Exclude stock from targeted waterways (Obj 5)	$11,200[a]
Adopt Larall effluent-to-land system (Obj 6)	$49,360[b]
Switch to a urease-treated urea product (Obj 7)	$0[c]
Spray nitrification inhibitor to pasture (Obj 8)	$0[c]
Redirect shed storm water to land (Obj 10)	$500
Install 3 additional culverts (Obj 12)	$1,050
TOTAL	**$62,120**

[a] *Required obligation under the Clean Streams Accord*

[b] *Can also be considered a Clean Streams obligation. Cost is also an existing cost (current system is non-compliant with current consent), rather than a completely new cost imposed by the One Plan. Purchase cost is quoted at $53,500 less fertiliser value of improved nutrient utilisation ($1340) and expected pasture response at 8:1 ($2800)*

[c] *Cost difference between treated and untreated urea is $4,100/yr. Cost for adopting nitrification inhibitors would be $53,240/yr. It has been estimated that a 6% pasture response would offset cost. 6% response is quite modest, and much higher responses would be expected. Accordingly, gross cost for the adoption of inhibitors is estimated at $0.*

6.4.2 Implications for farm returns

Fencing waterways is the only recommendation that will incur a direct production loss. Approximately 1.2 grazed hectares would be retired as riparian, worth an estimated gross loss of $6,200 per year. On the positive side, improved utilisation of effluent nutrient by the adoption of the Larall system could be worth an extra $1,750 to $7,000 depending on level of pasture response. Likewise, switching to urease-urea and adopting nitrification inhibitors requires only a 6% increase in pasture yield to breakeven. A response of 7.2% would be more than sufficient to offset lost grazing area associated with fencing waterways (~$6,670). Recent studies have reported yield improvements of 5-20%, so it is possible that inhibitors could result in even more substantial financial returns.

TABLE 16: Five-year strategy for compliance with One Plan requirements

OBJECTIVES	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Maintain existing mitigations					
1. Maintain existing urea at a maximum of 102 kg N/ha*	*See objective 7*				
2. Continue to avoid winter applications of N-fertiliser	→	→	→	→	→
3. Continue to graze off-farm during winter	→	→	→	→	→
4. Maintain current policies for stock, feeding & fertiliser*	→	→	→	→	→
Operate within N-loss targets					
5. Reduce N-loss by 0.2 kg N/ha/yr by fencing targeted streams	*See objective 12*				
6. Reduce N-los by 2.6 kg N/ha/yr by adopting Larall system	*See objective 14*				
7. Switch to a urease-urea product	102 kg N/ha/yr	102 kg N/ha/yr	102 kg N/ha/yr	102 kg N/ha/yr	102 kg N/ha/yr
8. Begin N-inhibitor spraying	Spray May & August, within 7 days of grazing	Spray May & August, within 7 days of grazing	Spray May & August, within 7 days of grazing	Spray May & August, within 7 days of grazing	Spray May & August, within 7 days of grazing
Effluent area and N-loading					
9. Expand the effluent application area	Start applying effluent to the new area.	→	→	→	→
Storm water runoff					
10. Direct stormwater runoff from dairy shed roof to land	Install new guttering and transfer pipe				
Fencing streams					
11. Exclude stock from waterways by fencing streams	1.9 km fencing on 60 Acre block (12a)	0.6 km fencing (12b)	0.5 km fencing (12c)	1.8 km fencing (12d)	
Additional culverts					
12. Install 3 additional culverts			Install 2 culverts	Install 1 culvert	
Effluent disposal to land					
13. Adopt 20-sprinkler Larall system to apply effluent at 210 m^3 per hectare per day when soil moisture deficit >4mm	Start as soon as possible				

* Objectives depend on maintaining existing farm management strategies. Any substantial change in stock policy, feeding policy, irrigation, inhibitor application, or N-use will require a reassessment of farm N-loss against N-targets (i.e. a new nutrient budget).

6.5 Other considerations

6.5.1 Council assistance

Fencing and planting waterways will be eligible for consideration of an environmental grant from Horizons Regional Council. Grants are available for enhancing 'water quality by retiring and planting stream banks'. Costs for fencing, plants and labour are all eligible under the grant scheme. Further, Glenbrook Farm would likely attract a higher grant rate (30% to 40% of costs) because this FARM Strategy is, for all intensive purposes, an 'environmental farm plan'. Contact for a local HRC representative is provided at the end of this section.

6.5.2 Follow up

Contacts for follow-up and further information include your Horizons Regional Council representative, and the farm business development consultant involved in this project.

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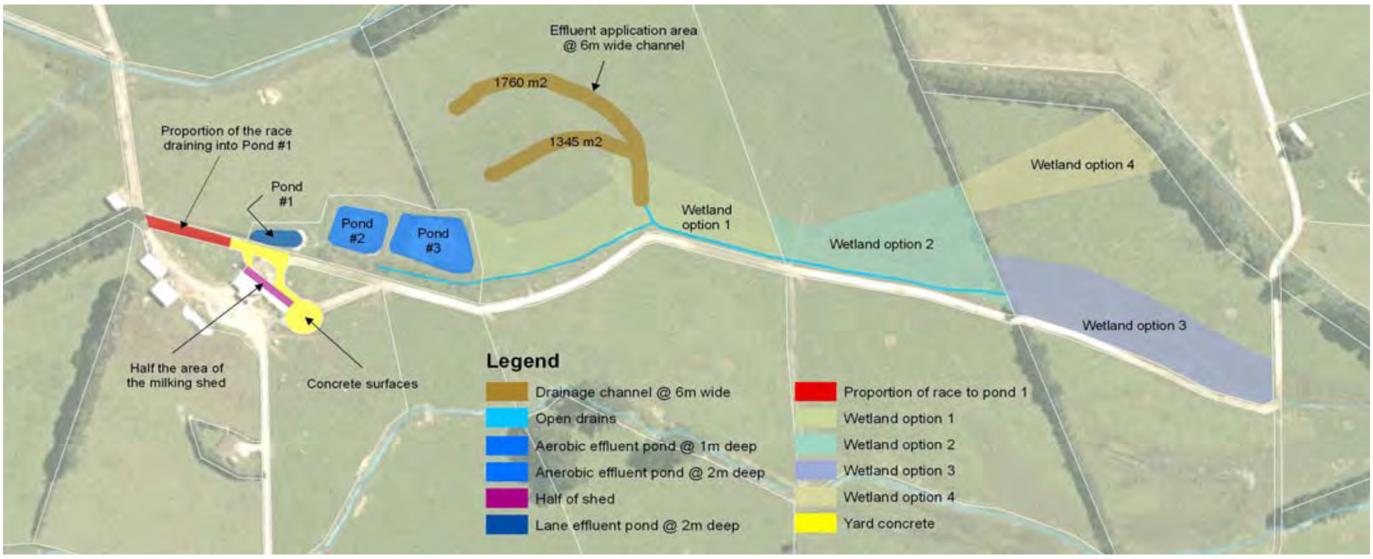
APPENDIX 1: EFFLUENT DISCHARGE TO LAND

Effluent volume: Dave Horne from Massey University used a soil water balance for the period 1994-2004 to estimate the average volume of effluent entering the ponds from 368 cows producing 53 litres of shed effluent per day. Areas capturing rainfall and effluent were calculated off orthophotography, and AWHC for Kopua silt loam (30mm) was taken from the National Soils Database. The average net effluent volume (i.e. excluding solids) was estimated at 8863 m^3/yr. This is the average amount discharged to land each year.



Discharge events and volumes: Volume of the last pond is 1490 m^3 and the siphon inlet height is adjustable, but is generally set at a depth of 250mm. Approximately 25% the last pond's volume will be siphoned during each discharge event (pond depth = 1000mm). At 25%, each discharge event will be delivering 373 m^3 of liquid effluent to the siphon outlet. A typical event spans three days, so application rate would be around 124 m^3/day. To deliver the full 8863 m^3 would require 24 siphoning events spread over the year.

Nutrient concentration & loss: A single effluent sample was taken from the last pond above the siphon inlet at an approximate depth of 0.5m. The sample was analysed by Massey University. High variation in effluent nutrient content is well recognised, and several samples taken throughout the year is generally recommended to obtain a reliable measure. However, results from the one sample aligned well with the lower ranges of reported values for treated effluent (Table A). Using the sample values, the annual amount of nitrogen discharged from the pond is estimated at 620 kg N/yr. Reported values suggest that nitrogen loads may be even higher (thereby justifying the collection and testing of more samples).

Table A: Effluent nutrient concentrations

	Measured concentration (mg/L)	Reported concentrations (mg/L)*		
		Lower	Upper	Average
NH_4-N	5.4			
NO_3-N	33.2			
TKN	36.8			
Total N	**70**	**74**	**132**	**90**
DRP	7.3			
Other P	9			
Total P	**16.3**	**18**	**29**	**23**

** Treated effluent concentrations (several studies) summarised in Longhurst et al., 2000*

Table B: Calculated N & P losses from Glenbrook effluent disposal

	From measured concentration (kg/ha)	Calculated from reported concentrations (kg/ha)		
		Lower	Upper	Average
NH_4-N	0.2			
NO_3-N	1.3			
TKN	1.4			
Total N	**2.6**	**2.8**	**5.0**	**3.4**
DRP	0.3			
Other P	0.3			
Total P	**0.6**	**0.7**	**1.1**	**0.9**

Discharge to land is facilitated by moving the siphon outlet to one of two points in the adjacent paddock (see map above). Both points represent ephemeral water channels with soils exhibiting extended soil-saturation characteristics (mottling and gleying). Making a generous assumption that soakage can extend out 3m either side of the channels' midline to a depth of 0.5m, then the maximum area for effluent disposal would be 1760 m^2 and the minimum 1345 m^2. Assuming available water holding capacity of the soil is 20% when dry, then each area can store up to 135 m^3 and 176 m^3 of liquid respectively before runoff or drainage occurs. So even with a dry soil, losses of effluent to drainage or runoff could be in the order of 570-612 m^3 per siphoning event (76-82% of discharged effluent). Factoring in 3 days evaporation at 6mm/d reduces this to 75-81%. While this is a very generalised calculation, it does serve to demonstrate that the siphoning system would be delivering volumes far in excess of what the soil can hold and process even at the best of times. In truth, soil pores are likely to be clogged from prolonged application, and the soil is only completely dry for a short part of the year.

If 80% of the effluent discharged from the ponds was ending up in water through runoff or drainage, then N-loss would be 496 kg N/yr. On a per hectare basis, **N-loss associated with the effluent system is therefore estimated to be 2.6 kg N/ha/yr**.

APPENDIX 2: INFORMATION CHECK

Assessment of current N-loss through Overseer Nutrient Budgets can only be as robust as the information used in the model. This appendix is provided as an assurance that the best information available was used for Glenbrook Farm at the time of assessment. Most information collected by farmer interview and a review of accounts by the farm consultant. Fertiliser receipts have not been sighted. Inputs for the 2005/06 season were used because the 2006/07 season was considered abnormal and therefore misrepresentative.

Production inputs

- 368 Freisan cows (peak) @ 138,258 kg MS/yr.
- 92 replacements grazed off at weaning.
- Main herd is wintered off-farm (out end of June; back end of July). Paddocks grazed out.
- 74 tn DM of balage, 23 tn DM good quality hay, 135 tn DM palm kernel, 43 tn DM corn silage, 10 tn DM Starch Pro.

Effluent management

- Two pond system + land application via siphon tube (set up in Overseer as '2 pond + discharge' because effluent system analysed separately).
- Sludge excavated every two years and applied to Front Block B.

Resource information

- Farm located 39 km from coast.
- Annual rainfall is 1865 mm (supplied by Horizons Regional Council).
- All blocks are classed as FLAT according to Overseer topography categories.

Block	Ha	Soil	Soil test results May 2007							
			Olsen P	Qt K	OrS	TBK	Qt Ca	Qt Mg	Qt Na	PR
60 Acres	23.9	Kopua silt loam (deep & wet phases)	26	7	20	-	12	20	11	-
Front Block[1]	36.1	Kopua stoney silt loam	50	8	7	-	12	30	8	-
Front Block B[1]	5.7	Kopua stoney silt loam	50	8	7	-	12	30	8	-
Stoney Block	77.2	Kopua stoney silt loam (shallow & bouldery phases)	50	8	7	-	12	30	8	-
Top Flats	23.3	Kopua silt loam (deep phase)	31	5	28	-	11	20	10	-
Trees & non grazeable	21.9									

[1] No soil test information available. Assumed values from Stoney Block.

Fertiliser

- 17 tonne urea-N across whole farm (2005/06). 102 kg N/ha.
- No winter application of urea (May, June, July).
- No inhibitors used.
- 400 kg of 30% potash superphosphate on October or March.
- Lime 1/3 of farm each year (~55 ha) using good quality lime at 2.5 tonne lime per hectare.

Fertiliser nutrient applied (kg nutrient/ha/yr)								
Area (ha)	N	P	K	S	Ca	Mg	Na
Whole farm	102	26	60	30	348	3	0

Pasture management

- Development status for all blocks has been set at DEVELOPED.
- Clover levels have been set at MEDIUM (the Overseer default).
- Pasture utilisation is estimated at an annual average of 80% (Overseer default for Friesians is 85%).
- Pasture utilisation estimated at 80% based on local information.

Assurance statement:

To the best of our knowledge, the information provided above is true and correct at the time the Overseer analysis was undertaken (December 2007).

Farm owners, operator or manager	***Nutrient management consultant***
Name:	*Name:* Andrew Manderson
Date:	*Date:*
Signed:	*Signed:*

APPENDIX 3: NUTRIENT VALUE OF EFFLUENT

Nutrient content of effluent applied to land is calculated for four effluent disposal systems. The nutrient value of sludge is not considered (applied separately). Nitrogen and phosphorus concentrations obtained from an effluent sample. Potassium is estimated at 50 mg/L (K is mostly in slurry in considerably greater quantities – 300 to 500 mg/L). Note that sulphur, magnesium and other nutrients can also be available in significant amounts. Further, nutrient concentrations from the one sample may be lower than average annual concentrations (see Appendix 1). Nutrient quantities calculated from the volume of effluent that is retained and processed in the soil (i.e. excludes effluent lost via runoff or deep drainage).

Table: Nutrient quantities applied to land under different effluent application systems

Treatment system	*Volume of effluent utilised (m^3/yr)*	*Total N (kg N/yr)*	*Total P (kg P/yr)*	*Total K (kg K/yr)*
Existing siphon system	1773	124	29	89
Travelling irrigator	7064*	494	115	353
Larall	8863	620	144	443
Wetland	0	0	0	0

** Under the set-up evaluated for the travelling irrigator, the volume of effluent utilised would be highly variable. Nutrient from effluent would therefore be similarly variable*

Table: Dollar value of applied effluent

Treatment system	*Nitrogen*	*Phosphorus*	*Potassium*	*Total value*
Existing siphon system	$177	$65	$ 93	**$336**
Travelling irrigator*	$707	$259	$371	**$1,337**
Larall	$887	$325	$465	**$1,678**
Wetland	$ -	$ -	$ -	$ -

Fertiliser value of the current siphon-tube system is estimated at $336/yr. Adopting the Larall system would improve this to $1,678 which represents a net saving of $1,342 (that would reduce the set-up price of the Larall system). However, the greater gain would be through improved pasture response. Research has demonstrated that 1 kg N from effluent is equivalent to 1 kg N from urea (in terms of pasture production, composition and nitrate leaching). Accordingly, the same pasture response rates for urea (e.g. 5:1 to 25:1 responses) could be expected for effluent.

Under the current siphon-tube system, 124 kg N with a low 5:1 response could be worth an extra 620 kg DM/yr or an equivalent of a modest $350. At a 20:1 response it would be worth $1,409. For the Larall system, 620 kg N at 5:1 could result in 3,100 kg DM more pasture worth $1,750 or upwards of $6,990 at a 20:1 response. A 20:1 response is not unrealistic under fast pasture growth conditions (50-70 kg DM/ha/day), particularly in summer when the irrigated effluent would be providing water as well as nutrient.

For calculation purposes, cost of purchasing the Larall system is offset by the additional fertiliser value of effluent ($1,342) and an expected average 8:1 pasture response ($2,800).

Note that calculations used by some effluent-system companies would estimate nutrient value considerably higher than the estimate above (possibly around the $4,000 to $6,000 mark for this particular property).

APPENDIX 4: LARALL SYSTEM

LARALL™ (Low Application Rate and Low Labour) system

This involves installing a series of connection points (hydrants) in each paddock on the effluent block, to which sprinklers can be attached. Each sprinkler covers an 18-20m radius, and twelve or more sprinklers can be operated at a time. Most LARALL™ systems irrigate into three or more paddocks at once, allowing large volumes of effluent to be pumped while still achieving low application rates (3-4mm/hr). These application rates give greater flexibility for the nutrient levels applied in the effluent to be fine-tuned, as long as the nutrient concentration in the effluent is tested. For example, a farmer requiring an input of 20kg nitrogen might achieve this through 2.5 hrs pumping, applying 9mm of effluent. The systems are designed to have the same pressure at all sprinklers, giving an even application throughout the system. Sprinklers are disconnected and moved around after use, but because the piping is all installed below ground in the paddock, minimal time for shifting is required (labour can be as low as 30 minutes per week). Nozzle sizes of 6mm and 7mm are used, with a self-cleaning screen attached to the base of pumps to avoid blockages in the system. Existing effluent systems can be easily converted to the LARALL™ system

Extract from Environment Canterbury website

ACKNOWLEDGEMENTS

Key people involved in the preparation of this report include:

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AgResearch

Mary Lund
Tararua Verterinary Services Ltd

Dave Horne & James Hanley
Institute of Natural Resources
Massey University

Phillip Percy
Perception Planning

7.17 CASE STUDY 3 REPORT (PAREWANUI CORPORATE DAIRY + SHEEP & BEEF FARM)

18 kg N/ha/yr Flock House N-loss (2007)

24 kg N/ha/yr N-loss target 2014

19 kg N/ha/yr N-loss target 2034

RESOURCE MANAGEMENT STRATEGY

Flock House Dairy Farm
Parewanui Road, Bulls

FARMS
farmer applied resource mgt strategies

Reference: FARMS/2007/RMS#004
Catchment: Rang_4a & Rang_4b
Prepared by: AgResearch Ltd.
Date: 10/12/07

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BACKGROUND

THE ONE PLAN & RULE 13*x*: At present eleven important catchments in the Manawatu-Wanganui Region have nutrient levels far in excess of what is desirable. To help address this issue Horizons have proposed a Rule in the One Plan that aims to lessen the nutrient-impact from activities associated with intensive farming. Resource consents concerning irrigation takes, fertiliser, stock feed, biosolids, soil conditioners, dumps, offal holes, and effluent, will be necessary for dairy farming, cropping, market gardening, and intensive sheep and beef farming. The Rule will come into effect at different times for each of the eleven catchments.

ONE FARM; ONE CONSENT: A new consent process will be available under the One Plan. The traditional approach of having several separate consents for a farm is replaced with a single whole-farm consent. This means only one consent – not many – is needed for the entire farm. This promises to make the process simpler, quicker and considerably less expensive. A *FARM Strategy* is a necessary prerequisite for a whole-farm consent.

FARM STRATEGY: A FARM Strategy (Farmer Applied Resource Management Strategy) represents an assessment of permitted and controlled activities for a farm, and a strategic plan to ensure those activities comply with One Plan specifications and water quality targets. It combines a nutrient budget, a comparision of farm nutrient-loss against catchment water-quality targets, an evaluation and recommendation of mitigation options (if the farm is operating outside of catchment water-quality targets) including cost and effectiveness, an assessment of eligibility for relevant consents, and a farm plan of works that spells out the where, when and how much of achieving sustainable land use within the given catchment of interest.

This report summarises an exploratory FARM Strategy for Flock House Dairy Farm (AgResearch) – a 611 ha seasonal supply dairy unit located near Parewanui settlement. The farm straddles two priority water management zones – the Coastal Rangitikei subzone (Rang_4a) and Tidal Rangitikei subzone (Rang_4b), both of which are part of the Coastal Rangitikei Water Management Zone (Rang_4). Rule 13x is due to come into effect on the 1st April 2014 for these areas. Flock House Dairy represents the fourth application of the FARM Strategy framework.

1.0 PLAN SUMMARY

- **Purpose:** Purpose is to identify how Flock House Dairy Farm can remain compliant under Rule 13*x* of the proposed One Plan. Emphasis is on identifying best options that achieve requirements without placing unnecessary strain on farm performance.

- **Farm overview:** A 611 ha (465 ha effective) seasonal-supply dairy farm owned by AgResearch but operated as a commercial entity with research obligations, running as two complementary units. The 324 ha **Dairy Platform** comprises the main dairy block (221 ef ha), an auxiliary Gravel Block (47 ef ha), and 56 ha of ungrazed land, all of which is dominated by fertile and productive alluvial soils (mostly class 1 & 2 land). Production is above average at 14.9 tn DM/ha, 1340 kg MS/ha, and 3.9 cows/ha (300,000 kg MS/yr from 850 FxJ cows across 221 ha) although this averages out if the Gravel Block is included (1120 kg MS/ha and 3.2 cows/ha). The 287 ha **Drystock Unit** comprises a dairy support block (128 ef ha), three research blocks (62 ef ha), an intermittently grazed block (8 ef ha), and 90 ha of ungrazed land mostly as forestry. Approximately half the Unit has fertile alluvial soils, and the other half is made up by sand country. Average rainfall is 900mm.

- **Clean Streams Accord:** All 3.8 km of qualifying waterways are fenced. A series of small lakes also qualify, and require 997 m of new fencing to prevent stock access. Effluent sump capacity at the dairy shed (20 m^3) is well below the 85 m^3 capacity required under the One Plan (and therefore the Accord), and an additional holding pond is required.

- **Nutrient loss and water quality:** On a whole farm basis **current N-loss is calculated at a modest 18 kg N/ha/yr**. N-loss for the Dairy Platform and Drystock Unit is calculated at 23 kg N/ha and 11 kg N/ha respectively. Low N-loss reflects a number factors, the largest of which is the averaging effect of including the Gravel Block and the Drystock Unit (both of which have low N-loss).

- **Permissible N-loss: Permissible N-loss is calculated at 24 kg N/ha/yr for the first year (2014)**, and becomes gradually tighter over the 20-yr implementation period (permissible N-loss by 2034 is 19 kg N/ha/yr). Compared with current N-loss (18 kg N/ha/yr), **Flock House farm is operating well within its N-loss limits, and no N-reductions or special mitigation actions are required**. Indeed, the farm has a comfortable buffer extending out for the full 20 years of consideration. A high permissible N-loss limit reflects a predominance of high class land.

- **Mitigations evaluation:** While no N-loss mitigations are required, several options were evaluated either for interest, or because they are a requirement under a different part of the FARM Strategy workbook. Promising options were evaluated in terms of effectiveness, cost, and future impact on farm revenue.

Option	Whole farm effectiveness	Cost	Practicality	Suitability
N-inhibitors	N-loss ↓ **2.7 kg N/ha/yr**	Only 6.5% yield response needed to break even; potentially considerably more profitable	High	✓✓✓
Stop use of urea in winter	N-loss ↓ **5 kg N/ha/yr**	Estimated $48,000 reduction in gross margin	Low	×
Install effluent holding pond	No impact with a small pond. Potentially N-loss ↓ **1 kg N/ha/yr** with a large pond	Small sealed pond recommended at a cost of $1,500	High	✓✓✓
Fence water bodies	Bug risk↓ & N-loss risk↓ & P-loss risk↓	$2,375 cost and $1,060/yr lost revenue (gross)	High	✓✓✓
New silage bunkers	N-loss potentially ↓ **0 - 3 kg N/ha/yr** (very tentative)	$180,000	Medium	✓✓

✓ *Non-negotiable. Required under Clean Streams Accord and/or One Plan.*
Silage storage requirements need clarification from the regional council.

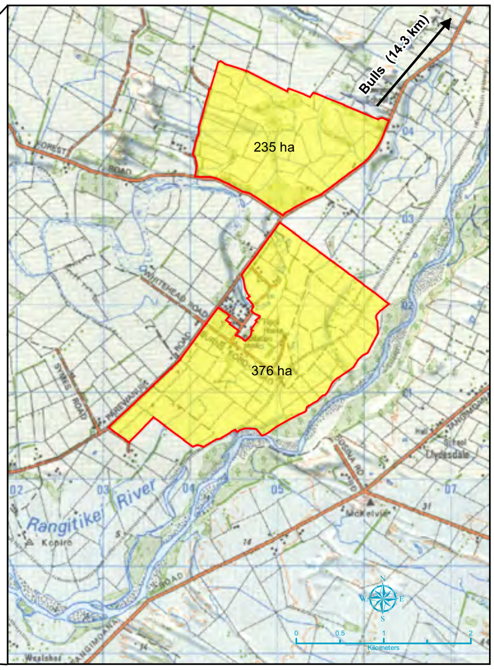
- **Voluntary mitigations**: Consider urease-treated urea and the spraying of nitrification inhibitors. While not a requirement, this practice promises reduced N-loss and increased farm returns if research findings are transferrable.

- **Compliance requirements**: Items needing attention include: installing an effluent holding pond with a capacity to hold at least 2 days of effluent, fencing the main lakes area to exclude stock from water bodies, deactivate use of the stock ford providing access to the Gravel Block (use alternative route), continue avoiding effluent application within 5m of existing riparian fences, and look to install two silage bunkers with facilities to collect leachate (pending clarification from the regional council. There are minor discrepancies between obligations in the One Plan and the FARM Strategy workbook).

- **Compliance cost**: Fencing water bodies ($2,375) and installing a new effluent holding pond ($1,500) can both be considered as existing compliance costs under the Clean Streams Accord ($3,855 total). Likewise with the $1,060/yr loss in gross revenue associated with retiring land around the lakes area. Ceasing stock-use of the ford and observing effluent irrigation separation distances will incur no cost. The only standalone cost directly resulting from One Plan obligations is the two silage bunkers ($180,000), which may or may not be required.

- **Full compliance cost: Total cost of achieving One Plan requirements and N-loss targets (irrespective of what obligation they fall under) is estimated at $183,880 pending regional council clarification of silage storage requirements**.

- **Compliance strategy:** Recommendations to achieve full compliance are made as 6 specific objectives for successive implementation over a five-year period. Any appreciable change in stock policy, feeding policy, or fertiliser will require a reassessment of farm N-loss against N-targets (i.e. a new nutrient budget).



This property is located 14.3 km south west of Bulls township.

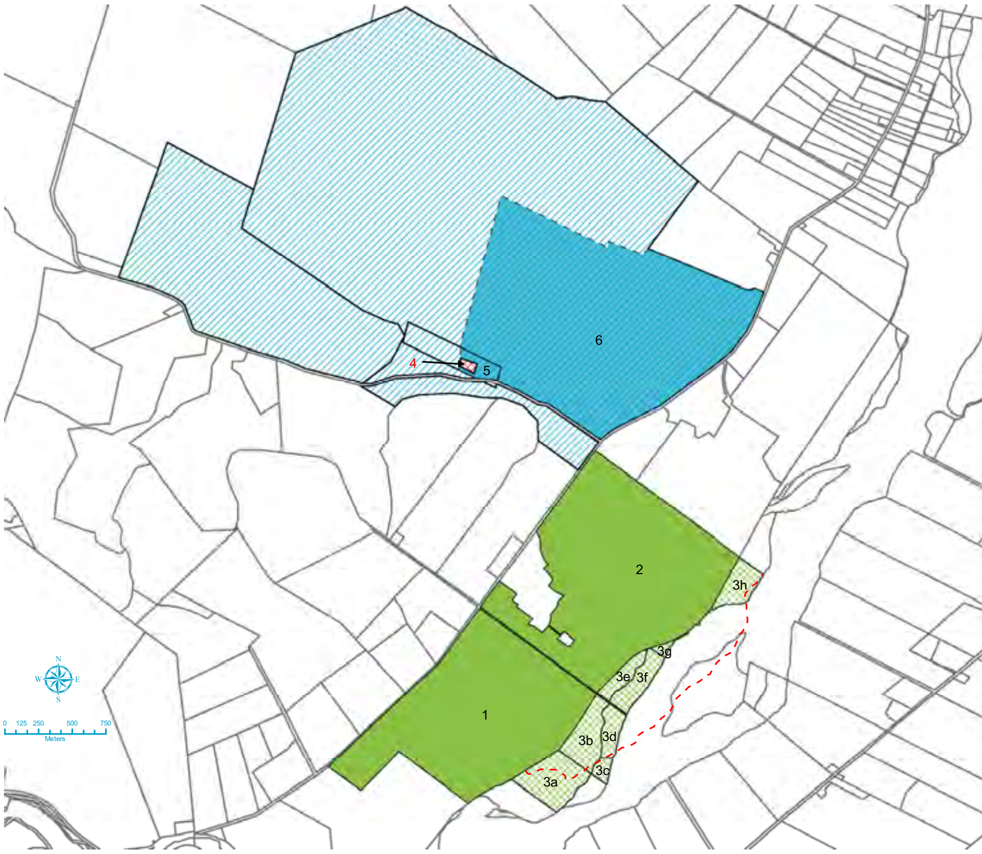
(Distances calculated by road between farm entry road and town centre).

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

FARM LOCATION & ACCESS

Flock House Dairy, Parewanui Road, Bulls

Prepared for Horizons Regional Council by AgResearch Ltd, as part of the FARMS initiative.
September 2007.



ID	LEGAL DESCRIPTION	AREA
1	WN48B/813, SECT 1, SO 37104	138.172 ha
2	WN48B/813, Pt SECT 2, SO 37104	164.657 ha
3x	Gazetted land (not owned)*	74.930 ha**
4	Gazetted land (Maori Reserve)	0.8196 ha***
5	PART OF Pt Section 47 (ownership unclear)	(3.7 ha)
6	PART OF WN48B/813, Section 1, SO 37105	(229.2 ha)
		601.459 ha

* Land not owned but used by AgResearch. Gazetted for Agricultural Purposes (NZGZ 1970 p 289) or Soil Conservation & River Control Purposes (NZGZ 1980 p 3257).

** Gazetted boundaries have not been updated to account for recent river channel changes. Area estimated from existing boundary fence (red dotted line).

*** Gazetted Maori Reserve (NZGZ 1969 p 297)

Legend

- Mapped river boundary 2006
- Legal title under AgResearch ownership
- Gazetted land (used but not owned)
- New dairy farm support block (not yet subdivided under new title)
- Balance of existing Flock House sheep and beef farm
- Gazetted land 2 (Maori Reserve)

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LEGAL TITLES AND PARCELS

Flock House Dairy Farm, Parewanui Road, Bulls

Prepared for Horizons Regional Council by AgResearch Ltd, as part of the FARMS initiative.
July 2007.

2.0 FARM DESCRIPTION

2.1 Existing farm business

2.1.1 The physical resource

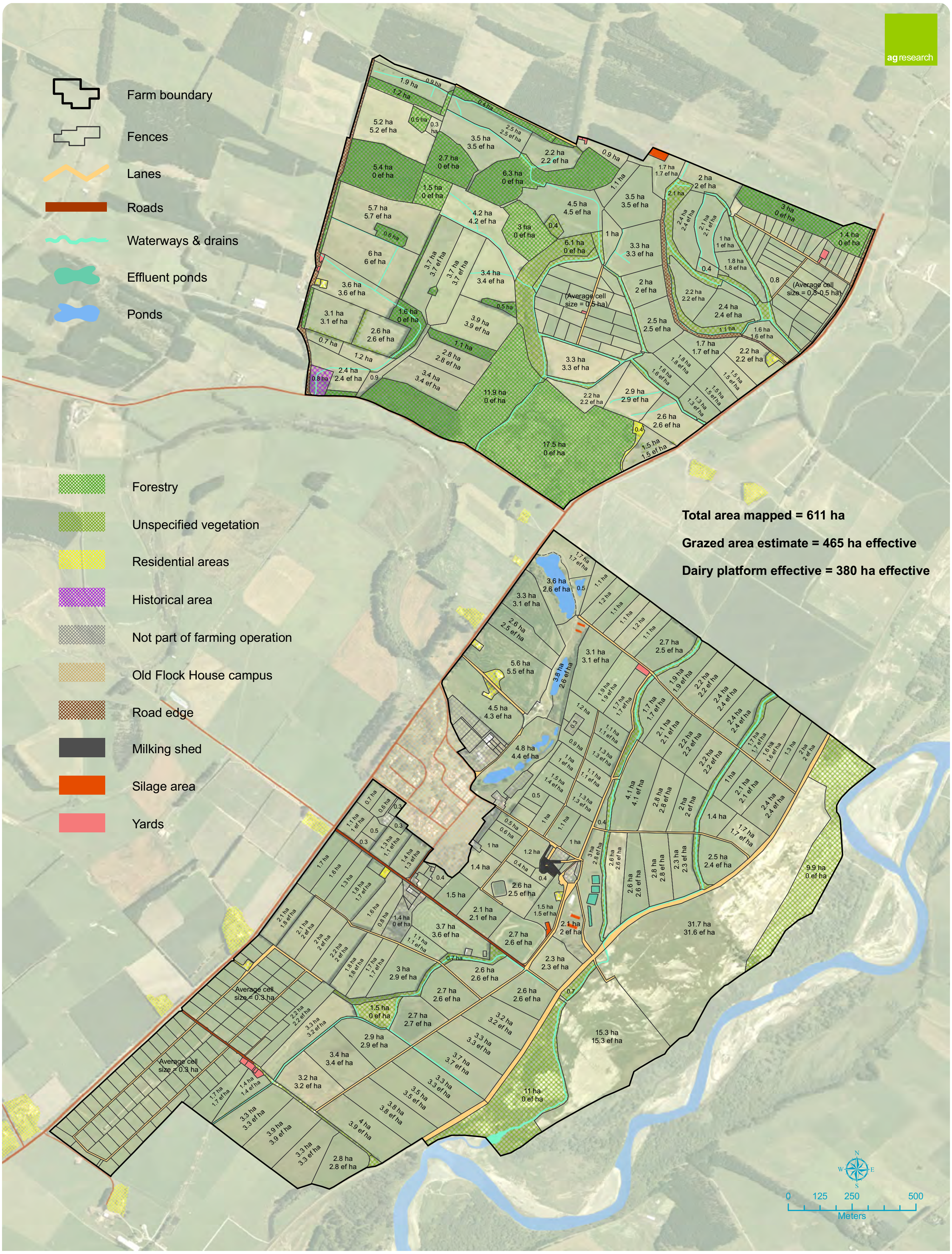
- The farm is located near Parewanui settlement 14.3 km south west of Bulls township on the northern bank of the Rangitikei River. This places it within the One Plan's *Coastal Rangitikei Water Management Zone* (Rang_4). Two subzones are implicated, including the *Coastal Rangitikei* (Rang_4a – 41% of farm) and *Tidal Rangitikei* (Rang_4b – 59% of farm). These are both priority-targeted catchments for nutrient management.
- Two distinct landscapes dominate – sand country located towards the north-west part of the farm, and fertile river flats on the south-eastern side. The sand country represents a complex of dunes, sandy flats and peaty hollows dominated by Himatangi, Pukepuke, Hokio, Waitarere, Foxton and Omanuka series soils. Dunes have rolling to steep slopes, and run in a general WNW to ESE direction. River flats include the former river plains and channel (evident as a winding channel with several small lakes/ponds) and the current flood plain, comprised of an alluvial-deposition soil series sequence common to the Manawatu and Rangitikei districts (Rangitikei + Parewanui → Manawatu + Karapoti → Kairanga).
- Total length of <u>perennial streams</u> is estimated at 3.8 km. While there are many smaller streams and drains across the farm (totalling 12.7 km in length), most are subject to seasonal water-table fluctuations and cease flowing during the summer months.
- Annual rainfall is 900 mm (supplied by Horizons). Long term records suggest rainfall is reasonably well spread over the year, although proximity to the coast (~5.5 km) contributes to high variation between years. A series of small lakes/ponds are located in a former channel of the Rangitikei River.
- Total area of the property has been mapped at **611 ha** with an estimated **465 ef ha** in pasture (excludes 146 ha as forestry, streams, roads, ponds, riparian, infrastructure, etc.). This includes 324 ha as the Dairy Platform (268 ef ha) and 287 ha as the Drystock Unit (197 ef ha) which includes a dairy support block (128 ef ha), three research units (62 ef ha), and an intermittently grazed area (8 ef ha). Note that the dairy effective area used in this report (268 ef ha) is different from the 250 ef ha currently used by farm management. Effective grazed area for Flock House is a moving target due to research obligations (e.g. 37 ef ha of the dairy platform was recently allocated to a parasitology study), the proposed sale of the current sheep and beef farm, and high flood return frequencies that can effectively destroy all grazeable land on the river side of the stop-bank in a very short period.

2.1.2 Farm system

- Flock House Dairy Farm is owned by AgResearch (303 legal hectares). A further 75 ha of gazetted land (estimate) is leased from the regional council. AgResearch also owns the neighbouring Flock House Sheep & Beef Unit (898 legal hectares), but this is currently being considered for sale. Approximately 233 ha of the Sheep & Beef Unit is currently used as a support block for the dairy platform. It is proposed that this 233 ha will be retained by AgResearch for dairy support and research purposes.
- The farm manager has the responsibility and authority to run the farm as a commercial and profitable business. However, commercially farmed land may be allocated to research purposes at any time.
- **Dairy platform**: Seasonal supply dairy-farming system running 850 predominantly Friesian x Jersey cows aiming to produce 300,000 kg of milksolids* (1120 kg MS/ha or 353 kg MS/cow). Dairy platform stocking rate is 3.2 cows per grazed hectare.
- **Drystock Unit**: The support block is primarily used to grow conservation grass and maize (cut and carry), and as a runoff for 302 replacement heifers and 575 wintered dairy cows. Other stock grazed include ewes and lambs (mostly for the research blocks) and bulls. Research blocks are often highly stocked (research overrides the need for production performance), which attributes the Drystock Block with an elevated stocking rate of 14.7 su/ha.

Dairy	
Breed	Friesian x Jersey
Live weight	460-478
Peak number milked	850
Replacements	302
Wintering	575 to support block
Production (target)	300,000 kg MS/yr
Stocking rate	3.2 cows/ha
Other stock	
Ewes	360
Lambs weaned	450
Purchased lambs	1200
Breeding bulls	31
R1 bulls	51

** Currently on target to produce 290,000 kg MS but farm manager is happy to use 300,000 kg MS for this project*



The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

PROPERTY MAP

Flock House Dairy Farm

Parewanui Road, Bulls

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

2.1.3 Infrastructure

- The property encompasses **20.1 km** of lanes and roads.
- Farm buildings, yards and other structures are in good serviceable condition. While a new rotary milking shed was recently installed, throughput capacity is limited by the high cow numbers and milking times are generally longer than most farms.
- The dairy unit is well subdivided with approximately 96 paddocks >1 ha (average paddock size = 2.2 ha). Research units are intensely divided into 0.3-0.5 ha grazing cells. Total length of fencing for the farm is **137 km** (boundary fencing = 17 km, internal fencing = 120 km).
- Shed effluent is stored in a 20,000 litre capacity sump and is sprayed via irrigator to land daily. Effluent application area is 47 ha.

2.1.4 *Clean Streams Accord* and Fonterra's *Effluent Indicator System*

The dairy industry entered into the *Clean Streams Accord* in 2003. Under the Accord, dairy farms are obligated to:

- Exclude cattle from lakes, rivers, and perennial streams deeper than a "Red Band" and "wider than a stride".
- Ensure farm races include bridges or culverts where stock regularly cross a watercourse. Regular is defined as more than twice a week.
- Manage dairy effluent appropriately according to regional council specifications.
- Manage nutrients using a nutrient budget.
- Protect regionally important wetlands.

The aim is to have 90 to 100% of dairy farms compliant by year 2012 (only four years away). Fonterra has also recently introduced the *Effluent Indicator System* for the 2007/08 season. Regional councils are invited to notify Fonterra about farmers who are "persistently and critically" non-compliant with effluent management. Failure to remedy non-compliance in the short term may result in payout reductions, or refusal to pick up milk over the longer term (3yrs).

- The farm has 3.8 km of perennial waterways that qualify as 'Clean Streams' streams, and a further 12.7 km of small streams and drains that do not qualify (dry up over summer). Currently all perennial waterways are adequately fenced to exclude stock from water. **No additional stream fencing is required under the Accord**.
- A series of small lakes/ponds are present on the property. Most would likely qualify as 'Clean Streams' lakes despite their borderline size (area and volume fluctuate seasonally). The lakes are contained within three intermittently grazed paddocks – either by bulls (paddock 1), when moving stock (paddock 2 – laneway is not fenced off), and when stock gain access through dilapidated fences (paddock 3). **Fencing around the lakes needs upgrading to be compliant under the Accord.**
- Current effluent storage capacity at the sump is 20,000 litres. The FARM Strategy workbook states that storage capacity should be sufficient to hold at least two days volume of effluent. Assuming each cow produces 50 litres of shed effluent per day, then 850 cows at peak milking would produce 850,000 litres over two days, which is well beyond the current sump capacity. **Effluent storage capacity would need to be upgraded to be compliant with the Accord**.
- The property is generally well served with culverts and bridges. The exception is the ford access to the river flats area beyond the stopbank (see photo). **Under the Accord the ford is compliant because stock crossings are considerably less than the regular 'twice per week' trigger condition.** However, it would not be compliant under the One Plan (see Section 6) and either a bridge or alternative access would be required.
- The farm has an existing nutrient budget prepared by Ian Power from AgResearch (Ruakura).
- While there can be numerous wet depressions across the farm, there are no wetlands (significant or otherwise) on the property other than those associated with the lakes area.

Stream crossing from the flood zone side of the stop-bank

2.1.5 Pasture and grazing management

- **Dairy Platform**: The herd is milked over a 285 day season between August and May. Half the herd is wintered off the main dairy platform in June and July, and 15% of the herd in August.
- **Drystock Unit**: The main paddock in the Intermittently Grazed Block runs 31 breeding bulls, while the remainder of the block receives infrequent grazing. Replacement dairy heifers (22% of herd), breeding ewes (360) and lambs (up to 1650) are distributed within the research and support blocks. The support blocks also provide a substantial amount of supplementary feed to the Dairy Platform (see below).
- Approximately 15 ha of the Drystock Unit is cropped in maize each year. Maize is harvested in March (~22 tn DM/ha) and ensiled to produce maize silage for feeding out on the dairy block. Likewise, approximately 600 tn DM pasture is harvested off the support block to produce silage/balage for feeding out on the dairy platform.
- Dairy supplement use includes palm kernel (160 tn DM), molasses (130 tn DM), good quality pasture silage (600 tn DM), and maize silage (350 tn DM). Supplements are not fed out on the Drystock Unit.
- Current pasture production is estimated at **14,850 kg DM/ha/yr** for the Dairy Platform. At a pasture utilisation rate of 80% (as an average for the entire year), this equates to 11,880 kg DM/ha/yr consumed, which is similar to the estimate of 12,000 kg DM/ha/yr provided by DairyTeam consultant, John Simmonds. This level of yield is considered above average for these particular soils. Pasture production from the Drystock Unit is estimated at **11,600 kg DM/ha/yr** (2821 su @ 75% utilisation & 550 kg DM requirement, plus supplement harvested). Whole farm pasture yield averages out at **13,230 kg DM/ha/yr**.
- Pasture production estimate is distributed across the farm (map opposite) using Land Use Capability units (map on page 14) and carrying-capacities for different units reported in LRG (1981). Similarly, potential carrying capacities have been used estimate potential levels of pasture production if all manageable limitations were overcome. Upper limit of potential pasture yield is estimated at **19050 kg DM/ha/yr** for the Dairy Platform, **18050 kg DM/ha/yr** for the Drystock Unit, and **18550 kg DM/ha/yr** for the whole farm. Many generalisations have been made to produce these maps, so they should be used for comparative or indicative purposes only. However, they do suggest that Flock House Farm has a wide degree of scope for increasing annual pasture yield into the future.

2.1.6 Farm performance

- No financial data where forthcoming from AgResearch to benchmark economic performance.
- Benchmarking production performance is not reported because of distortions. For example, pasture and stock production on research units is not a priority, so a comparison with commercial performance would be meaningless. Likewise, primary purpose of the support block is to provide supplementary feed to the dairy platform – stock performance on this particular block is almost incidental relative to dairying. Dairy performance is distorted by ongoing changes in grazeable area (owing to floods, land reallocation for research, and pending sale of the sheep/beef unit). However, stocking rate, milk production and the level of inputs suggest the dairy unit is being run at a more intense level relative to similar properties in the district, and it is probable that production performance is also above the local average.

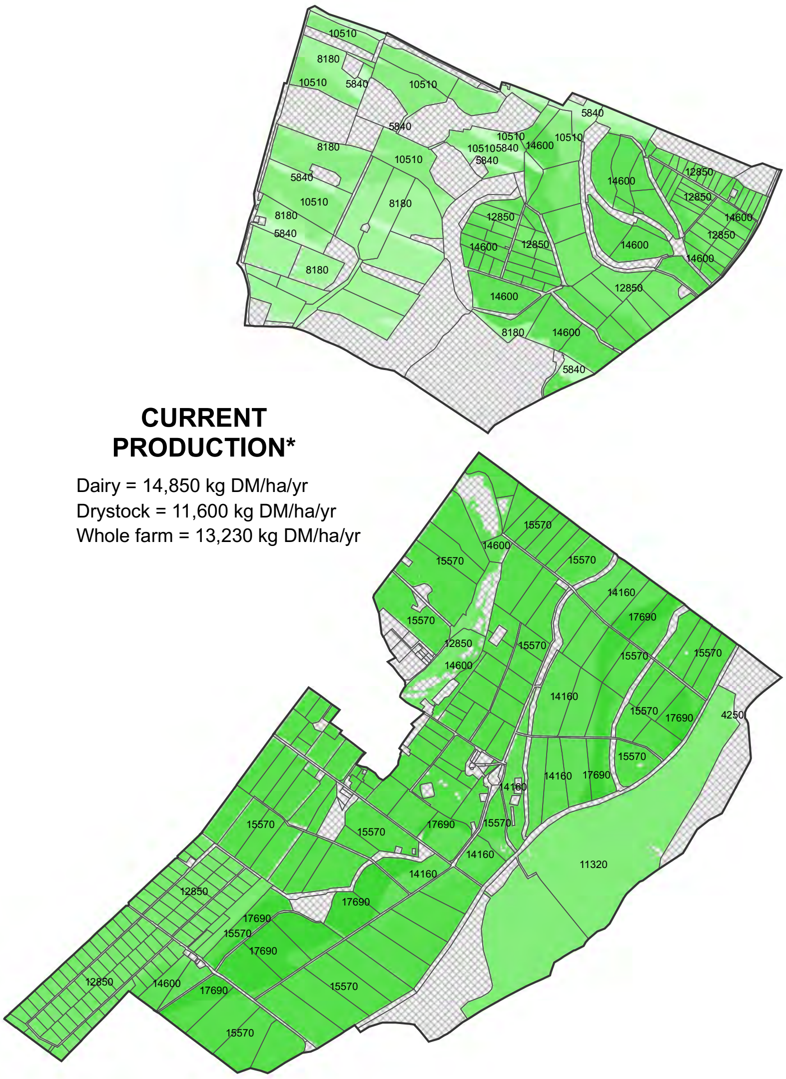
2.1.7 Evaluating Flock House under the One Plan's definition of 'intensive'

Under the One Plan, FARM Strategies are required for intensive farms. The Drystock Unit of Flock House Farm falls outside this definition, yet it is still an integral part of a predominantly intensive farming operation. This has implications for how N-losses and N-targets are calculated, and the degree of compliance required under One Plan conditions.

On the one hand, including the Drystock Unit will reduce leaching loss by averaging it across a larger area (see page 10), which could be considered good from the farmer's perspective. On the other, inclusion makes the Drystock Unit eligible for consideration against the full compliment of One Plan requirements for an intensive farm (e.g. fencing streams, stock crossings, etc). So including the Drystock Unit could potentially increase compliance costs.

It is proposed that farms running dual intensive/extensive systems be given the option to decide on whether an intensive/extensive distinction is made for the calculation of N-losses, N-targets, and the evaluation of compliance requirements. Towards this end, Flock House has been evaluated both on a 'farm unit' and 'whole of farm' basis. This includes the calculation of N-loss and N-targets separately for the Dairy Platform and the Drystock Unit, and for the farm as a whole.

It is unlikely that the Drystock Unit will require any actions or investment to be compliant with the One Plan or Clean Streams Accord (Section 6). As such, it would be far more advantageous to go with the 'whole of farm' option that averages current N-loss (Section 3).



CURRENT PRODUCTION*

Dairy = 14,850 kg DM/ha/yr
Drystock = 11,600 kg DM/ha/yr
Whole farm = 13,230 kg DM/ha/yr

ag research

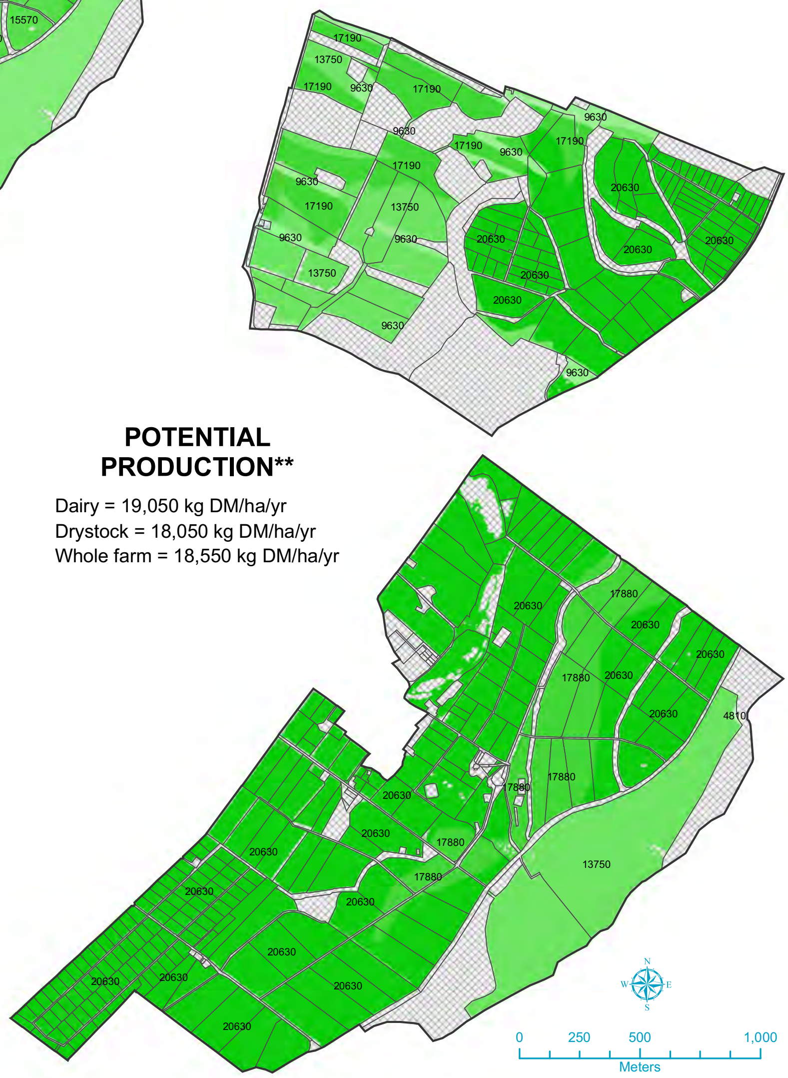
* Current production estimate

Calculated from total annual pasture production based on stocking rate and Overseer calculations.
Categories distributed according relative production potentials (see below) and adjusted according to relative yields used in Overseer.

** Potential production estimate

Potential production calculated from potential stocking rates reported for Land Use Capability (LUC) units in LRG (1981), using 1 su requiring 550kg DM/ha/yr & a variable pasture utilisation according to land class. Potential stocking rate defined as "the number of stock units per hectare capable of being carried on a particular LUC unit, assessed within the limits of present technology and given favourable socio-economic conditions" (LRG, 1981).

Reference
Land Resources Group. 1981. Stock carrying capacities and fertiliser data for the North Island. Internal report No.22. Aokautere Science Centre, Ministry of Works & Development, Palmerston North, New Zealand.



POTENTIAL PRODUCTION**

Dairy = 19,050 kg DM/ha/yr
Drystock = 18,050 kg DM/ha/yr
Whole farm = 18,550 kg DM/ha/yr

Pasture yield categories

Kg DM/ha/yr

- 4090 - 5000
- 5001 - 6000
- 6001 - 7000
- 7001 - 8000
- 8001 - 9000
- 9001 - 10000
- 10001 - 11000
- 11001 - 12000
- 12001 - 13000
- 13001 - 14000
- 14001 - 15000
- 15001 - 16000
- 16001 - 17000
- 17001 - 18000
- 18001 - 19000
- 19001 - 20000
- 20001 - 21000
- Excluded

FARMS Farmer Applied Resource Management Strategy

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PASTURE YIELD GAP

Flock House Dairy Farm

Parewanui Road, Bulls

FOR COMPARITIVE PURPOSES ONLY. Current production estimated from stocking rate and distributed according to Land Use Capability (LUC) classes for the property adjusted to relative yield. Potential production estimated from carrying capacities reported in LRG (1981), using 1 su requiring 550 kg DM/ha/yr and variable utilisation rates according to land class.

Fertiliser Inputs

Gravel Block, Dairy Platform: 15% potash superten 750 kg/ha; 435 kg/ha urea

Effluent Blocks, Dairy Platform: Urea 325 kg/ha (100 kg N/ha in winter)

Rest of Dairy Platform: DAP 282 kg/ha; Muriate of potash 75 kg/ha; urea 350 kg/ha (100 kg N/ha in winter)

Research Block, Drystock Unit: 300 kg/ha potash superten

Support Sand & Alluvial Blocks, Drystock Unit: 300 kg/ha potash superten; 86 kg/ha urea. Maize crop uses 500 kg/ha superten and 325 kg/ha urea

Soil test results

Block	Olsen P	Qt K	OrS	TBK	Qt Ca	Qt Mg	Qt Na
Support alluvial	35	12	11	-	9	35	8
Support sand	15	12	11	-	9	35	8
Intermittently grazed	35	12	11	-	9	35	8
Research 1 & 2	35	12	11	-	9	35	8
Fodder crop	-	-	-	-	-	-	-
Not grazed drystock	-	-	-	-	-	-	-
Karapoti block	35	12	11	-	9	35	8
Manawatu block	35	12	11	-	9	35	8
Parewanui block	35	12	11	-	9	35	8
Rangitikei effluent	50	19	10.2	-	10	46	7
Karapoti effluent	50	19	10.2	-	10	46	7
Flood block	35	12	11	-	9	35	8
Gravel block	35	12	11	-	9	35	8
Not grazed dairy	-	-	-	-	-	-	-

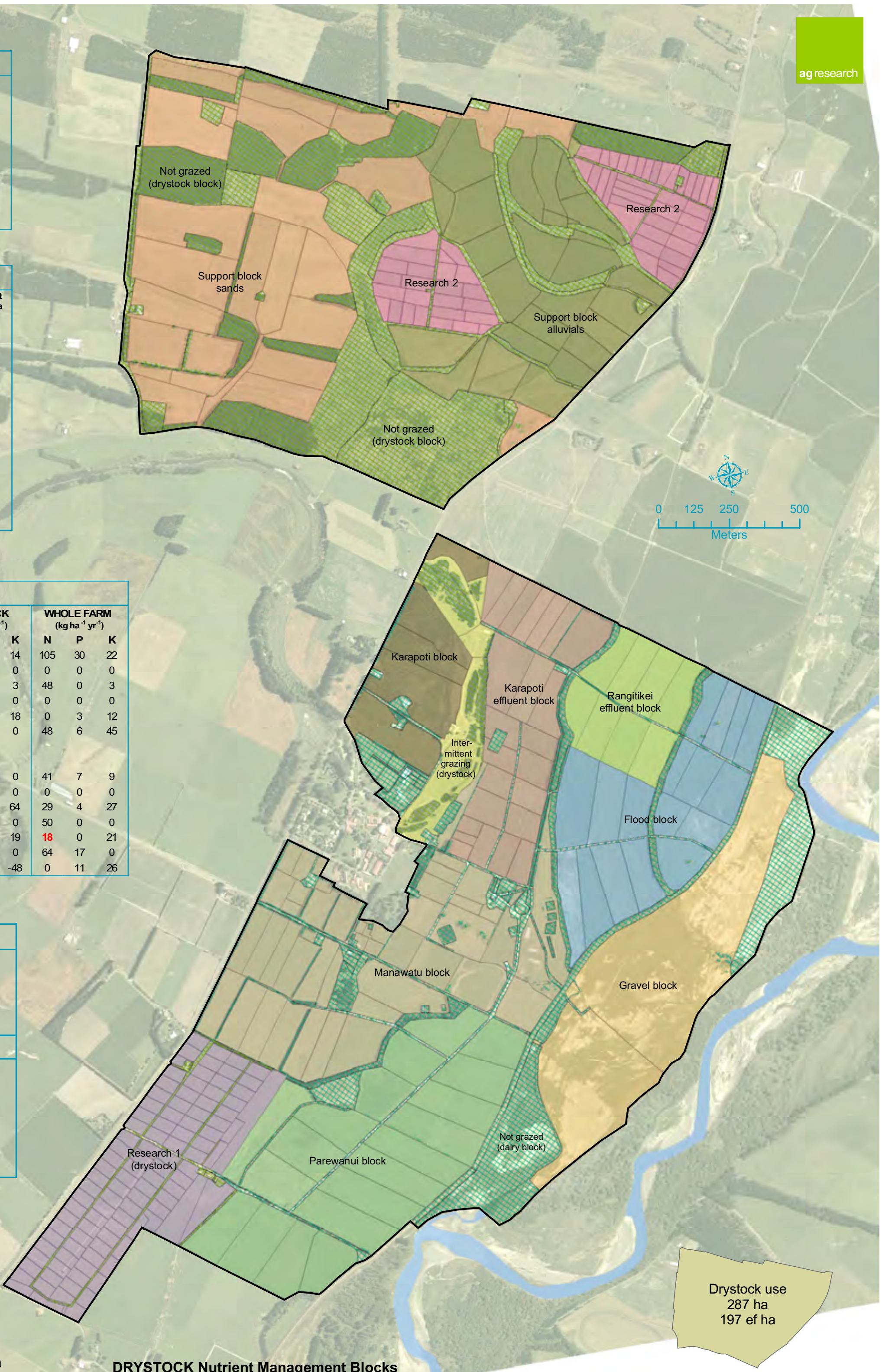
Nutrient Budget (NPK only)

	DAIRY (kg ha^{-1} yr^{-1})			DRYSTOCK (kg ha^{-1} yr^{-1})			WHOLE FARM (kg ha^{-1} yr^{-1})		
INPUTS	**N**	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**
Fertiliser	164	39	28	23	17	14	105	30	22
Effluent	0	0	0	0	0	0	0	0	0
Atmospheric/Clover N	18	0	3	89	0	3	48	0	3
Irrigation	0	0	0	0	0	0	0	0	0
Slow release	0	3	8	0	3	18	0	3	12
Supplements	82	10	78	0	0	0	48	6	45
OUTPUTS									
Product	67	11	16	5	1	0	41	7	9
Transfer	0	0	0	0	0	0	0	0	0
Supplement removed	0	0	0	69	10	64	29	4	27
Atmospheric	69	0	0	23	0	0	50	0	0
Leaching/runoff	**23**	0	23	**11**	0	19	**18**	0	21
Immoblisation/absorption	106	19	0	5	14	0	64	17	0
Change in inorganic soil pool	0	22	79	0	-4	-48	0	11	26

Nutrient loss and greenhouse gas emissions [1]

Parameter	Flock House Dairy	Flock House Dry-stock	Flock House Farm	Average NZ Farm
N leaching loss	23 kg N/ha	11 kg N/ha	18 kg N/ha	5-20 kg sheep/beef 30-50 kg N/ha dairy
P run-off risk	Low	Low	Low	
Greenhouse gases [2]				
Methane	4491	2037	3,465	2000-3000 sheep/beef 4200-5000 dairy
N_20 emissions	2453	1038	1,861	400-1400 shee p/beef 2500-3500 dairy
CO_2 emissions	1141	-251	559	30-130 sheep/beef 400-900 dairy
Forestry equivalents [3]	238	148	200	

Notes
1. Greenhouse losses are indicative only because all non -pastoral land was classified as 'trees' for Overseer analysis
2. Units = kg CO_2 equivalents/ha
3. Approximate area of forest to absorb total CO^2 equivalents (net 1 rotation)

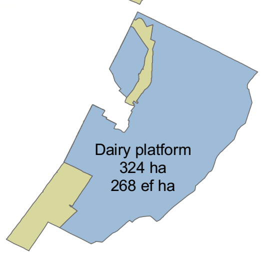


DAIRY Nutrient Management Blocks

Karapoti block	17 ha
Manawatu block	59 ha
Parewanui block	61 ha
Rangitikei effluent block	17 ha
Karapoti effluent block	30 ha
Flood block	37 ha
Gravel block	47 ha
Not grazed dairy	56 ha

DRYSTOCK Nutrient Management Blocks

Support block alluvial	50 ha
Support block sand	78 ha
Intermittent grazing	7.8 ha
Research 1	37 ha
Research 2	25 ha
Not grazed drystock	90 ha



The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

NUTRIENT MANAGEMENT

Flock House Dairy Farm

Parewanui Road, Bulls

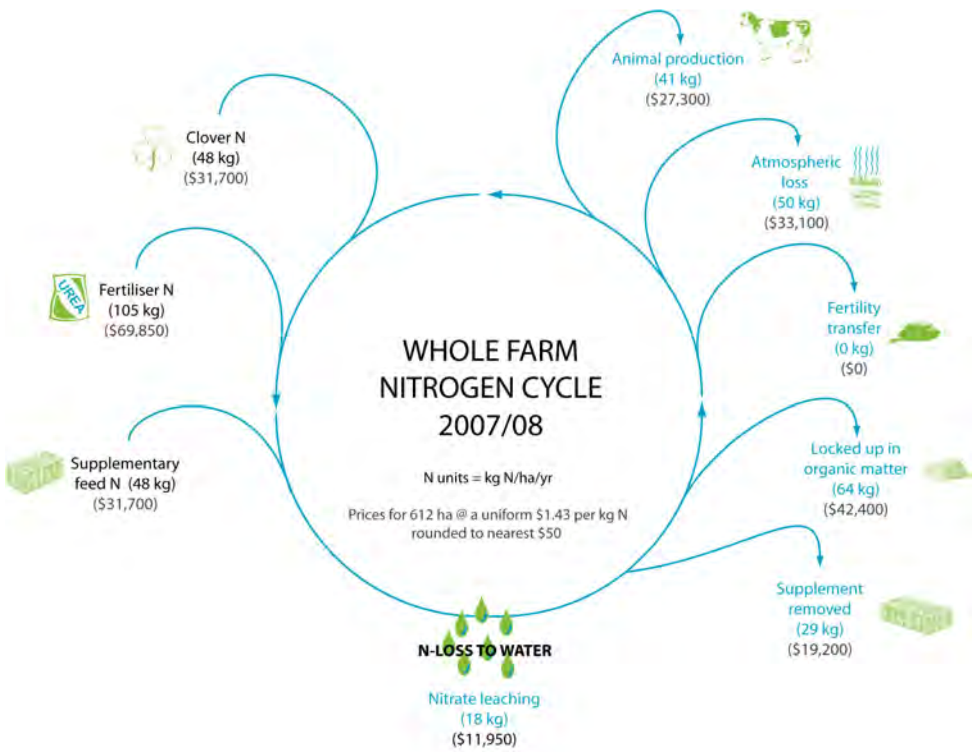
Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

3.0 FARM NUTRIENT BUDGET AND WATER QUALITY

- The farm was divided into eight dairy management blocks and six drystock nutrient management blocks for analysis using *Overseer Nutrient Budgets* (v 5.2.6.0). Two models were constructed for comparison (Dairy Platform and Drystock Unit), with whole farm totals calculated by aggregating nutrient quantities on a whole of platform/unit basis. Overseer outputs presented in the Nutrient Management Map opposite.
- Assumptions, settings and inputs for the Overseer model have been signed-off as being true and correct to the best of the farmer's and consultant's knowledge at the time this report was prepared (see Appendices).

3.1 Nitrogen budget and N-losses

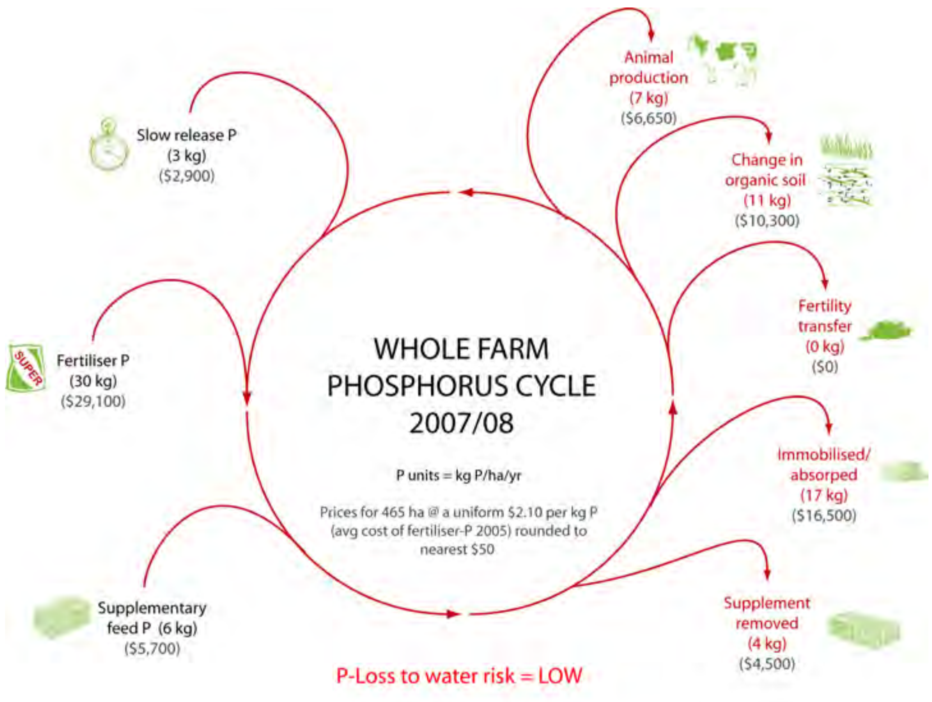
- **Dairy Platform**: **N-loss from the dairy platform is calculated at 23 kg N ha^{-1} year^{-1}**. Compared with other NZ dairy farms this is quite low (NZ average for dairy is 30-50 kg N ha^{-1} yr^{-1}). However, the Flood, Karapoti and Manawatu Blocks have N-losses between 29-31 kg N/ha/yr, which is sufficient to elevate nitrate concentrations in the drainage water above recommended drinking standards (i.e. >11.3 ppm). Losses from the effluent blocks are also high (30 kg N/ha/yr), but the size of the effluent application area is more than sufficient for utilising N applied through effluent (Overseer suggests 40 ha to operate within the rule of thumb 150 kg N/ha loading – current area is 47 ha). The Gravel Block has the lowest N-loss of the pastoral blocks at 17 kg N/ha/yr, attributable to its development status and pasture yield, and because it does not receive winter applications of urea. Also note that blocks with wet soils have slightly reduced N-losses due to limited availability of oxygen, but slightly higher atmospheric losses and contributions to greenhouse gases.
- **Drystock Unit**: **N-loss from the Drystock Unit is calculated at 11 kg N ha^{-1} year^{-1}**. This fits comfortably within the NZ average for sheep and beef farms (5-20 kg N ha^{-1} yr^{-1}). On a block basis, losses are notably highest on Support Block Sand (16 kg N/ha/yr) with its rapidly drained soils, the Intermittent Grazing Block (20 kg N/ha/yr) with its nil fertiliser use (utilisation of N is limited by availability of other nutrients), and the cropped portion of the Support Block Alluvial (31 kg N/ha/yr). Nitrate concentration of the water leaching from the cropped area is likely to be above recommended drinking water standards.



- **Whole Farm**: **Whole farm N-loss averages out at 18 kg N ha^{-1} year^{-1}**. This is low for what is effectively an intensive pastoral grazing system. Key reasons for a low N-loss include the averaging effect of the Drystock Unit (see above), a reasonably low stocking rate on the Dairy Platform (i.e. averaged across the Gravel Block also), high quality soils (mostly alluvial), and the low annual rainfall (less water available to drive leaching).

3.2 Phosphorus budget and P-loss

- Overseer rates the risk of P-loss via runoff as LOW for both the Dairy Platform (0.8 kg P/ha/yr) and the Drystock Unit (0.1 kg P/ha/yr). Only two blocks have elevated P-loss risk ratings. This includes the Flood Block (1.4 kg P/ha/yr) and Manawatu Block (1.2 kg P/ha/yr). Both are rated at MEDIUM.
- On average, the whole farm has a LOW P-loss risk rating (0.9 kg P/ha/yr).



3.3 Faecal microbes and waterway contamination

- Risk of faecal microbes entering water was not assessed for Flock House Farm due to gaps in research understanding. While there is a body of research on the effectiveness of mitigation practices, the preliminary methods and models of quantifying pathogen risk are still in an early stage of development.
- Direct deposition of dung to streams can represent a disproportional and large source of faecal contaminants to surface water (cf. nitrogen). Excluding stock from waterways is therefore widely recommended as a chief mitigation option. Most of the key waterways at Flock House have already been fenced, thereby contributing to a reduced contamination risk.
- Effluent application to land and artificial drainage are two indirect mechanisms linked to waterway contamination. Both involve water transporting pathogens to water bodies (either as runoff or drainage). Key mitigations known to be effective include planted riparian buffers, deferred effluent application, and strategic cattle access to poor draining soils (i.e. essentially any practice that minimises runoff or drainage, or avoids land contamination when runoff or drainage is likely to occur).

4.0 RESOURCE ASSESSMENT AND NUTRIENT LOSS TARGETS

4.1 Principles

Several catchments in the Manawatu-Wanganui Region have nutrient loads far higher than those required to meet community expectations. There is general agreement that these loads need to be reduced, but there is much disagreement over how it should be done.

An easy option is to apply a blanket N-cap to every farm in the catchment. However, this fails to recognise farm-to-farm differences in land use, the quality of land (productive potential), and the current use of mitigation practices. Through the FARM Strategy approach, a more equitable approach is proposed. At its heart is the identification of farm-particular nutrient-loss targets based on the capability and productivity of land, and the fact that **better land has a higher capacity to sustain high levels of production (i.e. it is more sustainable), relative to attempting comparable levels of production from low quality land by using excessive inputs inefficiently.**

Water quality targets have been related to land production-potentials using the Land Use Capability (LUC) system of land classification. This ranks land according to eight classes, where class 1 represents the most elite land, and class 8 land has very low productive value (e.g. bluffs, swamps, river beds, etc.). Nitrogen-loss targets by LUC class are included in the One Plan (table below), designed to be phased in over a twenty-year period. A farm's relative area of different LUC units will determine the level of N-loss that the farm needs to operate within to achieve catchment water quality targets.

Table 1: One Plan N-loss targets for LUC classes

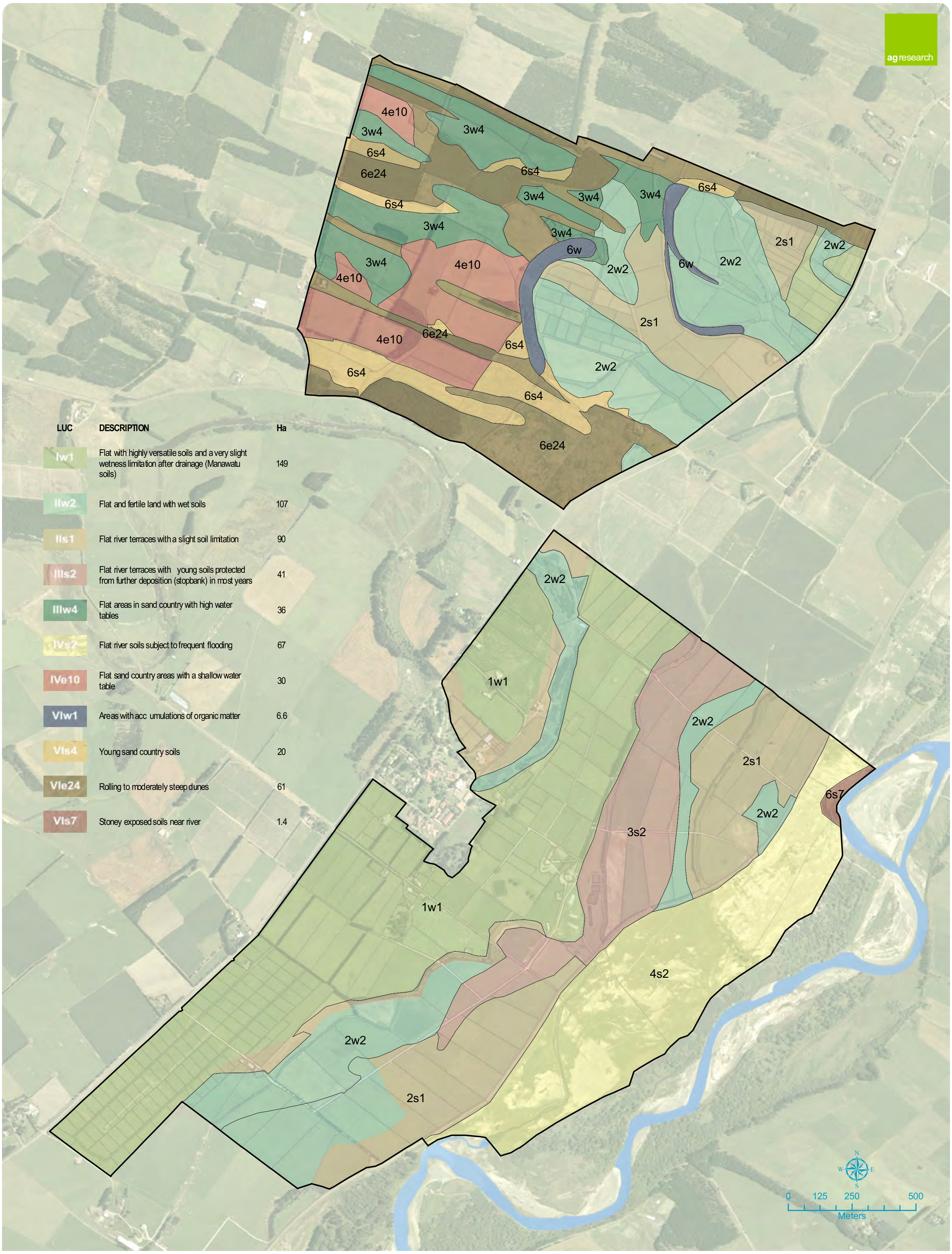
LUC	*N-loss targets (kg N ha^{-1} yr^{-1})* YEAR_01	YEAR_05	YEAR_10	YEAR_20
I	32	27	26	25
II	29	25	22	21
III	22	21	19	18
IV	16	16	14	13
V	13	13	13	12
VI	10	10	10	10
VII	6	6	6	6
VIII	2	2	2	2

4.2 Land resource assessment

The land resource for Flock House Farm has been described and evaluated according to the Land Resource Inventory (LRI) and Land Use Capability (LUC) Classification. Survey was undertaken at a 1:8,000 scale. The LRI system involves mapping landscape units according to five inventory factors (rock type, soil unit, slope class, erosion type & severity, and vegetation).

LRI is then classified as LUC, which further groups similar units according to their capacity for sustainable production under arable, pastoral, forestry or conservation uses. The LUC code (e.g. 6e7) indicates *general capability* (1-8 classes), the *major limitation* (4 subclass limitations of **w**etness, **e**rosion, **s**oil and **c**limate), and the *capability unit* to link with units with similar management requirements and production opportunities. Note that the capability units used in this report are specific to Flock House. A correlation with regional equivalents is presented in Table 2 in the *rLUC* column.

Land Use Capability is presented over the page. Description of the land resource by LUC is summarised as Table 2. N-loss targets for Flock House Farm have been calculated and presented on page 16.



LUC	DESCRIPTION	Ha
Iw1	Flat with highly versatile soils and a very slight wetness limitation after drainage (Manawatu soils)	149
IIw2	Flat and fertile land with wet soils	107
IIs1	Flat river terraces with a slight soil limitation	90
IIIs2	Flat river terraces with young soils protected from further deposition (stopbank) in most years	41
IIIw4	Flat areas in sand country with high water tables	36
IVs2	Flat river soils subject to frequent flooding	67
IVe10	Flat sand country areas with a shallow water table	30
VIw1	Areas with acc umulations of organic matter	6.6
VIs4	Young sand country soils	20
VIe24	Rolling to moderately steep dunes	61
VIs7	Stoney exposed soils near river	1.4

FARMS

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LAND USE CAPABILITY

Flock House Dairy Farm

Parewanui Road, Bulls

Survey and classification by LandVision Ltd, 2008. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

TABLE 2: Land resource description by LUC unit

	FARM LUC	Ha	DESCRIPTION	rLUC*	ROCK	SOIL	SLOPE	VEGETATION	EROSION	TARGET N-LIMIT**
	1w1	149	Old and elevated river flats with highly versatile soils. A very slight wetness limitation can remain with the Manawatu soils after drainage	1w1	Deep, medium textured alluvium	Moderately well drained Manawatu silt loams grading to drier Karapoti loamy sands	0-3°	Improved pasture	Nil	**32 kg N/ha/yr** (4777 kg N per LUC area)
	2w2	107	Flat and fertile river terraces with notably wet soils	2w2	Deep, fine textured alluvium	Kairanga heavy silt loam and Parewanui silt loam	0-3°	Pasture	Nil	**29 kg N/ha/yr** (3107 kg N per LUC area)
	2s1	90	Flat river terrace areas	2s1	Alluvium over gravels	Kairanga fine sandy loam & Rangitikei sandy loam	0-3°	Pasture	Nil	**29 kg N/ha/yr** (2620 kg N per LUC area)
	3s2	41	Flat river terrace near the river with young soils but protected from further deposition in most years (stopbank)	3s2	Coarse alluvium over gravels, with some gravel at surface	Rangitikei loamy sand	0-3°	Pasture	Nil	**22 kg N/ha/yr** (911 kg N per LUC area)
	3w4	36	Flat, low lying areas in the sand country with a high water table	3w4	Wind blown sands & organic deposits	Pukepuke black sand & patches of Omanuka peat	0-3°	Pasture	Nil	**22 kg N/ha/yr** (782 kg N per LUC area)
	4s2	67	Flat river terrace with very recent soils, and subject to frequent flooding	4s2	Alluvium and gravels	Rangitikei loamy sand + bare rock	0-3°	Pasture and riparian associations	Minor and moderate deposition	**16 kg N/ha/yr** (1074 kg N per LUC area)
	4e10	30	Flat, low lying areas in the sand country with a shallow water table	4e10	Wind blown sands	Himatangi sand	0-3°	Pasture and some forestry	Nil	**16 kg N/ha/yr** (487 kg N per LUC area)
	6w	6.6	Low lying swales and wet areas, possibly associated with former river channels, where organic matter has accumulated	6w2	Organic deposits and wind blown sands	Omanuka peat	0-3°	Pasture plus riparian & swamp associations	Nil	**10 kg N/ha/yr** (66 kg N per LUC area)
	6s4	20	Flat to gently undulating areas with relatively young soils showing the least degree of development (for sand country soils)	6s4	Wind blown sands	Hokio sand	4-7°	Pasture with some forestry	Slight wind erosion	**10 kg N/ha/yr** (203 kg N per LUC area)
	6e24	61	Rolling to moderately steep dunes	6e24	Wind blown sand	Waitarere sand & Foxton black sand	16-25°	Pasture	Slight to moderate wind erosion	**10 kg N/ha/yr** (614 kg N per LUC area)
	6s7	1.4	Small area of gravel and alluvium	6s7	Gravel and coarse alluvium	Bare rock and Rangitikei loamy sand	16-25°	Riparian associations and pasture	Moderate stream bank erosion	**10 kg N/ha/yr** (14 kg N per LUC area)

** rLUC represents the closest correlation to the regional Land Use Capability classification described by Noble (1985). Units identified at detailed mapping scales* are not always explicitly identified in the regional classification. An asterisk denotes the closest equivalent.

** Permissible N-loss limits proposed in the One Plan for Year 20 (see Table 1). Refers to N-losses from leaching and runoff. Farming within these values is necessary to achieve catchment water quality standards.

4.3 N-TARGETS for the Flock House Farm

To remain compliant under the One Plan, Flock House Farm is required to operate within the N-loss limits described below (Table 3). They represent the maximum permissible N-loss from leaching and runoff beginning 1st April 2014. N-targets will not change over the 20 year period unless Land Use Capability changes (unlikely). Calculation used the same land area used for the Overseer analysis.

Table 3: Permissible N-loss limits for Flock House (N-targets)

	Year	2014	2019	2024	2034
N-target (kg N/ha/yr)	*Dairy Platform*	26	23	21	20
	Drystock Unit	21	19	18	17
	Whole farm	**24**	**21**	**20**	**19**

4.4 Implications

4.4.1 Farm unit N-targets

Current N-loss from both the Dairy Platform and Drystock Unit are compared against permissible N-loss in Table 4. Note that a uniform N-loss across all years assumes a matched balance between current intensification trends and the development of mitigation technologies. The Drystock Unit is consistently well within acceptable N-loss tolerances for the full 20 years of interest. The Dairy Platform is within tolerances for 2014 and 2019, but would need to reduce N-loss by 2 and 3 kg N/ha/yr for the final two time periods.

Provided N-loss does not increase substantially over the next 20 years, then Flock House is not required to implement any new N-mitigation practices on the Drystock Unit, but will new practices will be required for the Dairy Platform further down the track.

Table 4: N-loss reductions required by farm unit

	Year	2014	2019	2024	2034
Drystock Unit	Current N-loss (kg N/ha/yr)	11	11	11	11
	Permissible N-loss (kg N/ha/yr)	21	19	18	17
	Required reduction (kg N/ha/yr)	***Nil*** *(10 kg in credit)*	***Nil*** *(8 kg in credit)*	***Nil*** *(7 kg in credit)*	***Nil*** *(6 kg in credit)*
Dairy Platform	Current N-loss (kg N/ha/yr)	23	23	23	23
	Permissible N-loss (kg N/ha/yr)	26	23	21	20
	Required reduction (kg N/ha/yr)	***Nil*** *(3 kg in credit)*	***Nil*** *(balanced)*	***2 kg N/ha*** *reduction required*	***3 kg N/ha*** *reduction required*

4.4.2 Whole farm N-targets

Unit N-loss was aggregated as an estimate of whole farm N-loss (18 kg N/ha/yr) and compared against whole farm N-targets (Table 5). Flock House Farm is consistently within acceptable N-loss tolerances for the full 20 years of interest. This demonstrates the effect of averaging N-loss across a greater area (i.e. compare with results for the Dairy Platform above). So provided N-loss does not increase substantially over the next 20 years, then Flock House Farm would not be required to implement any new N-mitigation practices. From a nutrient perspective the property is fully compliant, and will remain so if N-losses remain unchanged. However, while N-losses may be within N-targets, this does not necessary mean the uptake of N-mitigation practices should be completely ignored.

Table 5: N-loss reductions required for whole farm

Year	2014	2019	2024	2034
Current N-loss (kg N/ha/yr)	18	18	18	18
Permissible N-loss (kg N/ha/yr)	**24**	**21**	**20**	**19**
Required reduction (kg N/ha/yr)	***Nil*** *(6 kg in credit)*	***Nil*** *(3 kg in credit)*	***Nil*** *(2 kg in credit)*	***Nil*** *(1 kg in credit)*

5.0 MANAGEMENT OPTIONS FOR MITIGATING N, P AND BUGS

5.1 Existing practice

Flock House Dairy Farm is already implementing a wide variety of mitigation options, some of which include:

- A large proportion of erosion-susceptible dunes are protected by forestry (~61 ha), and a proportion of riverland is not grazed (21 ha).
- Most priority streams have been fenced and culverted.
- Paddocks enclosing the lakes are intermittently grazed to reduce potential impacts on water quality.
- Dairy shed effluent is applied to land (47 ha) which is well above the 40 ha need to a 150 kg N/ha loading.

Existing practices that mitigate N-loss, P-loss or faecal microbe contamination of water, will need to continue as part of this FARM Strategy (see Section 6.3.1).

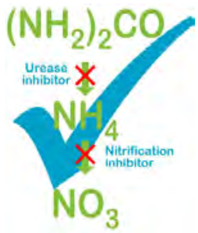
5.2 Additional mitigation options

The previous section compared current N-loss against N-loss targets. The farm is operating well within N-loss limits under the One Plan, and no special N-mitigations or management changes are required. However, this does not negate voluntary adoption of practices that are known to mitigate N, P and bug contamination of waterways. Further, mitigations may be required as the farm intensifies, or they may be a non-negotiable requirement under a different part of the One Plan (see Section 6).

A range of recognised best practices have been listed and rated in terms of relevance to Flock House farm (Table 7, over the page). Those with the highest relevance are evaluated further according to potential effectiveness and cost. Note that the listed mitigation practices are generally geared towards nitrogen, but with a recognition that many also affect P-loss, faecal microbes, and sediment loss. Recommendations for adoption are made based on relevance, cost and potential effectiveness.

5.2.1 Urease and nitrification inhibitors

Inhibitors interrupt urea-nitrogen transformation processes. Urease inhibitors work on the first part of the transformation by restricting the conversion of urea to ammonium (thereby restricting the amount of ammonium available for the second key transformation). Nitrification inhibitors operate on the second transformation by interrupting the microbial conversion of ammonium to nitrite then to nitrate. In effect both inhibitors reduce the amount of nitrate-N in soil, which is the main type of N associated with leaching. Recent studies report significant leaching-loss reductions of 30-80%, and improved pasture yields of around 5-20%.



Proposal: To replace the current urea fertiliser product with a urease inhibitor urea-product, and to spray the Dairy Platform and support blocks with a nitrification inhibitor according to manufacturer recommended rates and timings.

Effectiveness: While there is a rapidly growing body of research on the effectiveness of inhibitors, it is difficult to predict with any certainty how well they will perform on any given farm at any point in time. For the interim, and for the Flock House Farm given its location and climate, we suggest a conservative ***15% reduction*** in the leaching/runoff calculated by Overseer as an approximation of inhibitor effectiveness. Accordingly, adopting the use of inhibitors is **estimated to decrease whole farm N-loss by 2.7 kg N ha^{-1} yr^{-1}** (Drystock Unit = -1.7 kg N/ha/yr, Dairy Platform = -3.5 kg N/ha/yr).

Implications & cost: At $1.43 per kg urea-N, current urea cost is estimated at $73,050 (maize @ 150 kg N/ha, support blocks @ 40 kg N/ha, Gravel Block @ 200 kg N/ha, effluent areas @ 150 kg N/ha, balance of dairy @ 161 kg N/ha). Switching to urease-treated urea at $1.67 per kg urea-N would cost $85,300. The increased cost is $12,250. Cost of spraying with nitrification inhibitor twice per year at $148/ha (applied) equates to $112,800/yr for the dairy platform and support blocks ($148 x 381 ha x 2 applications). Total on the ground cost of adopting inhibitors is estimated at $125,050. Pasture and revenue implications are estimated at different response rates using a simple conversion (Table 6). A 6.5% yield increase is required to break even (6.5% response = $125,400 gross revenue). Note that these calculations do not factor in production obtained from supplements.

Table 6: Potential returns at increasing inhibitor response rates

Yield % increase	Extra kg DM/ha[a]	Kg DM/farm	Extra Kg MS[b]	Gross revenue[c]
5%	662	252032	15000	$ 96,450
10%	1323	504063	30000	$ 192,900
15%	1985	756095	45000	$ 289,350
20%	2646	1008126	60000	$ 385,800

a Using 13.2 tn/ha/yr for current pasture production across area receiving urea (381 ef ha)
b From ratio of current pasture yield (whole farm) to current MS production
c At a MS payout of $6.43 per kg

Recommendation: Consider using inhibitors. Recent research suggests this would likely to result in reduced N-leaching losses and improved pasture responses (amongst other things). Conservatively we estimate an N-loss reduction of at least 2.7 kg N/ha/yr for the Flock House property, with the additional cost of inhibitors being offset by pasture yield gains. If pasture response rates achieved at certain research sites were applicable to the Flock House operation, then a switch to inhibitors may result in even more substantial revenue gains.

TABLE 7: Relevance of common N-loss mitigation options (+ P-loss & faecal microbes)

MITIGATION OPTIONS	Issue & ranking[1]	Relevance or opportunity	NOTES
Mitigation options captured by Overseer			
Avoid winter (May, June or July) N-applications	N	HIGH	100 kg N/ha is applied during winter on main dairy block (excluding Gravel Block)
Ensure effluent application area is large enough to keep loading <150kg N/ha/yr	N, bugs, P	LOW	Current effluent area is more than adequate to achieve a 150 kg N/ha loading
Avoid winter effluent applications	N, bugs, P	LOW	Limited scope given the design of current system, but see below
Store effluent in a holding pond and spray at optimum times	N, bugs, P	HIGH	Capacity needs to upgraded anyway (Clean Streams Accord & One Plan)
Use supplements with N-concentrations that are lower than pasture (or higher energy content - e.g. maize)	N	LOW	Already practiced
Replace fertiliser N with equivalent supplement-N	N	LOW	Cannot be used strategically to target periods of growth when N is most needed.
Ensure other nutrients are non-limiting (optimal) for max yield per kg N input	N	LOW/MEDIUM	Limited soil test information suggests near optimal nutrient conditions. However, more soil testing required given the diversity of soils and land uses.
Decrease use of N-fertiliser	N	LOW	Not a preferred option given current low N-loss
Decrease stocking rate	N, bugs	LOW	Not a preferred option given current low N-loss
Change stock type or class	N	LOW	Not suitable. If anything there is more scope for dairy expansion and reduced drystock
Reduce imports of supplementary feed	N	LOW	Not a preferred option given current low N-loss. Further, most supplement is conserved within a closed system
Graze cattle off during winter (May, June, July)	N, bugs, P, sed	LOW	All ready practiced
Use a sealed wintering/standing pad with effluent collection and storage system	N, bugs	LOW	Unnecessary investment given size of the N-loss deficit. Maybe a longer term consideration
Increase supplement exports off farm	N	LOW	Not financially prudent at current time
Recycle effluent to land rather than pond treatment & disposal to waterways	N, bugs, P	LOW	Already practiced
Other mitigation activities			
Time N-fertiliser application for periods when N demand is greatest[2]	N	LOW	Already practiced[4]
Avoid high-rate, single dressings of N-fertiliser. Use split dressings (20-50kg N/ha per dressing)	N	LOW	Already practiced[4]
Adjust N-fertiliser rates & timings seasonally to respond to actual or expected production demand (seasonal variations)	N	LOW	Already practiced[4]
Use an N-fertiliser product with an N-uptake efficiency that is better than the current N-product	N	LOW	Urea is currently the most cost effective source of fertiliser-N. However, see note on urease treated urea below
Avoid N-applications when soils are saturated (leaching/runoff & low plant activity).	N	LOW	Already practiced[4].
Avoid N-applications during excessive dry periods (plant N-uptake low)	N	LOW	Already practiced[4]
Consider timing N-fert using a water balance on soils with high leach/runoff risk (shallow gravel soils, soils with high water tables, artificially drained soils)	N	LOW	Represents an extra workload difficult to justify without irrigation
Delay N-applications directly after dry periods until pastures have started recovering	N	LOW	Already practiced[4]
Ensure an adequate buffer distance from waterways when applying fertiliser[3]	N, P	LOW	Already practiced[4]
Use urea product treated with urease inhibitor	N	LOW	Given the local climate and proximity to the coast, our estimation is that inhibitors may be moderately effective
Ensure you can actually use the extra grass grown when N-fertiliser is used	N	LOW	Already practiced[4]
Spray nitrification inhibitor according to manufacturer recommended rates and timings, particularly on highly stocked areas (e.g. camps)	N	LOW	Our estimation is that inhibitors are likely to be moderately effective for Flock House Farm
Ensure effluent storage ponds do not overflow (part. winter)	N, bugs, P	LOW	No evidence to suggest ponds overflow
Use adequate buffer distance from waterways when applying effluent (+20m)	Bugs, N, P	LOW	To be evaluated but risk appears to be low given the wide riparian margins
Other best management works			
Ensure all paddocks are supplied with adequate troughs or dams	Bugs, N, P, sed	LOW	Farm owner has assured that all paddocks have reticulated stock water
Replace fords with bridges or culverts (or any other option that gets cattle out of streams)	Bugs, sed, N, P	HIGH	Access to river land over the stop bank requires the crossing of a substantial stream
Exclude stock from waterways and water bodies by fencing	Bugs, sed, N, P	HIGH	Eligible streams are fully fenced but fencing around the lake area requires attention
Create wetland attenuation zones where runoff converges	Bugs, sed, N, P	LOW	Not a preferred option given current low N-loss
Create riparian attenuation zones wider than 10-30m	Bugs, sed, P, N	LOW	Riparian buffers already in place around most sizeable waterways out to 10-20m
Ensure runoff from tracks/lanes is not channelled into streams near crossings	Bugs, sed, N, P	LOW	Generally adequate to good lane design without runoff risks near water crossings
Ensure there are no major leaks in the effluent irrigation system (e.g pipe joins).	N	LOW	No evidence of leaks
Invest in a high efficacy effluent treatment/disposal system (e.g. digesters)	N, bugs, P	LOW	For this farm there are many other lower cost options
Ensure runoff from yards, feed pads, etc. does not go directly into waterways	Bugs, N, P, sed	LOW	Already practiced
Ensure effluent storage ponds are sealed	N, bugs	LOW	No evidence of leaks
Ensure effluent storage ponds are of a sufficient size	N	LOW	Ponds of sufficient size for current herd size
Store leakable supplementary feeds (e.g. silage) on a sealed base with an effluent collection/storage/disposal system	N	HIGH	Six sizeable silage stacks located near the milking shed are in various states of being fed out.

[1] ***N***= *nitrogen loss,* ***P***= *phosphorus loss,* ***bugs*** *= faecal microbes,* ***sed*** *= sediment*

[2] *When pastures are higher than 25mm or 1000kg DM/ha, are actively growing, when soil temp >6degrees*

[3] *See formulas in Spreadmark code of practice*

[4] *Based on farmer assurance. Cannot be assessed conclusively within project limits. Assumed compliant until proven otherwise.*

5.2.2 Avoid winter applications of urea

Pasture N-uptake slows toward winter due to reduced plant activity, colder temperatures, and possibly wetter soils. Likewise risk of leaching and runoff increases with higher seasonal rainfall and lower evaporation rates. Currently 100 kg N-urea/ha is applied during winter to the main dairy platform (221 ha excluding the Gravel Block).

Proposal: To cease winter applications of urea (avoid applications in May, June, July).

Effectiveness: Stopping winter applications but keeping the same annual use of urea across the main dairy block decreases modelled N-loss for the whole farm by 2 kg N/ha/yr. Reduction across the Dairy Platform alone was modelled at 4 kg N/ha/yr.

Reducing annual urea-N use by the 100 kg N/ha applied in winter (i.e. current 161 kg N/ha/yr and 150 kg N/ha/yr dropped to 61 and 50 kg N/ha/yr) would **decrease whole-farm N-loss by 5 kg N/ha/yr**, or 8 kg N/ha/yr for the Dairy Platform.

Implications & cost: If urea is being used to grow more grass to extend the milking season (likely), then cost to the farm business can be estimated from returns on late season milk production. Assuming a late season urea response of 5 kg DM per kg urea-N (conservative), and a late season milk yield response of 140g MS per kg of extra pasture DM utilised, then gross revenue would be reduced by approximately $79,500*. Factoring in savings from not having to purchase as much urea ($31,560), then **stopping winter use of urea could potentially reduce farm gross margin by around $48,000**. However, this is only valid if annual urea use is reduced by 100 kg N/ha. If it was retained and redirected into applications during the non-winter months then the impact on gross revenue would be considerably less (although mid season response rates in sand country areas are difficult to estimate, and it is questionable if the extra dry matter produced during these periods can be fully utilised).

* 100 kg urea N applied over 221 ha = 22,070 kg N. At 5:1 pasture response an extra 110 tn DM produced. At 80% utilisation, 88.3 tn DM is consumed. At 140g MS/kg DM utilised, then 12,360 kg MS produced which equates to $79,500 at a payout of $6.43/kg MS.

Recommendation: The recommendation is to retain winter use of urea. While N-loss reductions could be substantial, the farm is currently operating well within its permissible N-limits. Further, equivalent N-reductions are currently being made through other parts of the farming operation, and stopping winter-N would represent a significant and unnecessary loss in revenue. However, it does represent a relatively easy and simple mitigation, and one that should be reconsidered if future developments result in greater N-losses from the farm system.

5.2.3 Install an effluent holding pond

Modern effluent sump systems have several advantages over traditional pond systems, but they also come with one or two important disadvantages in an environmental context. For Flock House, the greatest concern would be the risk of pump or power failure, thereby resulting in effluent overflow to land and possible seepage to groundwater or lateral movement to waterways. Currently Flock House has a 20,000 litre effluent sump and an estimated daily shed effluent production of 42,500 litres (850 cows at 50 L effluent per cow per day).

Proposal: Increase effluent storage capacity by installing a holding pond.

Effectiveness: Switching from the 'spray from sump' to the holding pond 'spray at optimal times' option[A] for effluent disposal in Overseer decreases modelled N-loss on the Dairy Platform by 1 kg N/ha/yr. Reduction on the effluent blocks, individually, is 4 kg N/ha/yr. Averaged across the farm, installing a holding pond and irrigating to land reduces modelled N-loss by 1 kg N/ha/yr. The majority of reduction is achieved by a greater proportion of N being lost to the atmosphere. However, it is not clear what size ponds Overseer bases its calculations on, or what the residence time of effluent is assumed to be. For the system recommended below, **it is unlikely that N-loss would be reduced appreciably by installing a small holding pond**.

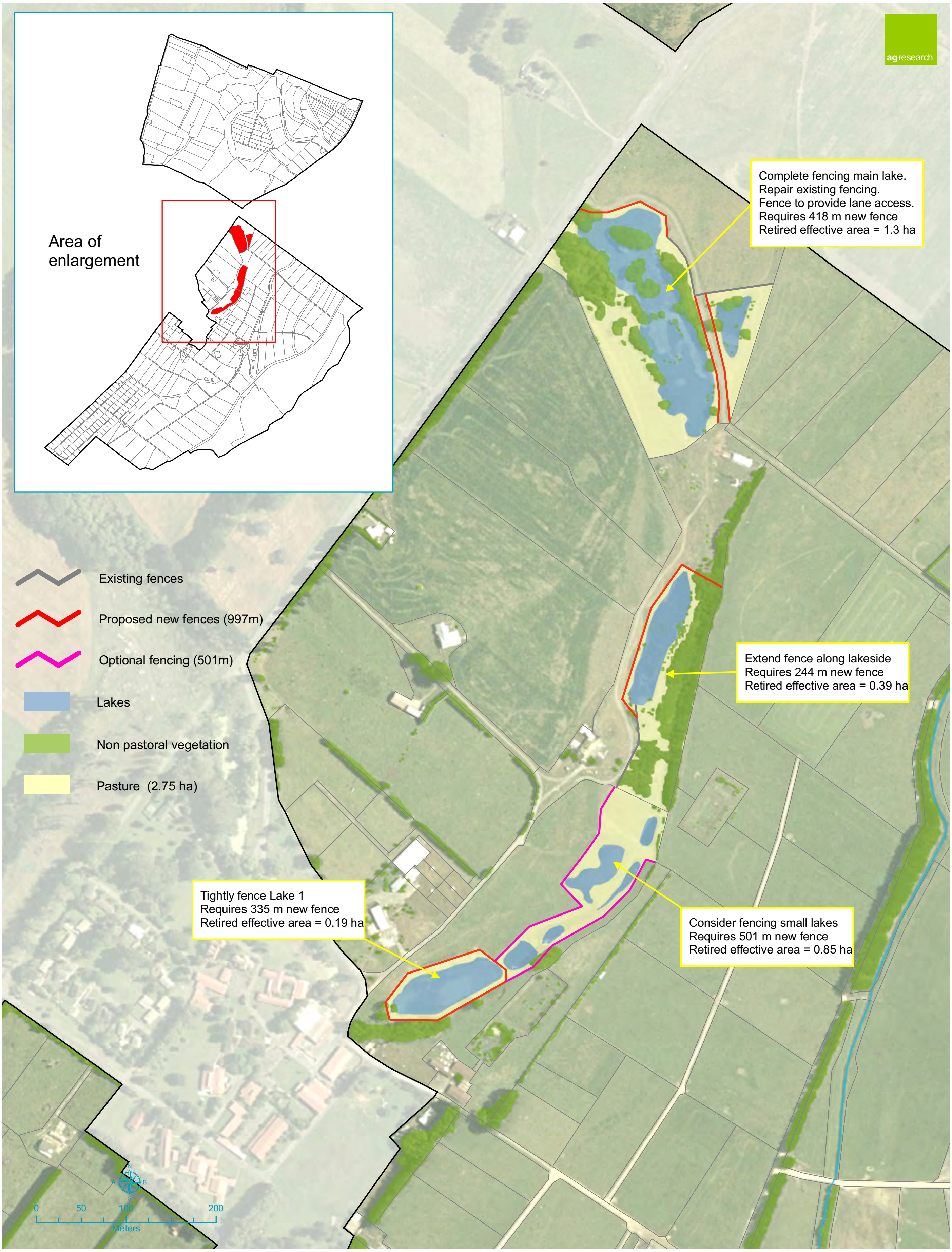
Implications & cost: Constructing and sealing a new holding pond would represent the greatest single cost. A pond with a capacity to hold 2½ days[A] of effluent would need to have a capacity of at least 106 m^3, which is quite small (e.g. 6m long x 6m wide x 3m deep). Cost of earthworks is estimated at $1,060 (at a $10/$m^3$ contractor rate), and sealing with clay at a 150mm thickness is estimated to cost a further $250 at a contract rate of $15/$m^3$ (surface area of base + sides = 108m^2 to a depth of 0.15m = 16m^3) assuming a clay material can be readily sourced. Total estimated cost would be $1,500 (includes small incidental costs).

For interest, if a larger pond was installed and effluent underwent longer residence times, then a considerable amount of nitrogen would be lost to the atmosphere. Overseer suggests 78 kg N/ha less would be applied by irrigating from a sizeable holding pond rather than the current direct application from a sump. Over the entire effluent block this represents 3650 kg of N, with an equivalent fertiliser value of $5,200 (urea-N at $1.43 per kg applied), and given effluent-N can induce N-responses similar to urea-N, then potential lost revenue could be in the order of $26,000 (assuming a 10:1 response, 80% utilisation, and 150 g MS per kg DM consumed). However, this <u>does not apply to a small pond</u> because most effluent would still be pumped directly from the sump (i.e. the small pond would only be used intermittently or during emergencies).

Recommendation: To install an effluent holding pond. A small pond would not be particularly expensive, nor would it appreciably impact on current N-responses achieved by applying effluent immediately to land. However, a small pond is unlikely to have any impact on current levels of N-loss. The greatest gain would be reduced risk of effluent flooding, and increased compliance with One Plan conditions (see Section 6).

[A] Note that rainfall is generally low and evaporation is high for the sand country area that Flock House is situated. Near optimal irrigation is achieved at most times without the need to adopt a deferred irrigation programme.

[B] It is likely that at least two days storage capacity will be required as a condition of this FARM Strategy (see Section 6). An extra half day provides a small buffer. If effluent generation is more than 50 L/cow/day then a larger pond may be required.



The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

WATERWAY PROTECTION

Flock House Dairy Farm

Parewanui Road, Bulls

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

5.2.4 Fence waterways and water-bodies

Direct access of stock to waterways amplifies contamination risks by faecal microbes, and to a lesser extent, the contribution of nutrient to water. Currently there is 3.8 km of qualifying waterways on the Flock House farm, all of which are already fenced and protected. However, there is also a series of small, partially fenced lakes that qualify as targeted under both the Accord and the One Plan (see map opposite).

Proposal: Exclude stock from the lakes area by installing 997m of two-wire electric fencing.

Effectiveness: Fencing the lakes may have little immediate impact on water quality. These are shallow sand country lakes that are very sensitive to surrounding fluctuations in water tables, and a history of receiving effluent from an abattoir. Specific reductions in nutrients and faecal contaminants could not be estimated.

Implications & cost: Cost depends on inclusion of the 'small lakes' block marked as optional on the Waterway Protection map opposite. Most are borderline as to whether they qualify as clean streams lakes (deeper than a red band gumboot), and are perhaps better defined as wetlands. They are therefore excluded from consideration, but fencing and lost pasture area have been calculated should the farm owner or manager choose to retire this area.

For the remainder, total required fence length is at 997 m. Fencing costs for erecting a two-wire waratah fencing system are estimated at $2.38/m. Excluding gates and other peripherals, cost of fencing would be approximately $2,375. This would also result in the retirement of 1.9 ha of pasture, equivalent to a gross revenue reduction of $1,060 (1.9ha x 11.6 tn DM x 80% utilisation x $0.06 gross margin equivalent per kg DM consumed).

Recommendation: To erect the recommended fences. While contract rates for fencing have been cited, it is probable that a cheaper fence can be erected given the amount of legacy fencing resources left over from previous research-related subdivision.

5.2.5 Manage silage effluent

Silage stacks are often overlooked as a source of environmental contamination. In truth, effluent leachate is 40 times stronger than dairy shed effluent, is very acidic (pH of 4 to 4.5), and generally has high nutrient levels (amongst other things). Under the One Plan, silage stacks that cover an area greater than 500m^2 require a sealed base. Concrete bunkers are a common option, because not only do permit the collection of leachate, but they also help facilitate the ensiling of better quality silage (improved compaction, etc.) and reduced wastage.

Flock House stores a considerable volume of maize and pasture silage on the Dairy Platform (harvested from the support blocks). In addition to five bunkers located around the farm, five silage stacks in various states of being fed out were noted (average dimensions of 15.5m wide and 45m long). Areas range from 620 m^2 to 730m^2, all of which are larger than One Plan's 500m^2 trigger value. Total area of stacked silage is summed at 3332 m^2 (0.3 ha). Volume was estimated by modelling stacks as geometric shapes ( ) with a uniform height of 2.5 m and a side pitch of 45^0. Total volume of the five stacks is calculated at 7,000 m^3. Weight is estimated using a conversion of 700 kg per m^3, which provides an estimate of 4,900 tonnes of silage stored in the five stacks. Note that this is an estimate of current weight, rather than original wet weight (possibly 10% more if stacked at 25% DM). Presumably the balance from the support blocks is stored in existing bunkers.

Proposal: Construct two new bunkers to store maize and pasture silage, using a design that captures effluent leachate in a sump. .

Effectiveness: The fate and dynamics of silage leachate underneath stacks is largely unknown. However, research involving collected leachate (probably from sealed bunkers) provides an idea of effluent generation and nutrient concentrations. Using design values reported in the Dairying and Environment manual, the five stacks could be producing 147 m^3 of effluent leachate (at 30 litres of leachate per tonne of well made silage). Put another way, if the silage was removed and the effluent remained, then there would be five ponds of black oily leachate 4.4 cm deep. It would likely be deeper if our calculations used the original wet-weight.

Most of the leachate is produced within 24 hrs of constructing a stack, and can continue producing significant amounts for about eight weeks. Because the five stacks are not sealed, it can be assumed that any leachate produced will enter the soil. This would be very little on a liquid basis (i.e. 44mm. Contrast this against the annual rainfall of 860mm), but very high on a potency basis (a pH of 4 would likely kill most soil life under pasture).

Black oily ponding long after silage has been removed suggests pollution, soil damage, and a potential risk to water quality

Potentially between 1 and 5 grams of nitrogen could be added with every litre of leachate produced (Dairying and the Environment manual). This equates to between 147 kg N and 735 kg N across the five stacks, which is equivalent to an application rate of 490 to 2450 kg N per hectare. What happens to this nitrogen is unclear. If conversion to gaseous forms was inhibited by the acidic environment, and the covered silage above minimised the risk of leaching, then it is conceivable the nitrogen remains in the soil until after the silage has been removed. In a worst case scenario, a significant amount of rainfall directly after the stack has been fed out could result in a plug of nitrogen moving down the profile (possibly still mostly in effluent form). If all the leachate-N was leached, then total N-loss from the Dairy Platform would be increased by approximately 0.5 to 2.7 kg N/ha, and whole farm N-losses increased by 0.3 to 1.6 kg N/ha. Consequently, installing bunkers and capturing silage leachate has the potential to not only reduce localised environmental damage (e.g. from a low pH), but also to reduce whole farm N-loss. However, further research is required to confirm leachate losses and determine N-leachate fate. Some industry commentators assert leachate production from silage is considerably lower than the numbers used above, and that very well made silage (35-50% DM at ensiling) will produce no effluent whatsoever.

There is good reason why pasture takes a long time to re-establish on former stack sites

Implications & cost: A recent quote obtained for a proposed dairy conversion (that requires a similar storage capacity for silage) suggests that the construction of two concrete-lined bunkers with the capacity to collect and store leachate would cost somewhere in the vicinity of $180,000 ($90,000 each).

Recommendation: Consider investing in the two silage bunkers. From a legal perspective, the five existing stacks are non-compliant under the One Plan because their size necessitates storage on a sealed base (see Section 6). Investment cost is high, so it is therefore recommended that a cost benefit analysis be undertaken for the foreseeable life of the bunkers (considering reduced labour and improved silage nutrition). From a nutrient perspective, it is possible that bunker construction would reduce farm N-losses somewhere in the order of 0-3 kg N/ha/yr, but this is a very tentative estimate and further investigation is required.

5.2.6 Bridge or culvert waterway crossings

Main stock-access to the Gravel Block is via a ford through a waterway that qualifies as targeted under the One Plan. Cattle can exhibit a tendency to defecate and urinate at waterway crossings, which elevates the risk of faecal contamination. The One Plan requires such crossings to be bridged or culverted. An alternative solution is available to Flock House. Stock access can be provided to the Gravel Block without having to cross the stream (i.e. an alternative route).

Proposal: Use the alternative route to provide stock access to the Gravel Block, but retain the existing ford for vehicle access.

Effectiveness: Potential slight reductions in nutrient and sediment contributions, and depending on stock through-volumes, potentially significant reductions in faecal coliform contributions.

Implications & cost: There is no financial cost or production loss associated with this option.

Recommendation: To start using the alternative route when taking cattle to and from the Gravel Block.

5.3 Achieving N-targets (summary)

Flock House Dairy Farm is fortunate to have a low current N-loss (18 kg N/ha/yr), and a high permissible N-loss under the One Plan (24 kg N/ha/yr for 2014). Low N-losses are largely attributed to inclusion of the Gravel Block and Drystock Unit in the Overseer modelling, which has the effect of averaging N-loss for the main Dairy Platform across the whole property. A high permissible N-loss rating is readily attributable to a predominance of high class land, with over 85% of the farm represented by LUC classes 1-4 (highly versatile soils and suitable for cropping).

Taken together, the **low current N-loss and a high permissible N-loss rating means no N-reduction or special mitigation practices are required for Flock House Dairy Farm under the One Plan**. Provided current N-loss does not change appreciably over the next 20 years, then it is likely that Flock House farm can continue to operate comfortably within the One Plan's N-loss limits out to 2034. There is also a substantial degree of buffering available should N-losses increase in the future (starting at 7 kg N/ha/yr in 2014 and decreasing to 2 kg N/ha/yr by 2034).

Several potential mitigation options have been evaluated as part of this study. While there is no obligation to consider these options from a nutrient management perspective (see above), some double as a compliance requirement under a different part of the One Plan or FARM Strategy workbook. Those with no compliance requirements are suggested for voluntary uptake.

Adopting the use of inhibitor products could reduce farm N-loss by 2.7 kg N/ha/yr, with costs being offset by likely gains in pasture production. There is even the potential for greater gains if response rates achieved at research sites were similarly achievable at Flock House. Installing a small effluent holding pond is also recommended. While it is unlikely to impact on N-loss in any meaningful way, the cost is small (~$1,000) relative to gains of reduced overflow risk and compliance with the One Plan.

Stopping the use of winter urea could reduce N-loss by 5 kg N/ha/yr, but this is not recommended because it has substantial implications for gross margin (potential decrease of $48,000), and it is not required as an N-mitigation at the present time. Approximately 997m of new fencing is recommended around the lakes area, at an estimated cost of $2,400 and a potential loss $1,000 gross revenue (1.9 ha of grazing would be retired). A bridge is not required to maintain access to the Gravel Block as an alternative route is available. Lastly, further consideration regarding an investment into two silage bunkers is strongly recommended. Cost would be appreciable (~$180,000), but it may be necessary under the One Plan, and there are potential gains in environmental quality, possibly N-reductions, and improvements in silage quality.

6.0 ONE PLAN REQUIREMENTS

Controlled and permitted activities relevant to Flock House Dairy Farm have been assessed to identify current levels of compliance under the One Plan (Table 9 over the page). Note that the list and terminology is a summary and only applies to the Flock House property. Refer to the One Plan together with the FARMS Strategy workbook for a full list of controlled and permitted activities. Non-compliant activities are further evaluated to identify actions or options required to become compliant (Section 6.3). There is an unavoidable degree of overlap with recommended N-loss mitigations (previous section) and recommendations to become fully compliant under the One Plan.

6.1 Existing consents

Currently there is one active consent for discharge to land (Table 8). Note that existing consents will be replaced by a Whole Farm Consent associated with this FARM Strategy, except for consents concerning large ground water takes, construction of bores, and any other type of consent not covered in the FARM Strategy workbook.

Table 8: Active resource consents Flock House Dairy Farm, 2007

Consent reference	*Consent Type*	*Max Daily (m^3/d)*	*Max Rate (l/s)*	*Started*	*Expires*
101544	Discharge to Land	42.5	-	21/12/00	21/12/25

6.2 Planning period

This FARM Strategy is designed for a 5-year planning period. However, it is recognised that the viability of some mitigation practices are strongly dependent on seasonal factors (cost, payout, climate, etc), and it is conceivable that the most suitable options for mitigating environmental impact will fluctuate annually. It is therefore recommended that the nutrient budget be reassessed each year, and mitigation practice adjusted accordingly.

6.3 FIVE-YEAR STRATEGY to achieve One Plan compliance

6.3.1 Maintaining existing mitigations

Existing mitigations have been reported in Section 5.1. Change with any of the listed activities may affect N-loss, and would therefore necessitate a nutrient budget reassessment. Accordingly, existing best-practice activities should be maintained for the first year, and reassessed with a new nutrient budget in the second year.

Objective 1: Maintain existing policies for stock, grazing and fertiliser. A significant deviation in these policies requires re-evaluation of the nutrient budget and N-targets. In particular maintain current use of the support block, including the wintering of dairy cows.

6.3.2 Effluent storage capacity

There must be sufficient effluent storage capacity to hold two days worth of effluent. Current effluent production is estimated at 85 m^3, which is 4.25 times more than the sump's current storage capacity (20 m^3). To become compliant it is recommended that a small holding pond lined with clay be installed with at least a 106 m^3 capacity (sufficient to hold 2½ days of effluent). Cost is estimated at $1,500.

Objective 2: Construct a holding pond that will hold at least 106 m3 of effluent.

6.3.3 Effluent application area

Effluent discharges to land must not be within 20m of a surface water body. Paddocks currently receiving effluent represent an area of 47.2 ha. Approximately 1.5 ha falls within the 20m separation zone from water, mostly as long strips running parallel to existing riparian fencing. In practical terms it is unlikely that these strips would ever get irrigated. Making sure the outer edge of the irrigation circle is at least 5m away from the riparian fencing would ensure ongoing compliance.

Objective 3: Continue to avoid applications of effluent within 5m of riparian fencing.

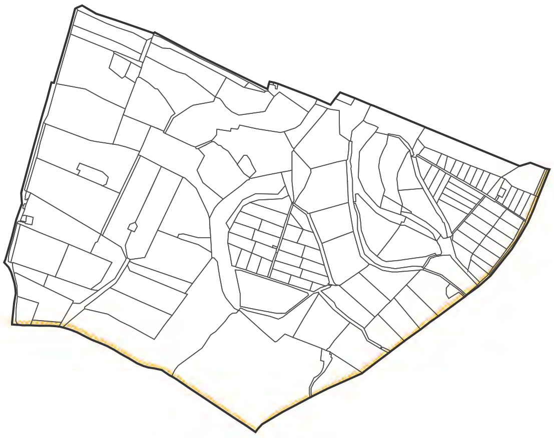
6.3.4 Proximity of feed storage to water bodies

Feed storage facilities must not be sited within 20m of a surface water bodies. Proximity of storage sites has been evaluated (map over the page), and all appear to located well away from water bodies. Current locations are compliant and no further actions are required.

TABLE 9: Summary of controlled and permitted activities under the One Plan (2007)

CONSENTABLE ACTIVITY	REQUIREMENTS	STATUS 07	NOTES
Farming within N-loss target?	1. Farm N-loss must be within N-loss targets	Compliant	Currently well within N-loss targets
Produce animal effluent?	1. No direct discharge of effluent to water from yards or pads	Compliant	
Store animal effluent?	1. No direct discharge of effluent to water from ponds & sumps	Compliant	
	2. Ancillary storm water must not discharge into pond or sump	Compliant	Shed roof has gutting running the full length and discharge is collected
	3. Effluent storage must be sealed and not leaking	Compliant	Current storage is a 20,000 concrete sump
	4. Effluent pond or sump must have capacity to hold 2-days of effluent between applications (if applied to land)	Requires attention	Current capacity is well below the 42.5 m^3 of effluent generated daily. There is visual evidence to suggest the sump has overflowed onto land in the past.
Apply effluent to land? **	1. No substantial leaks in irrigation pipes or equipment	Compliant	
	2. Discharge application must be > 20m from surface water bodies, bores, or the CMA	Uncertain	Paddocks where effluent is applied border several zones where effluent applications are not permitted. Requires further investigation.
	3. Discharge application must be > 20m from public areas & roads, or residences	Compliant	
	4. Discharge application must be > 50m from protected archaeological or biodiversity areas	Compliant	There is an archaeological/cultural site on the farm but it is located a considerable distance away from the effluent blocks.
	5. Must have a nutrient budget (emphasis on N)	Compliant	Nutrient budget recently completed by Ian Power
	6. Must not apply on days when drift will cause problems for neighbours	Compliant (assumed) *	
	7. No surface ponding for more than 5hrs after application	Compliant (assumed) *	Highly unlikely
Surface or ground water take?	1. Surface or ground water takes require a consent	Compliant	No current surface or ground water takes in operation
Use biosolids or soil conditioners?	1. Application of biosolids and/or 'soil conditioners' requires a consent	Compliant	Biosolids and soil conditioners not used (other than lime)
Active farm dump or offal hole?	1. Farm dumps or offal holes require a consent	Compliant	Farm manager reports there is no active farm dump or offal hole on the property. No dump or offal hole was sighted during farm visits.
Stock have direct access to waterways?	1. Stock must have adequate (reticulated) trough water available in each paddock (ideally to meet peak demand)	Compliant	Manager reports that all paddocks have troughs fed by a reticulated water system
	2. Waterways and water bodies that qualify under the Clean Streams Accord must be fenced	Requires attention	Qualifying waterways are already fenced. A further 997m of fencing required around the lakes area
	3. Stock crossings must have a bridge or culvert (or presumably an alternative stock access route)	Requires attention	Ford providing access to the Gravel Block crosses a targeted water course
	4. Runoff from bridges and culverts must be directed to land rather than water	Compliant	Runoff is redirected to land where practicable
Apply fertiliser?	1. No application of fertiliser directly to water bodies	Compliant (assumed) *	
	2. No application into protected biodiversity areas	Compliant (assumed) *	There is an archaeological/cultural site on the farm. It is fenced off so it is assumed that no fertiliser is applied.
	3. Must be applied in accordance with industry Code of Practice	Compliant (assumed) *	
	4. N-fertiliser use requires a nutrient budget	Compliant	
	5. Must not apply on days when drift or odour will cause problems beyond the farm boundary	Compliant (assumed) *	
Store and feed supplements?	1. Feed storage areas must be sealed to restrict effluent seepage (downwards percolation). Excludes silage pits <500m² and presumably hay sheds	Requires attention	Palm kernel is stored under cover but on bare dry ground. Seepage, if any, is likely to be small as it is covered. However, as the standard is current written, the palm kernel storage area will need sealing (e.g. concrete)
	2. Feed storage areas must be protected from water runoff entry	Compliant	Applies mainly to silage pit in this case, which is compliant
	3. Runoff from feed storage areas must not enter surface water bodies	Compliant	Unlikely given the proximity of the stacks to water courses
	4. Feed storage areas must not be sited within 50m of protected areas, or within 20m of bores, water bodies or the CMS	Uncertain	There are at least five silage bunkers and five silage stacks on the property. Requires further investigation.
	5. Feeding out must not take place within 50m of protected areas, or within 20m of bores, water bodies or the CMS	Compliant (assumed) *	
	6. Feed storage and feeding out shall not result in objectionable odour, dust or drift beyond the farm boundary.	Compliant (assumed) *	

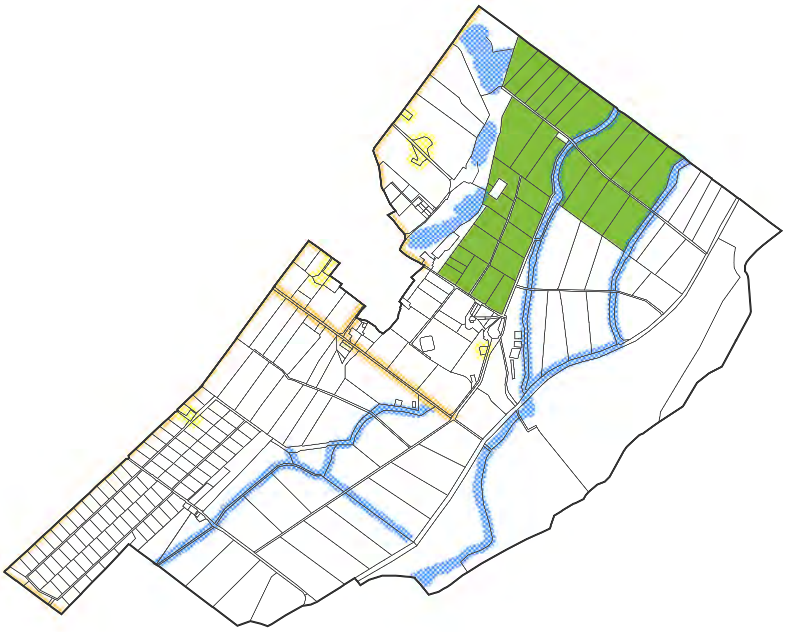
* Level of compliance cannot be assessed conclusively within project limits. Full compliance is assumed until proven otherwise.



EFFLUENT APPLICATION AREAS

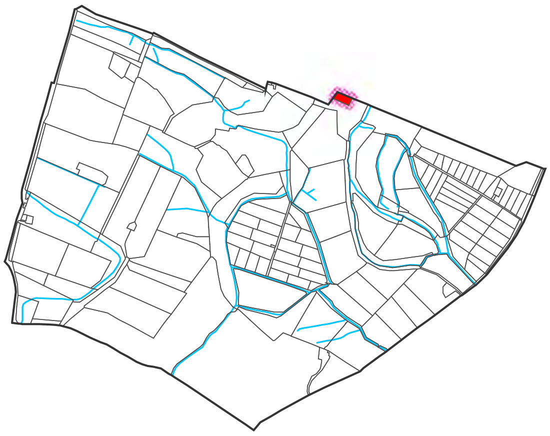
ONE PLAN separation distances

- No discharges of dairy effluent permitted within 20 m of a public road.
- No discharges of dairy effluent permitted within 20 m of residences, marae, schools, public buildings and public recreation areas.
- No discharges of dairy effluent permitted within 20 m of bores or surface water bodies.



Existing effluent application area

- Existing effluent application block (47.2ha). Restricted proportion = 1.5 ha (near streams) 'Effective' area of effluent application block = 45.7ha



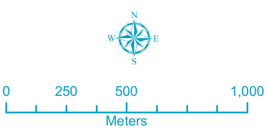
FEED STORAGE AREAS

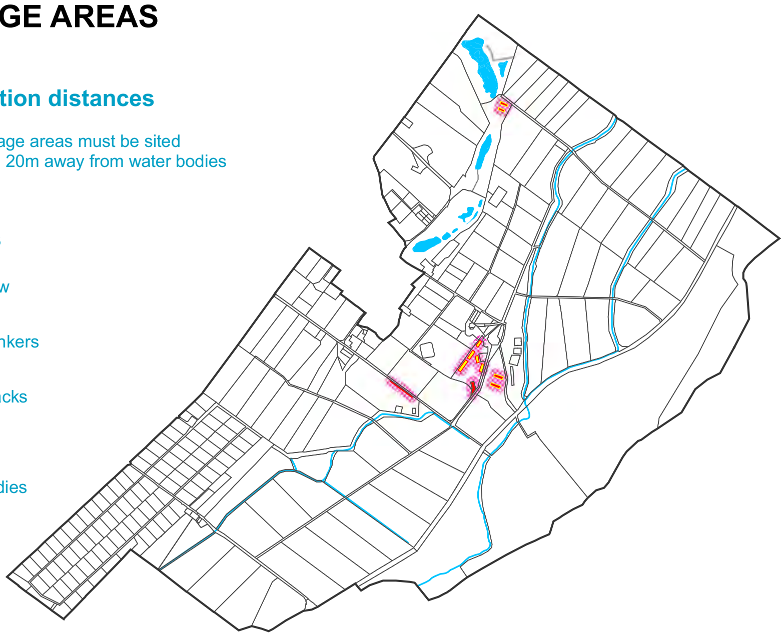
ONE PLAN separation distances

- Feed storage areas must be sited more than 20m away from water bodies

Feed storage sites

- Balage row
- Silage bunkers
- Silage stacks
- Water bodies





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AREAS WITH RESTRICTIONS

Flock House Dairy Farm

Parewanui Road, Bulls

Prepared by AgResearch, 2008

6.3.5 Exclude stock from targeted water bodies

Approximately 997m of new fencing is required to permanently exclude stock from the three main lakes. Excluding stock from these areas is a requirement for both the One Plan and the Clean Streams Accord. Cost is estimated at $2375, and lost revenue from the retirement of grazeable land (1.9 ha) is estimated at $1,060. There is also a series of smaller lakes that probably don't qualify as targeted. Retirement is completely optional. If they were fenced off as wetlands, then it would require 500m of fencing and a loss of 0.85 grazed hectares.

Objective 4: Achieve Clean Streams Accord and One Plan compliance by fencing the main lakes before 2012 (key date for the Accord).

6.3.6 Alternative stock route

Under the One Plan stock-crossings must be bridged or culverted. The ford providing access to the Gravel Block is therefore currently non-compliant. However, stock can be shifted via an alternative route that avoids any ford crossings, thereby negating any need for the installation of a new bridge.

Objective 5: Use the alternative route to provide continued stock access to the Gravel Block.

6.3.7 Silage bunkers

Under the One Plan, individual silage storage areas (i.e. individual stacks) that cover an area greater than 500m^2 must be sealed to restrict effluent leachate percolating into the soil. Currently all five silage stacks located near the dairy shed have bases estimated to be greater than 500m^2, and are therefore non-compliant. The obvious solution is to ensure future stacks are smaller than 500m^2 (e.g. have six or seven smaller stacks rather than five large stacks). However, this will not negate any associated environmental impacts in any meaningful way (it is likely that the same/similar volume and potency of leachate would be produced). Further, the FARM Strategy workbook makes no reference to a 500m^2 limit, suggesting that all silage requires sealed storage irrespective of stack size. In short, it is clear that the current silage stacks are non-compliant, but it is not clear if this can be remedied simply by building smaller stacks. We suggest that total silage volume across all stacks is more important than the size of individual stacks (again because the same or similar amount of leachate would be produced). It would therefore be prudent to start investigating options for sealing silage-storage areas, given the volume of silage harvested and stored by Flock House. The recommended option is the construction of two new bunkers (concrete lined) at an estimated cost of $180,000.

Objective 6: Pending final clarification of feed storage requirements from the regional council, look to install two new concrete-lined silage bunkers with the facility to collect and store leachate.

6.4 Summary of compliance cost estimates

6.4.1 Direct costs

Cost estimates are generated from local prices at time of writing and are therefore subject to change. Full cost could not be established in all cases (particularly secondary costs), and it is likely that a canny farmer could make substantial savings (cost of services is based on contract rates). **Total cost to become compliant with the One Plan estimated at $183,880**. Note that fencing water bodies and installing an effluent holding pond can both be considered as existing compliance costs under the Clean Streams Accord.

Table 10: Cost estimate summary

Construct an effluent holding pond (Obj 2)	$1,500[a]
Fence the lakes area (Obj 4)	$2,375[a]
Construct two silage bunkers (Obj 6)	$180,000[b]
TOTAL	**$183,880**

[a] Required obligation under the Clean Streams Accord

[b] Subject to clarification from the regional council concerning ambiguity around total silage volume stored on-farm, and the size of individual silage stacks

6.4.2 Implications regarding farm returns

Fencing waterbodies is the only recommendation that will incur a direct production loss. Approximately 1.9 grazed hectares would be retired, worth an estimated gross loss of $1,060 per year. This assumes the land around the lakes is currently grazed to its potential.

Effluent storage capacity (Obj 2)

Construct sealed holding pond with at least 106m3 storage

Effluent application area (Obj 3)

Continue to avoid applications of effluent within 5m of riparian fencing

Exclude stock from targeted water bodies (Obj 4)

Required fencing (997 m)

Optional fencing (501 m)

Approximate area to be retired (1.9 ef ha)

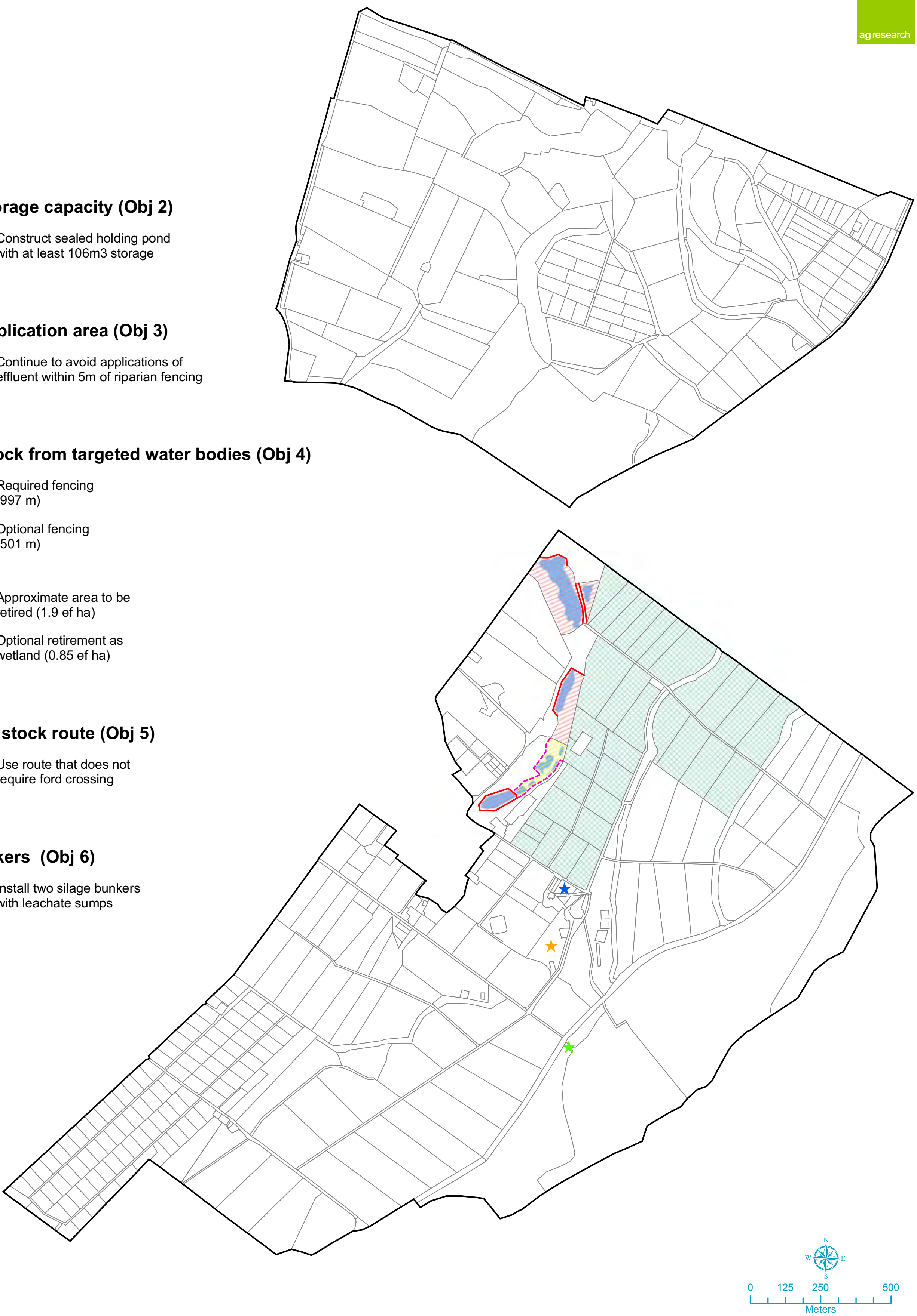
Optional retirement as wetland (0.85 ef ha)

Alternative stock route (Obj 5)

Use route that does not require ford crossing

Silage bunkers (Obj 6)

Install two silage bunkers with leachate sumps



The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

REQUIRED WORKS

Flock House Dairy Farm

Parewanui Road, Bulls

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

TABLE 11: Five-year strategy for compliance with One Plan requirements

OBJECTIVES	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Maintain existing mitigations[1]					
1. Maintain current policies for stock, feeding & fertiliser. Particularly important to retain current purpose of the support unit, including the wintering of dairy cows	→	→	→	→	→
Operate within N-loss targets					
No special management actions are required at the current time	-	-	-	-	-
Effluent storage capacity					
2. Construct a holding pond that will hold at least 106 m³ of effluent. Seal with clay or other recommended material	Initiate as soon as possible				
Effluent application area					
3. Continue to avoid applications of effluent within 5m of riparian fences	→	→	→	→	→
Proximity of feed storage to surface water					
No special management actions are required at the current time	-	-	-	-	-
Fencing water bodies					
4. Exclude stock from water bodies by fencing the lakes area with a 2 wire electric system	Erect 997m of fencing	-	-	-	-
Alternative stock route					
5. Use the route that does not require a stream crossing to get cows to the Gravel Block	→	→	→	→	→
Silage bunkers					
6. Install two concrete lined silage bunkers with the facility to collect and store leachate[2]	Bunkers can be installed anytime before 2014 (when Rule 13 comes into effect for Flock House Dairy Farm). However, earlier is probably better than later.				

[1] Any substantial change in stock policy, feeding policy, irrigation, inhibitor application, or N-use will require a reassessment of farm N-loss against N-targets (i.e. a new nutrient budget).

[2] Silage bunkers are a sound farming option irrespective of One Plan requirements. However, if the One Plan is the primary driving reason for considering bunkers, then clarification should be sought from the regional council regarding definition discrepancies between the One Plan and the FARM Strategy workbook. If the One Plan definition is used then bunkers may not be required. Rather, all that needs to be done is to ensure each individual silage stack never covers an area greater than $500m^2$. If the workbook definition is used, then bunkers are definitely necessary. Note that the One Plan states that intensive farms require a FARM Strategy prepared according to the specifications in the FARM Strategy workbook, meaning workbook specifications carry just as much obligation as One Plan Rules.

6.5 Other considerations

6.5.1 Council assistance

Fencing and planting waterways will be eligible for consideration of an environmental grant from Horizons Regional Council. Grants are available for enhancing 'water quality by retiring and planting stream banks'. Costs for fencing, plants and labour are all eligible under the grant scheme. Further, Flock House farm would likely attract a higher grant rate (30% to 40% of costs) because this FARM Strategy is, for all intensive purposes, an 'environmental farm plan'. Contact for a local HRC representative is provided at the end of this section.

6.5.2 Follow up

Contacts for follow-up and further information include your Horizons Regional Council representative, and the farm business development consultant involved in this project.

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DairyTeam

APPENDIX 1: INFORMATION CHECK

Assessment of current N-loss through Overseer Nutrient Budgets can only be as robust as the information used in the model. This appendix is provided as an assurance that the best information available was used for Flock House Farm at the time of assessment. Separate models were constructed for the Drystock Unit and the Dairy Platform.

Drystock production

- 360 ewes @65kg average live weight
- August lambing and December weaning with all lambs off by 30 June
- 450 lambs weaned @27.5kg live weight
- Purchase 1,200 lambs (@25kg) in December and off June following year (@38kg)
- 15ha conventionally cropped in maize (October). 22 t DM/ha cut in March & exported to dairy platform, then resown in pasture (April).
- 171 R1 heifers in October @75kg and out June @ 260 kg. 131 R2 heifers in July @131kg & out August @500kg. 425 dairy grazers in June @450kg & out August @550kg. 150 dairy grazers in August @550 & out September @550kg. 31 breeding bulls in July @ 600kg & out June @600kg. 51 R1 bulls in September @280kg & out June @400kg. 74% cattle are male.

Dairy production

- Peak milking 850 Friesian Jersey cross cows producing 300,0000kg MS/yr @ 478 kg average live weight.
- 285 day milking season.
- 22% of herd total as replacements
- Off farm wintering – 50% herd off in June & July, 15% off in August (grazed on support block).
- Supplements: 160 tn DM palm kernel; 130 tn DM molasses; 600 tn DM good quality pasture silage; 350 tn DM maize silage.

Resource information

- Annual rainfall is 900 mm (supplied by Horizons Regional Council).
- Farm located 5 km from coast

Block	Ha	RY (%)	Topo	Dom soil	Drainage	Sheep: cattle			Soil test results*							
									Olsen P	Qt K	OrS	TBK	Qt Ca	Qt Mg	Qt Na	PR
Support alluvial	35	100	Flat	Kairanga slm	Poor	31:69			35	12	11	-	9	35	8	-
Support sand	78	100	Roll	Himatangi s	Well	31:69			15	12	11	-	9	35	8	-
Intermittently grazed	8	100	Flat	Rangitikei ls	Well	31:69			35	12	11	-	9	35	8	-
Research 1 & 2	62	100	Flat	Kairanga slm	Poor	31:69			35	12	11	-	9	35	8	-
Fodder crop	15	0	Flat	Kairanga slm	Poor	-			-	-	-	-	-	-	-	-
Not grazed drystock	90	0	-	-	-	-			-	-	-	-	-	-	-	-
Karapoti block	17	100	Flat	Karapoti ls	Well	0:100			35	12	11	-	9	35	8	-
Manawatu block	59	100	Flat	Manawatu slm	Well	0:100			35	12	11	-	9	35	8	-
Parewanui block	61	100	Flat	Parewanui slm	Poor	0:100			35	12	11	-	9	35	8	-
Rangitikei effluent	17	100	Flat	Rangitikei ls	Well	0:100			50	19	10.2	-	10	46	7	-
Karapoti effluent	30	100	Flat	Karapoti ls	Well	0:100			50	19	10.2	-	10	46	7	-
Flood block	37	100	Flat	Rangitikei ls	Mod	0:100			35	12	11	-	9	35	8	-
Gravel block	47	75	Flat	Rangitikei ls	Well	0:100			35	12	11	-	9	35	8	-
Not grazed dairy	56	0	-	-	-	-			-	-	-	-	-	-	-	-

* Limited soil test information available

Pasture management

- Development status for all blocks set at DEVELOPED except for the Gravel Block (DEVELOPING).
- Clover levels set at MEDIUM for all blocks.
- 200 t DM and 400 t DM cropped as balage from drystock alluvial and sand support blocks respectively (exported to dairy platform)
- Drystock pasture utilisation is estimated at 70%. Research blocks estimated at 75%. Dairy blocks estimated at 85% (Overseer default), except the Gravel Block (80%).

Fertiliser

- 300 kg/ha/yr potash superphosphate for Drystock research blocks and support sand & alluvial blocks. 86 kg urea for support sand & alluvial blocks.
- Drystock maize crop uses 500 kg/ha superphosphate and 325 kg/ha urea in October
- No winter application of urea for drystock blocks (May, June, July).
- Main dairy platform excluding Gravel and effluent blocks: DAP 282 kg/ha; Muriate of potash 75 kg/ha; urea 350 kg/ha.
- Gravel block: 15% Potash superten 750 kg/ha; urea 435 kg/ha.
- Effluent blocks receive no fertiliser other than urea (325 kg/ha urea)
- No inhibitors used.
- Winter urea application: All blocks except the Gravel Block receive 100 kg N/ha during winter.

Effluent management

- 20,000 litre sump.
- Effluent applied to land (47ha) via irrigator at a fast rate (Rangitikei & Karapoti effluent blocks).

Assurance statement:

To the best of our knowledge, the information provided above is true and correct at the time the Overseer analysis was undertaken (January 2008).

Farm owner, operator or manager

Name:

Date:

Signed:

Nutrient management consultant

Name: Alec Mackay

Date:

Signed:

ACKNOWLEDGEMENTS

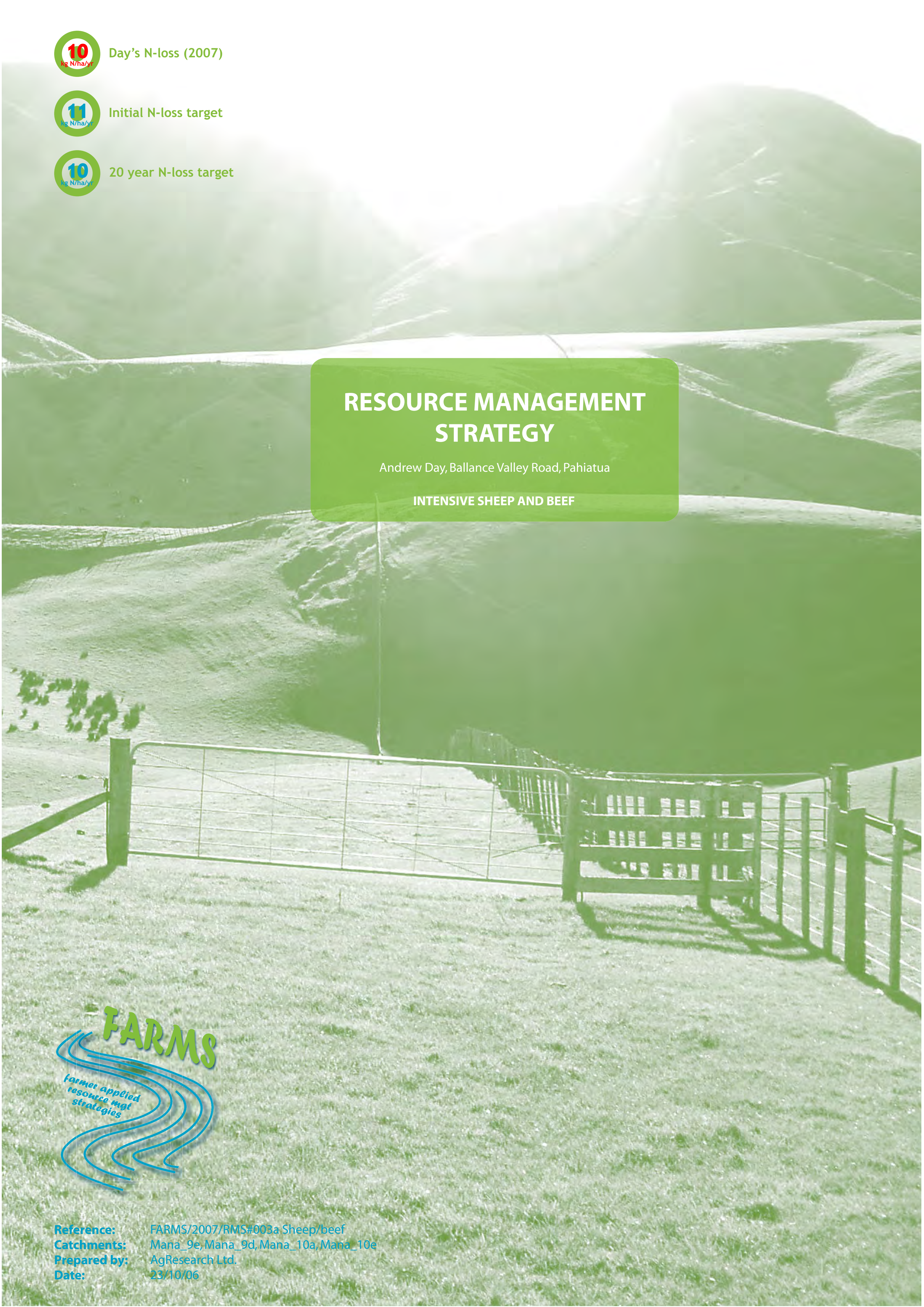
Key people involved in the preparation of this report include:

Gareth Hughes
AgResearch

Alec Mackay &
Andrew Manderson
AgResearch

John
Simmonds
DairyTeam

7.18 CASE STUDY 4 REPORT (PAHIATUA SHEEP & BEEF FARM)



10 kg N/ha/yr Day’s N-loss (2007)

11 kg N/ha/yr Initial N-loss target

10 kg N/ha/yr 20 year N-loss target

RESOURCE MANAGEMENT STRATEGY

Andrew Day, Ballance Valley Road, Pahiatua

INTENSIVE SHEEP AND BEEF

FARMS
farmer applied resource mgt strategies

Reference: FARMS/2007/RMS#003a Sheep/beef
Catchments: Mana_9e, Mana_9d, Mana_10a, Mana_10e
Prepared by: AgResearch Ltd.
Date: 23/10/06

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BACKGROUND

THE ONE PLAN & RULE 13*x*: At present eleven important catchments in the Manawatu-Wanganui Region have nutrient levels far in excess of what is desirable. To help address this issue Horizons have proposed a Rule in the One Plan that aims to lessen the nutrient-impact from activities associated with intensive farming. Resource consents concerning irrigation takes, fertiliser, stock feed, biosolids, soil conditioners, dumps, offal holes, and effluent, will be necessary for dairy farming, cropping, market gardening, and intensive sheep and beef farming. The Rule will come into effect at different times for each of the eleven catchments.

ONE FARM; ONE CONSENT: A new consent process will be available under the One Plan. The traditional approach of having several separate consents for a farm is replaced with a single whole-farm consent. This means only one consent – not many – is needed for the entire farm. This promises to make the process simpler, quicker and considerably less expensive. A *FARM Strategy* is a necessary prerequisite for a whole-farm consent.

FARM STRATEGY: A FARM Strategy (Farmer Applied Resource Management Strategy) represents an assessment of permitted and controlled activities for a farm, and a strategic plan to ensure those activities comply with One Plan specifications and water quality targets. It combines a nutrient budget, a comparision of farm nutrient-loss against catchment water-quality targets, an evaluation and recommendation of mitigation options (if the farm is operating outside of catchment water-quality targets) including cost and effectiveness, an assessment of eligibility for relevant consents, and a farm plan of works that spells out the where, when and how much of achieving sustainable land use within the given catchment of interest.

This report summarises an exploratory FARM Strategy for Andrew Day who runs a 973 ha sheep and beef farm located near Pahiatua. The property does not qualify as being 'intensive' under the One Plan, nor is it located within any of the eleven targeted catchments (despite the farm straddling four water management subzones). However, interest has been expressed in converting part of the farm to a dairy unit (which does necessitate a FARM Strategy under the One Plan). The opportunity is taken here to assess both the proposed dairy conversion (as report RMS #3b) and the current operation as an example intensive sheep and beef unit (this report – RMS #3a). The Day property represents the third application of the FARM Strategy framework.

1.0 PLAN SUMMARY

- **Purpose:** Purpose is to identify how the Day farming operation can remain compliant under Rule 13*x* of the proposed One Plan. Emphasis is on identifying best options that achieve requirements without placing unnecessary strain on farm performance.

- **Farm overview:** A 973 ha (885 ha effective) sheep/beef breeding and finishing farm located hard up against the eastern side of the Tararua Ranges producing 7,050 kg pasture DM/ha/yr and running 8369 stock units (9.5 su/ha) with an emphasis on sheep (70:30 sheep: cattle ratio). Topography is predominantly hill country (598 ha), steepland (288 ha) and a small proportion of flat to undulating land (88 ha). Rainfall is seasonally reliable (1,470mm/yr) but positioning against the range exposes the farm to strong west and south-west winds. Financial and physical performance is well above average.

- **Nutrient loss and water quality:** Current N-loss calculated at 10 kg N/ha/yr using Overseer Nutrient Budget model. P-loss risk to water is HIGH (2.4 kg P/ha/yr). Nutrient contribution from yards and unfenced waterways was not calculated. Risk of faecal pathogens entering water was not fully assessed. Sediment yield for the whole farm estimated at 3,400 tonnes per year.

- **Permissible N-loss:** Detailed Land Use Capability (LUC) mapping was undertaken to link One Plan water-quality targets to the Day farm. Permissible N-loss is calculated at 11 kg N/ha/yr for the first year, and reduces slightly over the 20-yr implementation period to 10 kg N/ha/yr. Compared with current N-loss **the Day farm is currently operating with its N-target and no special mitigation practices are required for compliance.**

- Over the 20-yr implementation period it is likely that the N-cap will be breached by at least 3 kg N/ha/yr according to current intensification trends. N-loss implications for a dairy-conversion intensification scenario are investigated as report RMS #3B.

- **Mitigations evaluation:** While no N-loss mitigations are required, several options were evaluated either for interest, or because they are a requirement under a different part of the FARM Strategy. The most relevant options were evaluated further to identify likely effectiveness, cost, and future impact on farm revenue.

Option	N, P & bug effectiveness	Cost	Practicality	Rating
Urease-urea replacement	N-loss ↓ **1 kg N/ha/yr**	Increase of $8,000 but potentially offset by at least +$8,000 production gains	High	✓✓✓
Wetland for yard runoff	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$2,700 cost for fencing & planting	Medium	✓✓
Fence waterways	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$400,000 cost for 40 km sheep-proof fencing	Low	✓
Planted riparian buffers	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$405,200-$407,800 cost and $10,400 to $31,250/yr lost revenue depending on buffer width (10-30m).	Extremely low	×
Install 28 new culverts	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$15,000 cost	Low	✓
Install 45 new troughs	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$19,475 cost	Low	✓
Construct 18 new dams	Bug risk↓ & P-loss risk↓ & N-loss risk↓	$18,000 cost	Low	✓
New bridge?	*Bug risk↓ & P-loss risk↓ & N-loss risk↓*	*$20,000 cost*	*?*	

✓ Non-negotiable. Required under the One Plan. See below.

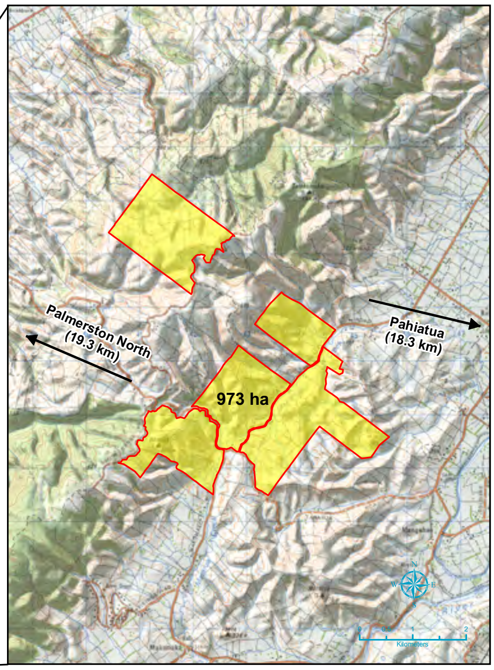
- **Voluntary mitigations:** Consider replacing current urea product with one that is treated with urease-inhibitor. While not a requirement, this practice promises reduced N-loss and increased farm returns.

- **Compliance requirements:** Current practice was evaluated against One Plan requirements. Items that need attention include: physically excluding stock from targeted waterways with 40 km of new riparian fencing; controlling stock-effluent discharge from sheep yards by constructing a receiving wetland; decommission existing offal hole and excavate a new offal hole in an area compliant with One Plan specifications; install 28 new culverts at all points where stock cross targeted waterways; install 18 new dams and 45 new troughs in paddocks where stock currently rely on water from targeted waterways. Riparian fencing will isolate a sizeable strip of land that can either be retired (3 ha representing $3,700 lost gross revenue) or subdivided and bridged (at an estimated $20,000 cost).

- **Compliance strategy:** Recommendations for full One Plan compliance are made as nine specific objectives for successive implementation over a five-year period. Any appreciable change in stock policy, feeding policy, fertiliser policy, or any related N-input will require a reassessment of farm N-loss against N-targets (i.e. a new nutrient budget).

- **Compliance cost:** Cost of full One Plan compliance is estimated at $455,000 or $475,000 if a new bridge is installed. The greatest cost arises from the waterway protection programme (including new fencing, culverts, dams, and troughs). This reflects the dissected landscape and related high incidence of waterways found in hill country.

- **The good news:** Under the One Plan the Day farming operation is not categorised as intensive nor does it fall within a targeted catchment. In short, a FARM Strategy is not required for this operation. The farm has been examined solely as a research exercise. This means the waterway protection programme (new fencing, culverts, etc.) does not need to be implemented as a One Plan requirement at the current time. However, note that the offal hole changes are still required (because offal holes qualify under a different rule), and possibly some mitigations around controlling effluent runoff from the older set of sheep yards (may qualify under discretionary Rule 13-27).



This property is located 18.3 km north west of Pahiatua township, and 19.3 km south east of Palmerston North.

(Distances calculated by road between farm centre and town centre).

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

FARM LOCATION & ACCESS

Andrew Day, Balance Valley Rd, Pahiatua

Prepared for Horizons Regional Council by AgResearch Ltd, as part of the FARMS initiative.
September 2007.

agresearch

ID	LEGAL DESCRIPTION	AREA
1	SECT 12 Blk XIX Mangahao Survey District, Pt SBDN 1	62.4584 ha
2	Blk VI Mangahao Survey District, SECT 117	1.6946 ha
3	Blk VI Mangahao Survey District, SECT 119	0.4046 ha
5	WN87/25, Blk VI Mangahao Survey District, SECT 79	106.0782 ha
6	WN87/26, Blk VI Mangahao Survey District, SECT 116	8.9030 ha
7	WN39A/678, Blk VI Mangahao Survey District, SECT 72	40.2662 ha
8	WN21A/646, Blk VI Mangahao Survey District, SECT 71	43.5037 ha
9	WN115/76, Blk VI Mangahao Survey District, SECT 70	44.6165 ha
10	WN57/165, Blk VI Mangahao Survey District, SECT 67	125.756 ha
11	WN100/235, Blk VI Mangahao Survey District, SECT 80	63.5356 ha
12	WN52A/46, DP 84455, LOT 1	24.250 ha
13	WN71/228, Blk VI Mangahao Survey District, SECT 114	52.4067 ha
14	WN105/284, Blk VI Mangahao Survey District, SECT 115	53.0138 ha
15	WN245/277, Blk II Mangahao Survey District	81.1394 ha
16	WN241/185, Blk II Mangahao Survey District, SECT 5	81.0383 ha
17	WN238/220, Blk II Mangahao Survey District, SECT 3	81.1394 ha
18	WN69/221, Blk VI Mangahao Survey District, SECT 78	106.584 ha
		976.7884 ha

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

LEGAL TITLES AND PARCELS

Andrew Day, Balance Valley Rd, Pahiatua

Prepared for Horizons Regional Council by AgResearch, as part of the FARMS initiative, July 2007. Please note that legal areas for rural parcels can be imprecise. Total farm area for this report has been calculated at 973 ha using orthophotography.

agresearch

2.0 FARM DESCRIPTION

2.1 Existing farm business

2.1.1 The physical resource

- The farm is located on the south east side of the Tararua Ranges approximately 18.3 km north west of Pahiatua township.
- Location places the farm within the *Middle Manawatu* (**Mana_10**) and *Upper Gorge* (**Mana_9**) *Water Management Zones*. Four *subzones* are implicated, including the *Lower Mangahao* (**Mana_9e**), *Upper Mangahao* (**Mana_9d**), *Middle Manawatu* (**Mana_10a**), and *Aokautere* (**Mana_10e**), none of which are priority-targeted under the One Plan (for nutrient management).
- The Wellington Fault Line bisects the property parallel to the Tararua Ranges. The range side is made up of Triassic/Jurassic argillite and greywacke steepland (~286 ha), together with extensive inclusions of high rolling country with characteristic Ramiha type soils (~298 ha). Easy hills prevail on the other side of the farm, dominated by loess-mantled Tertiary sandstones, limestones and unconsolidated sands (~363 ha), interspersed with narrow floors of alluvial flats (~30 ha). Lowest point above sea level is 130 m and highest point is 505 m.
- Total length of perennial streams is estimated at 22.4 km (flow all-year-round, most years). Length of ephemeral water networks is estimated at 55.3 km.
- Annual mean rainfall is 1470 mm (supplied by Horizons) and ranges between 1325 mm through to 1540 mm across the farm.
- Total area of the property has been mapped at **973 ha** with an estimated **885 ha** in pasture (all non-pastoral vegetation mapped out at a high level of detail – see property map over the page). Area of the main farm is 730 ha (671 ha effective), with a further 243 ha (214 ha effective) leased (Windfarm block).

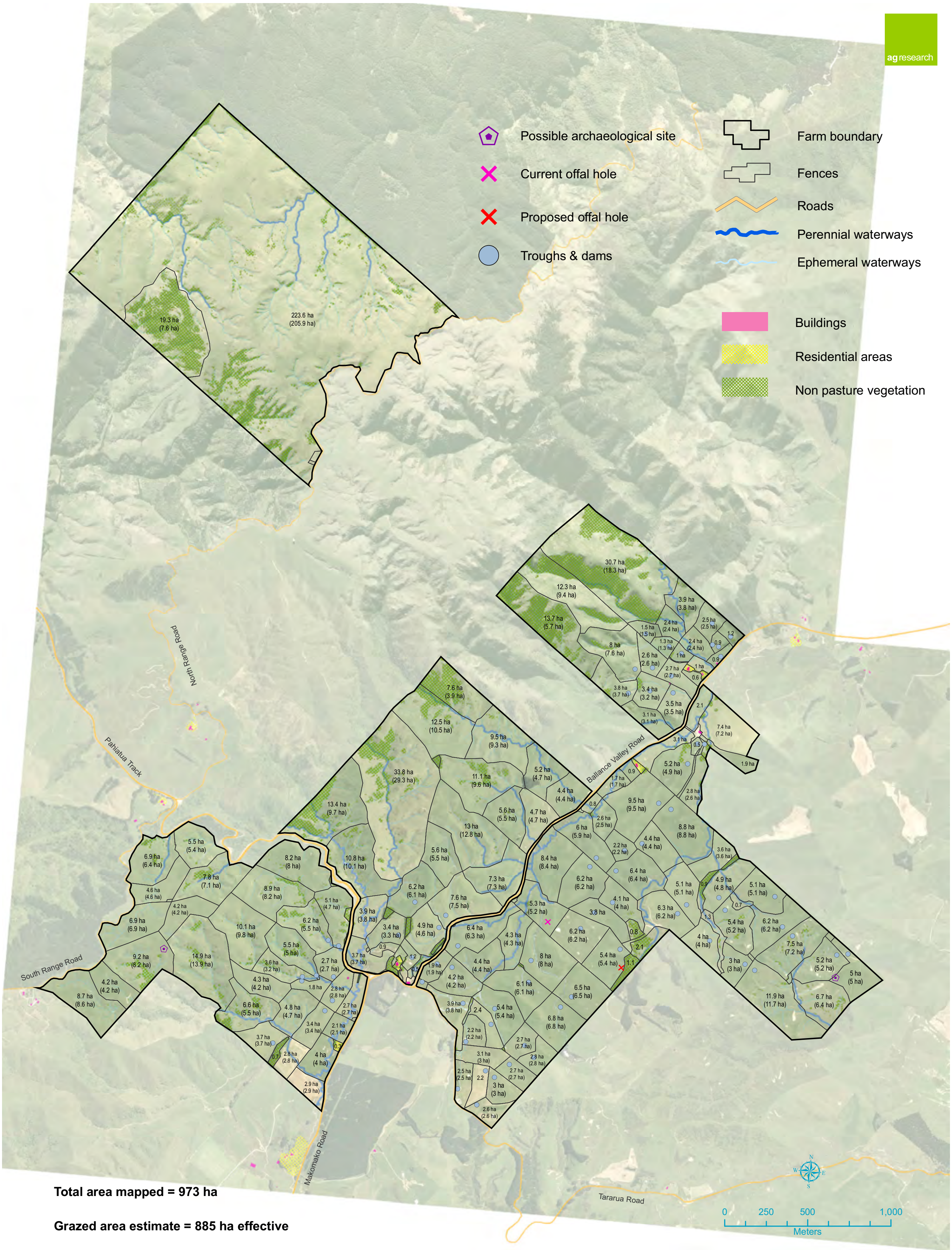
2.1.2 Infrastructure

- The main farm is well subdivided into approximately 130 main paddocks ranging in size from 3 to 34 ha. The leased block (Windfarm) has less than effective fences (essentially operated as one large paddock).
- Total length of fencing is 154 km (boundary fencing = 34.8 km, internal fencing = 118.7 km) mostly as conventional 8-wire.
- Farm buildings, yards and other structures are in good serviceable condition. Buildings include four houses, a hay shed, and two woolsheds.
- Stock water is provided by a reticulated system for part of the main farm, with the remainder served by dams and streams.

2.1.3 Farm system

- A partnership (Andrew Day as part owner and full time farm manager) running primarily as a sheep/beef breeding and finishing property with occasional (limited) grazing of dairy heifers. Total stock units wintered is 8369 su at a 70:30 sheep:cattle ratio, giving a stocking rate of 9.5 su per effective hectare (over the whole farm). Note that stocking rate for the main farm is 11.3 su/ha (excluding the Windfarm Block).

Sheep	**June 2007**
MA ewes	4430
Ewe hoggets	1620
Wether hoggets	470
Rams	35
Sheep stock units	6083
Cattle	**June 2007**
MA cows	116
R2 heifers	31
R1 heifers	52
R2 bulls	41
R1 bulls	164
Breeding bulls	2
R1 dairy grazers	63
Cattle stock units	2286
Summary	**June 2007**
Total stock units	8369
Sheep:cattle ratio	70:30
Stocking rate	9.5 su/ha



Total area mapped = 973 ha

Grazed area estimate = 885 ha effective

FARMS

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

PROPERTY MAP

Andrew Day

Ballance Valley Road, Pahiatua

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

2.1.4 Enterprises

Sheep:

- The ewe flock is comprised of Coopworth Composite cross sheep achieving a consistently high lambing percentage of 140% in the main flock and a typical 75% lambing with the ewe hoggets.
- Terminal sire rams are put across 1500 MA ewes from 7th April, then a commercial ram from 21st April for the remainder of the flock. Ewe hoggets are mated to terminal sires from 21st April also.
- Weaning is progressive from December through January, often in fortnightly drafts. Normal weaning weights are around 30 kg. Around 1200 lambs are drafted prime at the start of weaning (~14 kg carcass weight), followed by fortnightly drafts till the end of January and then every 3-4 weeks at a 15.5-16 kg carcass weight. Last of the lambs are usually sold in mid to late May. Lambs are sold under a fixed pricing and supply contract.
- Lambs shorn mid January and hoggets shorn either pre-lamb or in September. The main shear operates under a split flock 8-10 month system, based on ewe age.

Cattle:

- The breeding herd of Friesian Angus Hereford crosses is farmed predominantly on the leased block, returning to the main farm for a short 4-6 weeks during TB testing. Calving is from 20th October, and weaning from early May (calves weaned to the main farm).
- Finishing system: Weaned bull calves enter a semi-cell grazing system alongside an existing 110-120 Friesian bulls (purchased October-December at a 100 kg live weight). Finishing bulls are sold from December through to April at 260 kg carcass weight, with the tail end (~20) carried over to November at a 300 kg carcass weight. Cells are grazed rotationally by the sheep flock between weaning to April to help minimise internal parasite risks.
- The breeding herd is being developed so heifer calves are retained and raised as herd replacements (Angus sire).

Dairy heifers:

- Two mobs of dairy heifers are grazed under a May-to-May (full year) contract, arriving at 200 kg and leaving at 420 kg. One mob is managed under a weight gain system and the other on a flat weekly fee.

2.1.5 Financial and physical performance

- The farm business has been analysed using the Profit Check database system. This provides a benchmark for existing performance and identifies opportunities for improvement. Note that the analysis was undertaken prior to the initiation of this farm strategy, and uses a more generous effective area. Key performance indicators include:

	2007	Class average	Comment
General Production KPI's			
Area (ha) effective	910	530	Larger than average
Stocking Rate (su/ha)	8.5	10.2	Low – influenced by lease block*
MA Lambing %	139	123	Very good
Hogget lambing %	37.5	42.8	Average
Flock lambing %	113	98	Very good
Sheep deaths and missing	6.4	8.2	Low
Cattle deaths and missing	0	4.4	Very low
Financial KIP's			
Sheep GFI/ssu$	67.79	61.24	Above average
Cattle GFI/csu$	62.53	49.16	Well above average
Total GFI/su$	67.44	59.52	Well above average
Total GFI/ha$	572	612	Below average
R&M Expenses ($/ha)	36	48	Below average
Total FWE $/su	30.44	40.43	Well below average
FWE /GFI %	45	72	Very good
EFS/ha	251	95	Very good
EFS/GFI %	43.9	10.8	Very good
EBIT $/ha	314	198	Very good
Interest & rent/GFI %	13.6	25.1	Low
Return on Capital %	2.2	1.3	Above average
Return on Equity %	1.7	-1.5	Above average
Change in Equity		NA	
% Change in Equity		NA	
Term Borrowings ($/su)	66	NA	Moderate
Times interest Covered	4	NA	Very good

GFI = Gross Farm Income
FWE = Farm Working Expenses
EFS = Economic Farm Surplus (GFI – FWE +/- adjustments)
EBIT = Earnings Before Interest & Tax (GFI – FWE)
NA = Not applicable

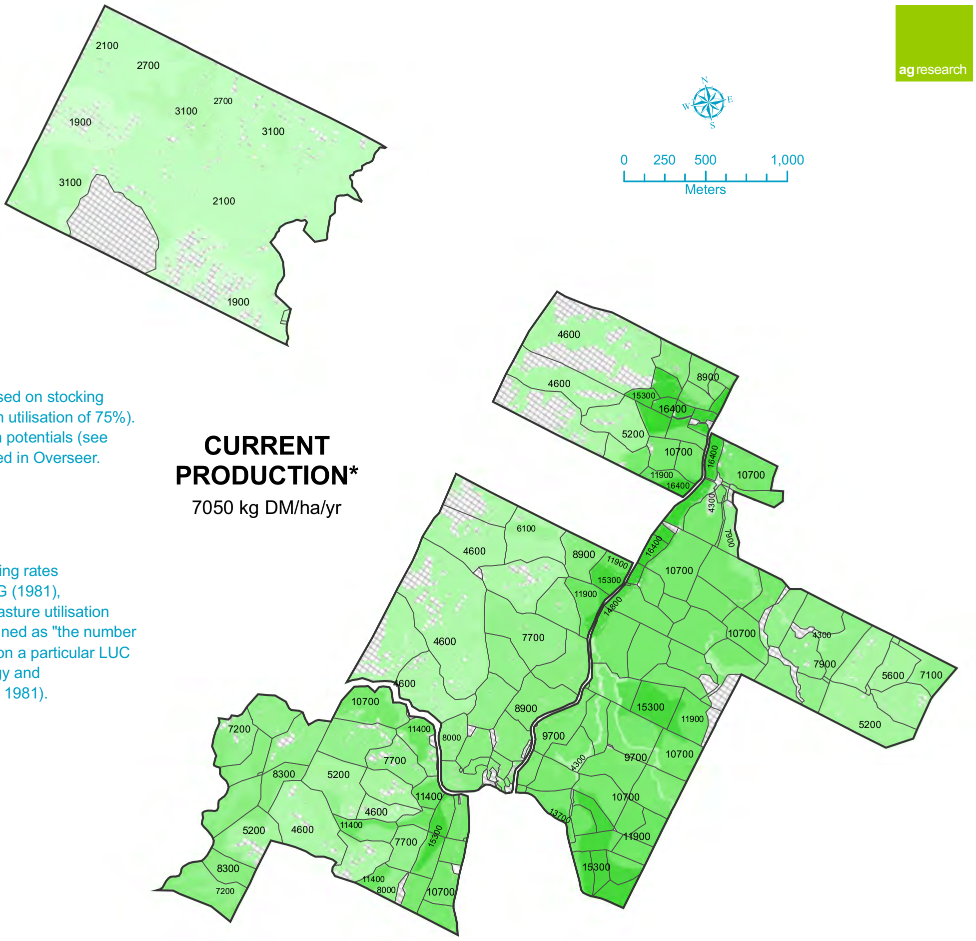
** Stocking rate averaged across the whole farm is low (9.2 su/ha) but reasonably high for the main farm when the Windfarm Block is excluded (11.3 su/ha).*

2.1.6 Financial and physical performance *(continued)*

- Generally the business appears to be very well managed with high levels of financial and physical performance.
- Stocking rate is below average, possibly due to the extensive management of the Windfarm block. However, this is of less concern if an effective area of 885 ha is used, or if the Windfarm block is excluded.
- Lambing performance is well above average, which highlights a major strength of the business. Calving performance lags slightly, possibly as a reflection of the Windfarm block.
- Returns on sheep per stock unit are nearly 11% above average, and cattle returns are 27% above average.
- Animal health expenditure is very low. Good all-round stock health and nutrition is suggested by the low stock losses (6.4% for sheep; 0% for cattle).
- Wool production and associated returns is much lower than the class average at 4 kg and $8.67 per sheep stock unit.
- Farm Working Expenses are low, accounting for only 45% of Gross Farm Income. This suggests an efficiently operated business (provided the resource is being maintained).
- Operating surplus (as EBIT) is strong at $314/ha (56% above class average).
- Return on Equity is positive indicating a gain in the net equity has occurred.
- Times Interest Covered (TIC) is a measure used to determine the serviceability of debt and rent (EBIT/Interest & Rent). As a rule of thumb, most banks prefer this index to be at least 1.3 or higher. An index result of 4 indicates a strong level of financial flexibility.

2.1.7 Pasture and grazing management

- The Windfarm block is severely under-developed in terms of soil fertility and subdivision, and is therefore only grazed under an extensive grazing system. A short-term lease agreement negates the rationality of developing the block at present.
- Cattle finishing on the flats and rolling country is under a semi-cell type grazing system. Stock are on a 50-60 day rotation from April/May, then down to a 15 day rotation in September. Bulls are stocked at a lower rate than the heifers (2.5 *cf*. 3.0 su/ha).
- 3-4 ewe mobs are placed on separate rotations from weaning (70 day rotation in winter). Ewes are then set stocked from lambing, with ewes/paddock numbers set from previous paddock performance.
- No supplementary feed is made or purchased. Standing pasture makes up 100% of feed utilised (although crops may be grown in some years).
- Current pasture production is estimated at **7,050 kg DM/ha/yr** using Overseer Nutrient Budgets (the Overseer model considers soil fertility, stocking rate, production, fertiliser use, irrigation, supplementary feed, and local growing conditions). At a utilisation rate of 75% (as an average for the entire farm) this equates to 5,300 kg DM/ha/yr consumed, which aligns well with current stocking rate (at 9.5 su/ha and a requirement of 550 kg DM/ha/yr/su then annual pasture intake would need to be 5230 kg DM/ha/yr). Note that the Windfarm block will be dragging down the whole farm average considerably.
- Current levels of pasture production have been distributed across the farm (map opposite) using Land Use Capability units (map on page 14) and carrying-capacities for different units reported in LRG (1981). These were further refined by using relative yield percentages for nutrient management blocks (page 10) to better reflect development status. Similarly, potential carrying capacities have been used estimate potential levels of pasture production, if all manageable limitations were overcome (e.g. optimal pH, soil nutrient status, drainage condition, etc.). Upper limit of potential pasture yield is estimated at **13,200 kg DM/ha/yr**. Many generalisations have been made to produce these maps, so they should be used for comparative or indicative purposes only. Misrepresentation is likely because the farm touches on the outer boundaries of three different Land Use Capability Regions (which affects the representative quality of carrying-capacities reported in LRG, 1981). However, they do suggest that the Day property has wide scope for increasing annual pasture yield into the future.



CURRENT PRODUCTION*

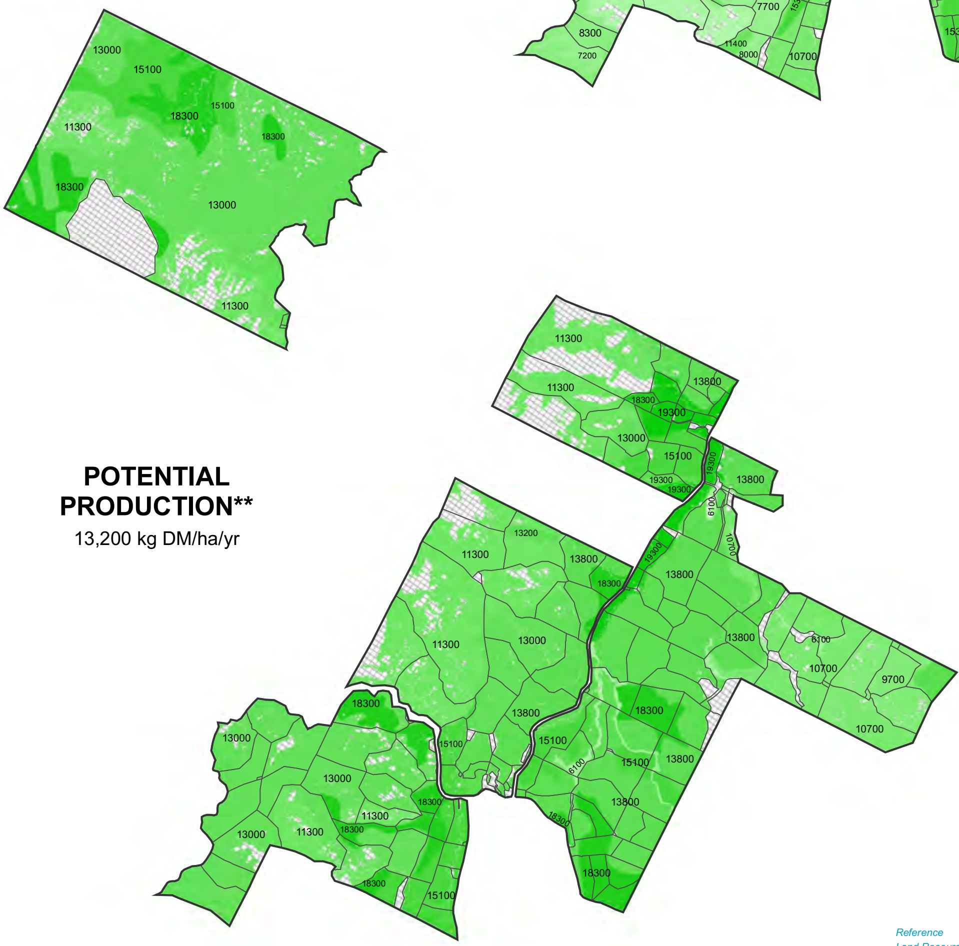
7050 kg DM/ha/yr

*** Current production estimate**

Calculated from total annual pasture production based on stocking rate (8369su x 550kg DM/su @ average whole farm utilisation of 75%). Categories distributed according relative production potentials (see below) and adjusted according to relative yields used in Overseer.

**** Potential production estimate**

Potential production calculated from potential stocking rates reported for Land Use Capability (LUC) units in LRG (1981), using 1 su requiring 550kg DM/ha/yr & a variable pasture utilisation according to land class. Potential stocking rate defined as "the number of stock units per hectare capable of being carried on a particular LUC unit, assessed within the limits of present technology and given favourable socio-economic conditions" (LRG, 1981).



POTENTIAL PRODUCTION**

13,200 kg DM/ha/yr

Pasture yield categories

Kg DM/ha/yr

- 1900 - 2000
- 2001 - 3000
- 3001 - 4000
- 4001 - 5000
- 5001 - 6000
- 6001 - 7000
- 7001 - 8000
- 8001 - 9000
- 9001 - 10000
- 10001 - 11000
- 11001 - 12000
- 12001 - 13000
- 13001 - 14000
- 14001 - 15000
- 15001 - 16000
- 16001 - 17000
- 17001 - 18000
- 18001 - 19000
- 19001 - 20000
- Non pastoral

Reference
Land Resources Group. 1981. Stock carrying capacities and fertiliser data for the North Island. Internal report No.22. Aokautere Science Centre, Ministry of Works & Development, Palmerston North, New Zealand.

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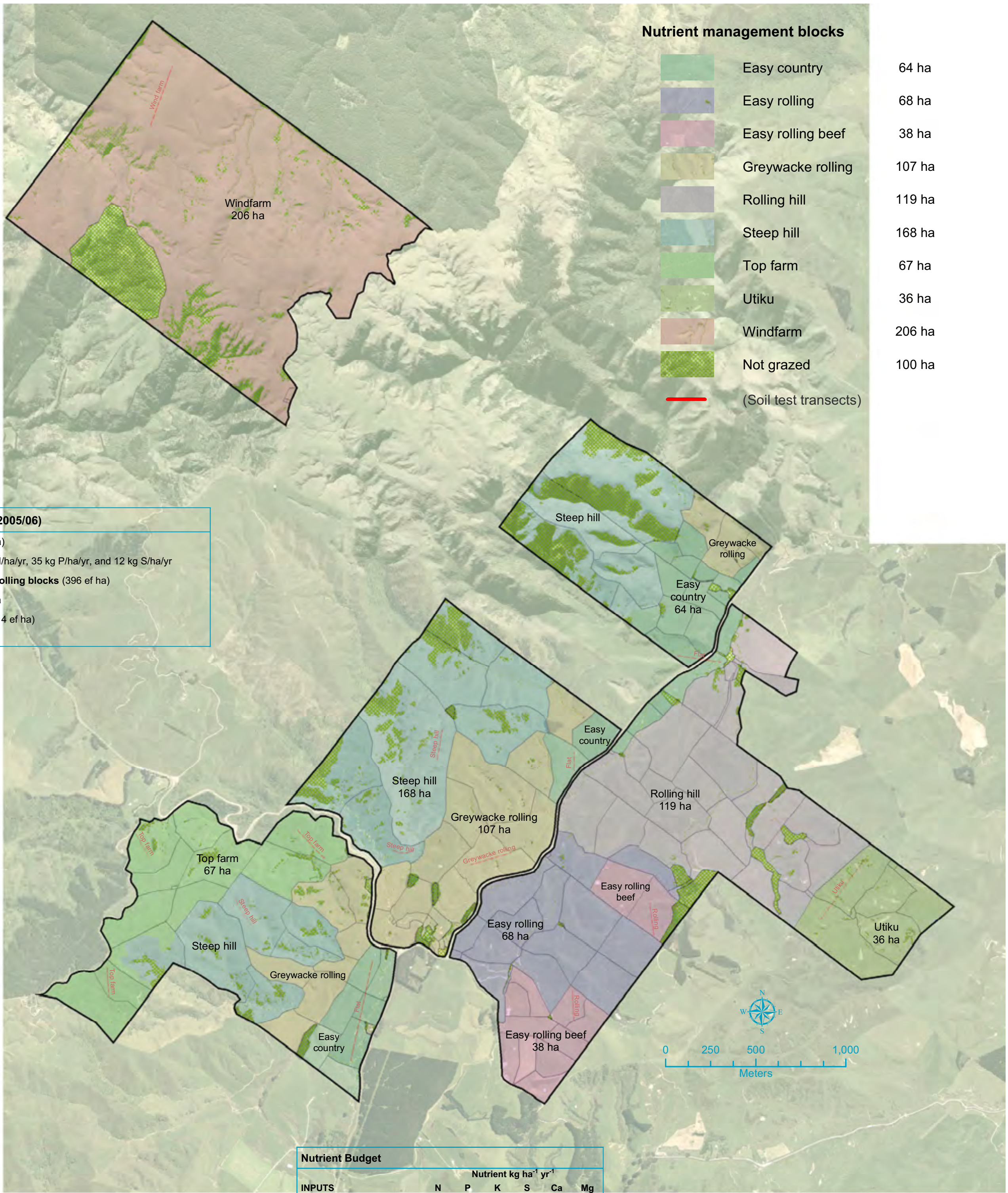
PASTURE YIELD GAP

Andrew Day

Ballance Valley Road, Pahiatua

FOR COMPARITIVE PURPOSES ONLY. Current production estimated from stocking rate and distributed according to Land Use Capability (LUC) classes for the property adjusted to relative yield. Potential production estimated from carrying capacities reported in LRG (1981), using 1 su requiring 550 kg DM/ha/yr and variable utilisation rates according to land class.

agresearch



Nutrient inputs (2005/06)

Main farm (671 ef ha)

Equivalent of 22 kg N/ha/yr, 35 kg P/ha/yr, and 12 kg S/ha/yr

Easy country plus rolling blocks (396 ef ha)

Additional 46 kg N/ha

Wind farm block (214 ef ha)

No fertiliser

Nutrient Budget

INPUTS	N	P	K	S	Ca	Mg
	Nutrient kg ha^{-1} yr^{-1}					
Fertiliser	29	24	0	8	0	0
Effluent	0	0	0	0	0	0
Atmospheric/Clover N	38	0	2	4	3	6
Irrigation	0	0	0	0	0	0
Slow release	0	3	32	8	3	5
Supplements	0	0	0	0	0	0
OUTPUTS						
Product	8	1	0	1	2	0
Transfer	0	0	0	0	0	0
Supplement removed	0	0	0	0	0	0
Atmospheric	18	0	0	0	0	0
Leaching/runoff	**10**	2	12	20	8	7
Immobilisation/absorption	31	12	0	0	0	0
Change in inorganic soil pool	0	11	22	0	-4	4

Soil test results (May 2006)

Block	Olsen P	Qt K	Org-S	SO_4-S	Qt Ca	Qt Mg	Qt Na	ASC
Easy country	50	6	8	8	8	18	7	-
Easy Rolling	25	5	7	7	4	10	4	-
Easy Rolling Beef	25	5	7	7	4	10	4	-
Rolling Hill	25	5	7	7	4	10	4	-
Utiku	17	7	6	4	5	13	5	-
Greywacke rolling	20	8	11	12	5	15	8	-
Steep hill	23	8	9	8	5	24	8	-
Top farm	20	9	15	15	6	17	7	-
Windfarm	5	9	13	13	3	15	7	-
Non grazed	-	-	-	-	-	-	-	-

Nutrient loss and greenhouse gas emissions

Parameter	Day farm	Average NZ Farm SB
Nitrate leaching loss	10	5-20
Phosphorus Run-off risk	High	
Greenhouse gases		
Methane	2127	2000-3000
N_20 emissions	804	400-1400
CO_2 emissions	118	30-130

Note.
1. Approximate area of forest to absorb total farm CO^2 equivalents is 270 ha pine (net 1 rotation)

FARMS

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NUTRIENT MANAGEMENT

Andrew Day

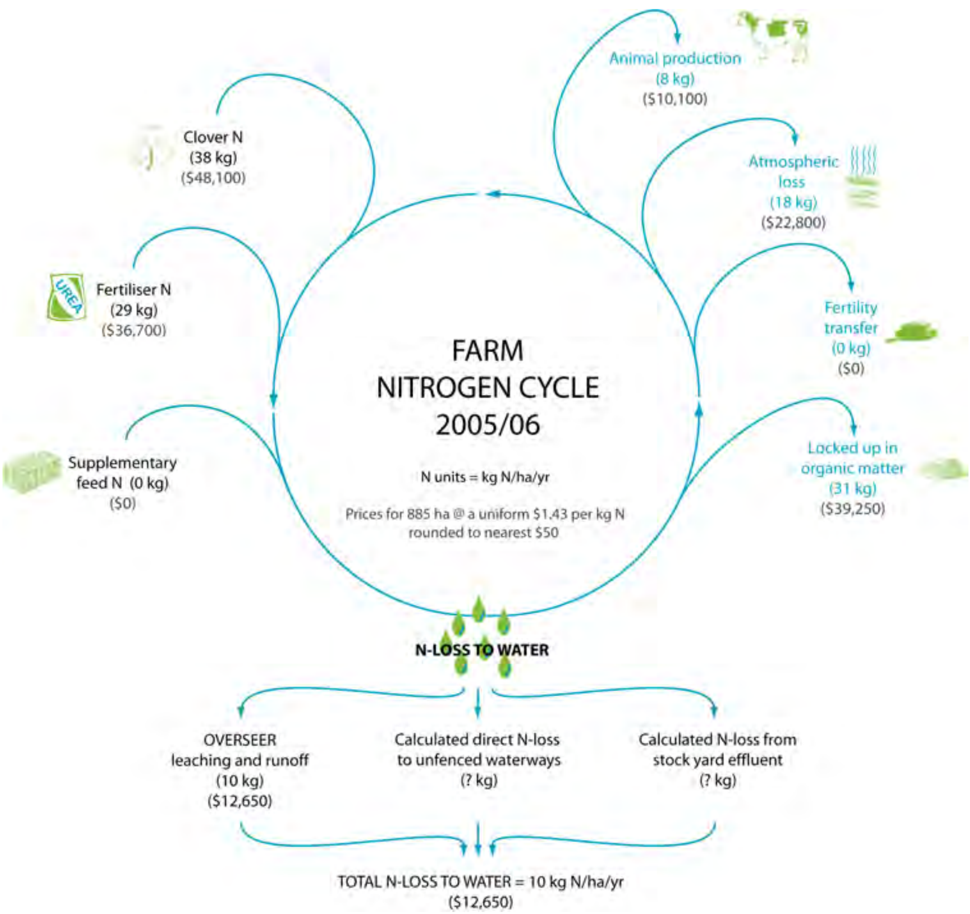
Ballance Valley Road, Pahiatua

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

3.0 FARM NUTRIENT BUDGET AND WATER QUALITY

3.1 Nitrogen budget and N-losses

- The farm was divided into ten nutrient management blocks for analysis using *Overseer Nutrient Budgets* (v 5.2.6.0). Key inputs and Overseer outputs are summarised in the Nutrient Management Map opposite.
- Assumptions, settings and inputs for the Overseer model have been signed-off as being true and correct to the best of the farmer's and consultant's knowledge at the time this report was prepared (see appendices). Note that fertiliser inputs over 2004-06 have been averaged to provide a more representative indication of fertiliser use.
- ***Overseer* calculates N-loss for the Day sheep and beef operation at 10 kg N ha^{-1} year^{-1}** (N lost by runoff or leaching).



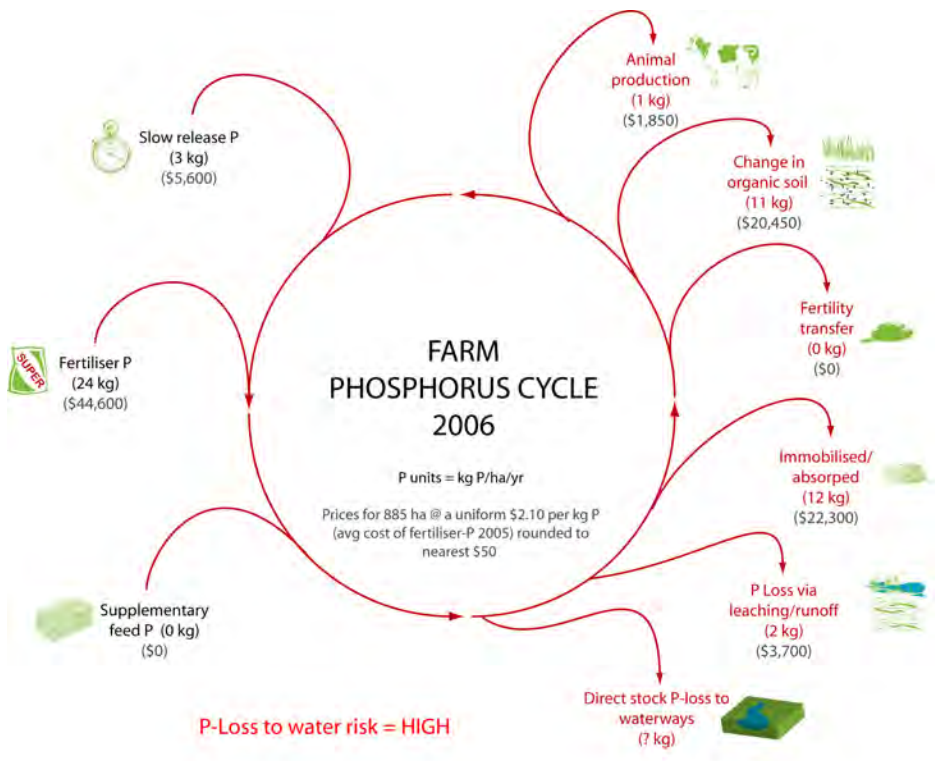
- Overseer does not yet accommodate all conceivable N-loss pathways to water. For the Day property, it is likely that significant additional contributions are a made through direct defecation/urination of stock to unfenced waterways (only a small proportion of perennial streams are excluded from stock), and from yard runoff given the current design and volume of stock that pass through the yards on an annual basis. N-loss contributions from either cannot be robustly estimated due to gaps in research understanding, particularly in relation to sheep and beef farming. However, while quantification is a challenge, there is sufficient understanding around mitigation practices to minimise N-loss risk from these sources.

3.2 Faecal microbes and waterway contamination

- Risk of faecal microbes entering water was not assessed for the Day farm. While there is a body of research on the effectiveness of mitigation practices, the preliminary methods and models of quantifying pathogen risk are still in an early stage of development.
- Direct deposition of dung to streams can represent a disproportional and large source of faecal contaminants to surface water. Installing bridges and culverts at crossings, and excluding stock from waterways, are therefore widely recommended as a chief mitigation option.

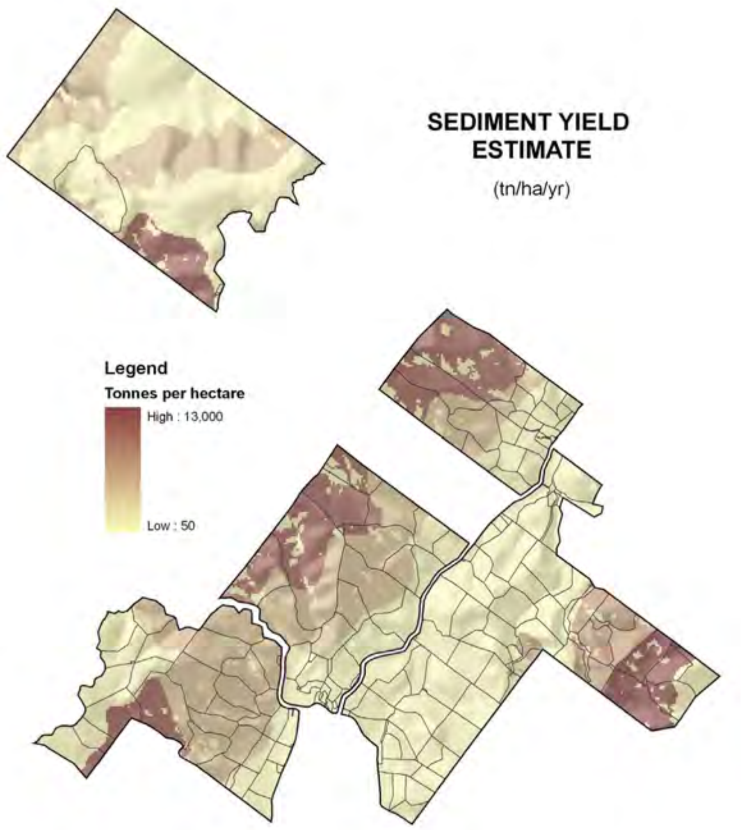
3.3 Phosphorus budget and P-loss

- Overseer estimates total P-loss to surface water at 2.4 kg P ha^{-1} yr^{-1}. Losses include those from soil and runoff, fertiliser type and application, and effluent application. This figure gives the whole farm a **HIGH P-loss** estimate, although individually, several of the rolling-country blocks rate as having an EXTREME P-loss.



3.4 Sediment loss

- Sediment yield has been estimated by John Dymond of Landcare Research (Palmerston North). Yield includes losses from mass movement erosion (e.g. slips) and surface erosion (e.g. sheet or wind erosion).
- Total loss from the entire farm (973 ha) is estimated at **3,412 tonnes of sediment per year**. To put this in context, the mass of sediment travelling under Fitzherbert Bridge at the peak of the 2004 Flood was measured at 1,700 tonnes per minute.
- It has been estimated that upwards of 70% of sediment loss from some Manawatu-Wanganui hill country farms can be controlled through the use of soil conservation practices (when fully established). In principle, sediment loss from the Day property could therefore be reduced down to 1,020 tn/yr.
- Soil conservation measures to minimise erosion risk and sediment loss are currently being evaluated by LandVision Ltd., as part of the preparation of a SLUI Whole Farm Plan.



4.0 RESOURCE ASSESSMENT AND NUTRIENT LOSS TARGETS

4.1 Principles

Several catchments in the Manawatu-Wanganui Region have nutrient loads far higher than those required to meet community expectations. There is general agreement that these loads need to be reduced, but there is much disagreement over how it should be done.

An easy option is to apply a blanket N-cap to every farm in the catchment. However, this fails to recognise farm-to-farm differences in land use, the quality of land (productive potential), and the current use of mitigation practices. Through the FARM Strategy approach, a more equitable approach is proposed. At its heart is the identification of farm-particular nutrient-loss targets based on the capability and productivity of land, and the fact that **better land has a higher capacity to sustain high levels of production (i.e. it is more sustainable), relative to attempting comparable levels of production from low quality land by using excessive inputs inefficiently.**

Water quality targets have been related to land production-potentials using the Land Use Capability (LUC) system of land classification. This ranks land according to eight classes, where class 1 represents the most elite land, and class 8 land has very low productive value (e.g. bluffs, swamps, river beds, etc.). Nitrogen-loss targets by LUC class are included in the One Plan (table below), designed to be phased in over a twenty-year period. A farm's relative area of different LUC units will determine the level of N-loss that the farm needs to operate within to achieve catchment water quality targets.

Table 1: One Plan N-loss targets for LUC classes

LUC	*N-loss targets (kg N ha^{-1} yr^{-1})*			
	YEAR_01	YEAR_05	YEAR_10	YEAR_20
I	32	27	26	25
II	29	25	22	21
III	22	21	19	18
IV	16	16	14	13
V	13	13	13	12
VI	10	10	10	10
VII	6	6	6	6
VIII	2	2	2	2

4.2 Land resource assessment

The farm's land resource has been described and evaluated according to the Land Resource Inventory (LRI) and Land Use Capability (LUC) Classification. Survey was undertaken at a 1:10,000 scale. The LRI system involves mapping landscape units according to five inventory factors (rock type, soil unit, slope class, erosion type & severity, and vegetation).

LRI is then classified as LUC, which further groups similar units according to their capacity for sustainable production under arable, pastoral, forestry or conservation uses. The LUC code (e.g. 6e7) indicates *general capability* (1-8 classes), the *major limitation* (4 subclass limitations of **w**etness, **e**rosion, **s**oil and **c**limate), and the *capability unit* to link with units with similar management requirements and production opportunities.

Day's Land Use Capability is presented over the page. Description of the land resource by LUC is summarised as Table 2. N-loss targets for the Day farm have been calculated and presented on page 16.

The Land Use Capability (LUC) system

Land Use Capability (LUC) is a classification of land according its capacity for sustainable production under various land uses (arable, pastoral, forestry, conservation). The LUC code has three parts:

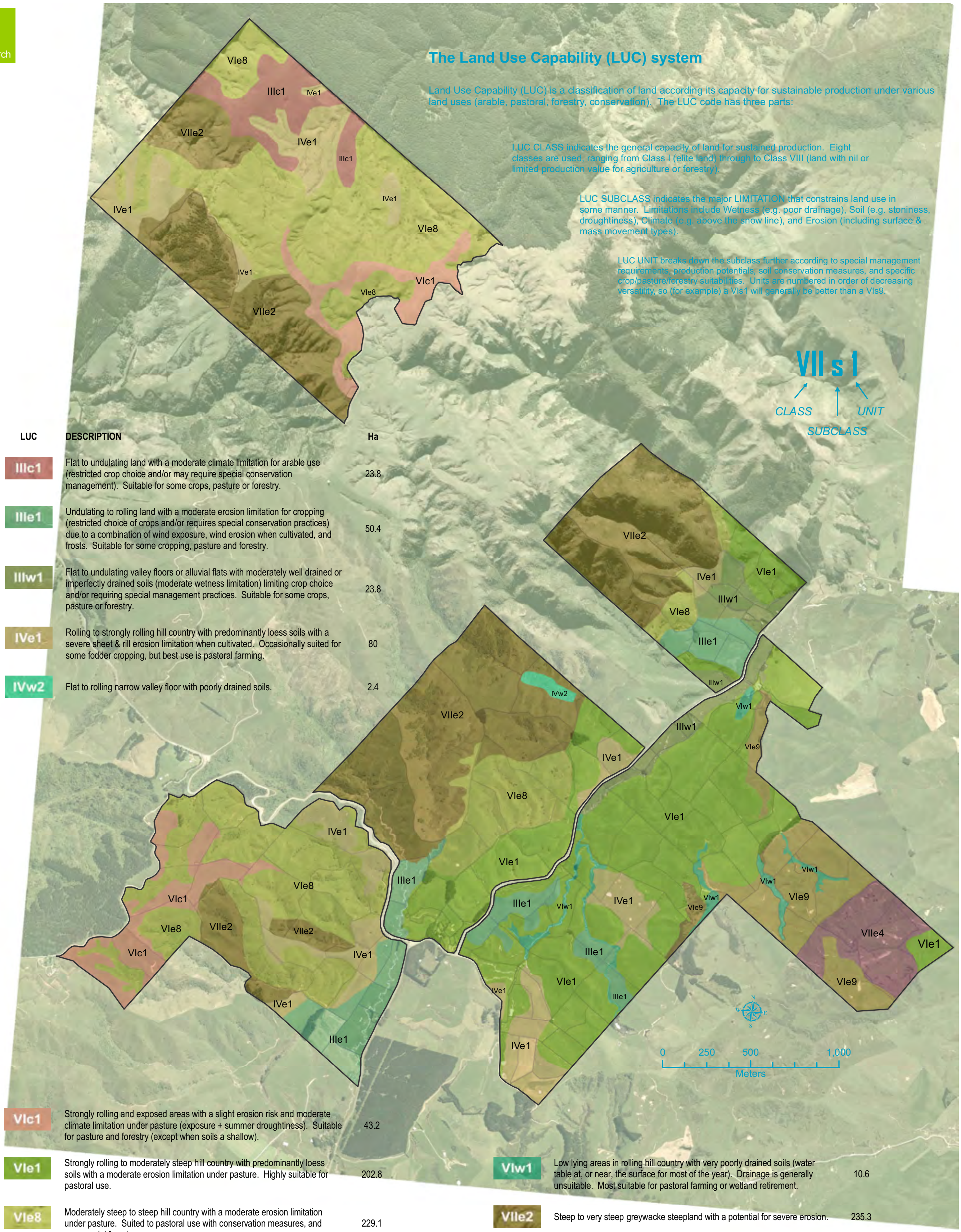
LUC CLASS indicates the general capacity of land for sustained production. Eight classes are used, ranging from Class I (elite land) through to Class VIII (land with nil or limited production value for agriculture or forestry).

LUC SUBCLASS indicates the major LIMITATION that constrains land use in some manner. Limitations include Wetness (e.g. poor drainage), Soil (e.g. stoniness, droughtiness), Climate (e.g. above the snow line), and Erosion (including surface & mass movement types).

LUC UNIT breaks down the subclass further according to special management requirements, production potentials, soil conservation measures, and specific crop/pasture/forestry suitabilities. Units are numbered in order of decreasing versatility, so (for example) a VIs1 will generally be better than a VIs9.

VII s 1

CLASS — SUBCLASS — UNIT



LUC	DESCRIPTION	Ha
IIIc1	Flat to undulating land with a moderate climate limitation for arable use (restricted crop choice and/or may require special conservation management). Suitable for some crops, pasture or forestry.	23.8
IIIe1	Undulating to rolling land with a moderate erosion limitation for cropping (restricted choice of crops and/or requires special conservation practices) due to a combination of wind exposure, wind erosion when cultivated, and frosts. Suitable for some cropping, pasture and forestry.	50.4
IIIw1	Flat to undulating valley floors or alluvial flats with moderately well drained or imperfectly drained soils (moderate wetness limitation) limiting crop choice and/or requiring special management practices. Suitable for some crops, pasture or forestry.	23.8
IVe1	Rolling to strongly rolling hill country with predominantly loess soils with a severe sheet & rill erosion limitation when cultivated. Occasionally suited for some fodder cropping, but best use is pastoral farming.	80
IVw2	Flat to rolling narrow valley floor with poorly drained soils.	2.4
VIc1	Strongly rolling and exposed areas with a slight erosion risk and moderate climate limitation under pasture (exposure + summer droughtiness). Suitable for pasture and forestry (except when soils a shallow).	43.2
VIe1	Strongly rolling to moderately steep hill country with predominantly loess soils with a moderate erosion limitation under pasture. Highly suitable for pastoral use.	202.8
VIe8	Moderately steep to steep hill country with a moderate erosion limitation under pasture. Suited to pastoral use with conservation measures, and commercial forestry.	229.1
VIe9	Moderately steep to steep slopes in sandstone hill country. Can have moderate soil slip & tunnel gully erosion limitations under pasture. Generally requires conservation plantings under pastoral use, and has a medium site index value for forestry.	46.2
VIw1	Low lying areas in rolling hill country with very poorly drained soils (water table at, or near, the surface for most of the year). Drainage is generally unsuitable. Most suitable for pastoral farming or wetland retirement.	10.6
VIIe2	Steep to very steep greywacke steepland with a potential for severe erosion.	235.3
VIIe4	Steep slopes in sandstone steepland with shallow soils, low natural fertility, and a potential for severe erosion under pasture.	25.2

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LAND USE CAPABILITY

Andrew Day

Ballance Valley Road, Pahiatua

Survey and classification by LandVision Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

TABLE 2: Land resource description by LUC unit

	LUC	Ha	DESCRIPTION	ROCK	SOIL	SLOPE	VEGETATION	EROSION
	IIIc1	23.8	Flat to undulating land with a moderate climate limitation for arable use (restricted crop choice and/or may require special conservation management). Suitable for some crops, pasture or forestry.	Loess over greywacke	Ref. #15	$0-7^0$	Semi improved pasture	Nil.
	IIIe1	50.4	Undulating to rolling land with a moderate erosion limitation for cropping (restricted choice of crops and/or requires special conservation practices) due to a combination of wind exposure, wind erosion when cultivated, and frosts. Suitable for some cropping, pasture and forestry.	Loess over greywacke & massive sandstone	Ref. #1, #3, #7, #17	$0-15^0$	Improved & semi-improved pasture. Some rush areas.	Nil. Potential moderate risk for wind erosion under cropping.
	IIIw1	23.8	Flat to undulating valley floors or alluvial flats with moderately well drained or imperfectly drained soils (moderate wetness limitation) limiting crop choice and/or requiring special management practices. Suitable for some crops, pasture or forestry.	Fine alluvium over gravels	Ref. #1, #2	$0-7^0$	Pasture	Minor streambank erosion in places.
	IVe1	80	Rolling to strongly rolling hill country with predominantly loess soils with a severe sheet & rill erosion limitation when cultivated. Occasionally suited for some fodder cropping, but best use is pastoral farming.	Loess over greywacke & massive sandstone	Ref. #2, #3, #4, #7, #11, #12, #14, #15	$8-20^0$	Improved & semi-improved pasture. Some rush areas.	Nil. Potentially severe sheet & rill under cropping.
	IVw2	2.4	Flat to rolling narrow valley floor with poorly drained soils.	Fine alluvium over gravels	Ref. #16	$0-15^0$	Pasture	Minor gully erosion.
	VIc1	43.2	Strongly rolling and exposed areas with a slight erosion risk and moderate climate limitation under pasture (exposure + summer droughtiness). Suitable for pasture and forestry (except when soils a shallow).	Loess over greywacke	Ref. #3, #4, #15	$16-20^0$	Improved & semi-improved pasture.	Nil. Potentially slight wind erosion risk.
	VIe1	202.8	Strongly rolling to moderately steep hill country with predominantly loess soils with a moderate erosion limitation under pasture. Highly suitable for pastoral use.	Loess or patches of loess over sandstone, unconsolidated sands, and some limestone	Ref. #3, #4, #5, #9	$16-25^0$	Improved & semi-improved pasture. Some rush areas.	Minor soil slip and gully erosion in places. Potential for moderate erosion.
	VIe8	229.1	Moderately steep to steep hill country with a moderate erosion limitation under pasture. Suited to pastoral use with conservation measures, and commercial forestry.	Greywacke and patches of loess over greywacke	Ref. #11, #12, #14, #15	$21-35^0$	Semi-improved pasture with patches of rushes, gorse & manuka/kanuka	Minor sheet and gully. Potential for moderate erosion.
	VIe9	46.2	Moderately steep to steep slopes in sandstone hill country. Can have moderate soil slip & tunnel gully erosion limitations under pasture. Generally requires conservation plantings under pastoral use, and has a medium site index value for forestry.	Loess over sandstone	Ref. #3, #4, #7, #9, #10	$21-35^0$	Semi-improved pasture plus patches of rushes, manuka, forestry, bush, & wetland vege	Minor soil slip or earthflow in places. Potential for moderate soil slip and tunnel gully erosion.
	VIw1	10.6	Low lying areas in rolling hill country with very poorly drained soils (water table at, or near, the surface for most of the year). Drainage is generally unsuitable. Most suitable for pastoral farming or wetland retirement.	Sandstone and unconsolidated sand	Ref. #2	$8-15^0$	Semi-improved pasture with patches of rushes & wetland vegetation	Nil.
	VIIe2	235.3	Steep to very steep greywacke steepland with a potential for severe erosion.	Greywacke	Ref. #12	$+26^0$	Semi-improved pasture with patches of manuka, gorse, bush & forestry	Minor soil slip, gully and sheet erosion in places. Potential for severe erosion.
	VIIe4	25.2	Steep slopes in sandstone steepland with shallow soils, low natural fertility, and a potential for severe erosion under pasture.	Sandstone and limestone & some loess patches	Ref. #5, #8, #10	$21-35^0$	Semi-improved pasture with patches of rushes or manuka/kanuka	Minor soil slip and earthflow in places. Potential for severe erosion.

4.3 N-TARGETS for Day's sheep and beef farm

If the Day property qualified as an intensive sheep and beef operation under the One Plan, then it would be required to operate within the N-loss limits described below (Table 3). They represent the maximum permissible whole-farm N-loss from leaching and runoff. N-targets will not change over the 20 year period unless Land Use Capability changes (unlikely). Calculation of N-targets used the same land area used for the Overseer analysis.

Table 3: Permissible N-loss limits for Day farm (N-targets)				
Year	*Year 1*	*Year 5*	*Year 10*	*Year 20*
N-target (kg N/ha/yr)	**10.6**	**10.5**	**10.2**	**10**

4.4 Implications

4.4.1 Uniform N-loss over 20 years

Current N-loss for the Day farm has been calculated at 10 kg N/ha/yr. This is consistently equal to, or less than, the N-targets over the 20 year period (Table 4). So provided N-loss does not increase substantially over the next 20 years, then the Day farming operation is not required to implement any new N-mitigation practices. From a nutrient perspective the property is fully compliant, and will remain so if N-losses remain unchanged. However, note this excludes contributions made directly to unfenced waterways and via yard runoff. Further, while N-losses may be within N-targets, this does not necessary mean the uptake of N-mitigation practices should be completely ignored. Also note that high stocking rates carried in previous years would have likely have breached the N-targets.

Table 4: Reduction required at a uniform N-loss				
Year	*Year 1*	*Year 5*	*Year 10*	*Year 20*
Current N-loss (kg N/ha/yr)	10	10	10	10
N-target (kg N/ha/yr)	**11**	**11**	**10**	**10**
Required reduction (kg N/ha/yr)	***Nil*** *(1 kg in credit)*	***Nil*** *(1 kg in credit)*	***Nil*** *(balanced)*	***Nil*** *(balanced)*

4.4.2 Predicted intensification N-loss over 20 years

The current loss of 10 kg N/ha/yr can legally increase under the One Plan up to 11 kg N/ha/yr. Further, it could conceivably increase beyond 11 kg N/ha/yr provided sufficient mitigation options are available to offset any increase.

Industry trends suggest farm production will change significantly over the next 20 years, and these changes will likely impact on N leaching and runoff losses. One possible intensification for the Day property is a dairy conversion. A conversion represents a significant change that requires a comprehensive analysis to determine N-loss implications. Consequently, converting part of the farm to dairy is evaluated separately as report RMS #3b.

Intensifying the existing sheep and beef operation is possible and likely over the 20 year period. However, reliable predictions cannot be made for such a long time period, so rather than designing and evaluating an intensification scenario, it is far easier to speculate on a uniform 1 kg N/ha increase every five years to gain an idea of how intensification may impact on the future farming under the One Plan. An N-loss increase of 4 kg N/ha over 20 years would have little initial impact (Table 5), and it would take ten years before the farm was non-compliant. However, note that a 1 kg N/ha/yr increase every five years is conservative – the farmer has indicated that N-loss has been above the 10-13 kg N/ha/yr in previous years (but also note the averaging effect of including the lowly stocked Windfarm Block).

Table 5: Predicted N-loss reduction required under an intensification scenario				
Year	*Year 1*	*Year 5*	*Year 10*	*Year 20*
Predicted N-loss (kg N/ha/yr)	10	11	12	13
N-target (kg N/ha/yr)	**11**	**11**	**10**	**10**
Difference (required reduction)	***Nil*** *(1 kg in credit)*	***Nil*** *(balanced)*	***2 kg N/ha*** *reduction required*	***3 kg N/ha*** *reduction required*

5.0 MANAGEMENT OPTIONS FOR MITIGATING N, P AND BUGS

5.1 Existing practice

The Day operation is already implementing a wide variety of mitigation options, some of which include:

- A large area of land has been retired from grazing under QEII Trust covenant (19.3 ha).
- A proportion of paddocks with perennial streams have culverts to reduce the risk of stock entering water during grazing and mustering.
- Several large areas of steepland retain extensive coverage of woody vegetation that help reduce risks concerning erosion, P-loss and sediment loss.
- Over 1.0 km of perennial streams have already been excluded/fenced from the grazing rotation.

Existing practices that mitigate N-loss, P-loss or faecal microbe contamination of water, will need to continue as part of this FARM Strategy (see Section 6.3.1).

5.2 Additional mitigation options

The previous section compared current N-loss against N-loss targets. The farm is operating within N-loss limits under the One Plan, and no special N-mitigations or management changes are required. However, this does not negate voluntary adoption of practices that are known to mitigate N, P and bug contamination of waterways. Further, mitigations may be required as the farm intensifies, or they may be a non-negotiable requirement under a different part of the One Plan (e.g. fencing waterways – see Section 6).

A range of recognised best practices have been listed and rated in terms of relevance to the Day farming operation (Table 6, over the page). Those with the highest relevance are evaluated further according to potential effectiveness and cost. Note that the listed mitigation practices are generally geared towards nitrogen, but with a recognition that many also affect P-loss, faecal microbes, and sediment loss. Recommendations for adoption are made based on relevance, cost and potential effectiveness. Options for minimising erosion and sediment losses are considered separately as part of the SLUI Whole Farm Plan.

5.2.1 Urease and nitrification inhibitors

Inhibitors interrupt urea-nitrogen transformation processes. Urease inhibitors work on the first part of the transformation by restricting the conversion rate of urea to ammonium (thereby limiting the amount of ammonium available for the second key transformation). Nitrification inhibitors operate on the second transformation by interrupting the microbial conversion of ammonium to nitrite then to nitrate. In effect both inhibitors reduce the amount of nitrate-N in soil, which is the main type of N associated with leaching. Recent studies report significant leaching-loss reductions of 30-80%, and improved pasture yields of around 5-20%.

Proposal: To replace the current levels of fertiliser N with a urease inhibitor urea-product. At current usage (~33 tonne N) this equates to 48 kg/ha of urease-treated urea for the whole farm, and an additional 100 kg/ha urease-urea for the intensive blocks (396 ha). An average of 49 kg N/ha/yr is used for calculations (33 tn N over 671ha). Nitrification inhibitors were not considered. A helicopter can conceivably spray steeper parts of the farm, but cost is likely to be prohibitive relative to the level of potential response.

Effectiveness: While there is a rapidly growing body of research on the effectiveness of urease inhibitors, it is difficult to predict with any certainty how well they may perform on any given farm at any point in time. Research specific to hill and steepland environments is also underdeveloped. For the interim, and for the Day farm given its location and climate, we suggest a conservative 10% reduction in the leaching/runoff calculated by Overseer as an approximation of inhibitor effectiveness. Accordingly, adopting the use of inhibitors is **estimated to decrease N-loss by at least 1 kg N ha^{-1} yr^{-1}.**

Implications & cost: While a substantial proportion of current N is applied as DAP, comparative costs are calculated using urea-N equivalents (for simplification). Equivalent on-the-ground cost for normal urea at 49 kg N/ha/yr would be $47,000 ($1.43/kg N x 49 kg x 671ha), while a shift to urease treated urea would cost $28,550 ($1.67/kg N x 49 kg N x 671ha). The outright cost difference is $7,900/yr or $11.76/ha.

Pasture response over-and-above normal urea response rates would need to be in the order of 2% extra DM grown in order to break even (2.05% of current 7050 kg DM/ha = extra 9.7 tn DM/671ha). Assuming extra DM grown is worth at least 8.2c/kg/ha (based on current pasture yield and gross farm income), then return @ 2.05% response = $11.85/ha). Urease-related responses greater than 2% could result in revenue gains. A conservative 5% response has the potential to produce an extra $28.91/ha.

Recommendation: If urea is to become a consistently used farm input, then seriously consider switching to urease-treated urea. Recent research suggests this would likely to result in reduced N-leaching losses and improved pasture responses (amongst other things). Conservatively we estimate an N-loss reduction of at least 1 kg N/ha/yr for the Day property, with the additional cost of urease urea being offset by pasture yield gains. If pasture response rates achieved at certain research sites were applicable to the Day operation, then a switch to urease-treated urea may have even more substantial revenue gains.

TABLE 6: Relevance of common N-loss mitigation options (+ P-loss, faecal microbes, sediment)

MITIGATION OPTIONS	Issue & ranking***	Relevance or opportunity	NOTES
Mitigations captured by Overseer			
Avoid winter (May, June or July) N-applications	N	LOW	Urea is not applied during the winter months
Ensure effluent application area is large enough to keep loading <150kg N/ha/yr	N, bugs, P	LOW	Not applicable
Avoid winter effluent applications	N, bugs, P	LOW	Not applicable
Use supplements with N-concentrations that are lower than pasture (or higher energy content - e.g. maize)	N	LOW	Currently there is a 'no supplement' policy
Replace fertiliser N with equivalent supplement-N	N	LOW	Currently there is a 'no supplement' policy
Ensure other nutrients are non-limiting (optimal) for max yield per kg N input	N	LOW	
Decrease use of N-fertiliser	N	LOW	Already a low rate (~49 kg N/ha/yr)
Decrease stocking rate	N, bugs	LOW	Not a preferred option
Change stock type or class	N	LOW	Not a preferred option
Reduce imports of supplementary feed	N	LOW	Not applicable
Graze cattle off during winter (May, June, July)	N, bugs, P, sed	LOW	Not a preferred option
Use a sealed wintering/standing pad with effluent collection and storage system	N, bugs	LOW	Not applicable
Increase supplement exports off farm	N	LOW	Not a preferred option
Recycle effluent to land rather than pond treatment & disposal to waterways	N, bugs, P	LOW	Not applicable
Other mitigation activities			
Time N-fertiliser application for periods when N demand is greatest*	N	LOW	There is less control over N application timings in hill country (cf. flat land)
Avoid high-rate, single dressings of N-fertiliser. Use split dressings (20-50kg N/ha per dressing)	N	LOW	There is less control over N application timings in hill country (cf. flat land)
Adjust N-fertiliser rates & timings seasonally to respond to actual or expected production demand (seasonal variations)	N	LOW	There is less control over N application timings in hill country (cf. flat land)
Use an N-fertiliser product with an N-uptake efficiency that is better than the current N-product	N	LOW	See use of urease inhibitor urea below
Avoid N-applications when soils are saturated (leaching/runoff & low plant activity).	N	LOW	There is less control over N application timings in hill country (cf. flat land)
Avoid N-applications during excessive dry periods (plant N-uptake low)	N	LOW	There is less control over N application timings in hill country (cf. flat land)
Consider timing N-fert using a water balance on soils with high leach/runoff risk (shallow gravel soils, soils with high water tables, artificially drained soils)	N	LOW	There is less control over N application timings in hill country (cf. flat land)
Delay N-applications directly after dry periods until pastures have started recovering	N	LOW	There is less control over N application timings in hill country (cf. flat land)
Ensure an adequate buffer distance from waterways when applying fertiliser**	N, P	LOW	Already practiced where possible
Use urea product treated with urease inhibitor	N	HIGH	Based on current research, there are several environmental and production benefits of switching to a urease treated urea product
Ensure you can actually use the extra grass grown when N-fertiliser is used	N	LOW	Already practiced
Spray nitrification inhibitor according to manufacturer recommended rates and timings, particularly on highly stocked areas (e.g. camps)	N	LOW	Potentially for the flatter blocks even with the low stocking rate (cf. dairy) but probably unsuitable for most of the farm if it has to be flown on.
Use an irrigation schedule or soil-water monitoring to guide effluent application.	N, bugs, P	LOW	Not applicable
Ensure effluent storage ponds do not overflow (part. winter)	N, bugs, P	LOW	Not applicable
Use adequate buffer distance from waterways when applying effluent (+20m)	Bugs, N, P	LOW	Not applicable
Irrigation systems: Avoid N runoff & deep drainage losses by ensuring effective application rates & timings according to soil-water balance, irrigation scheduling, or soil-water monitoring	N	LOW	Not applicable
Other best management works			
Ensure all paddocks are supplied with adequate troughs or dams	Bugs, N, P, sed	HIGH	Only a small proportion of the farm is currently served with a reticulated water system.
Replace fords with bridges or culverts	Bugs, sed, N, P	HIGH	If extensive riparian fencing is undertaken then a considerable number of new culverts would be required
Exclude stock from flowing waterways by fencing	Bugs, sed, N, P	HIGH	Total length of perennial waterways is 22.4 km. Currently stock have access to 21.7 km.
Create wetland attenuation zones where runoff converges	Bugs, sed, N, P	MEDIUM	Potential for creating many wetland areas but would require localised fencing of many small areas, some of which would be included with riparian fencing anyway.
Create riparian attenuation zones wider than 10-30m	Bugs, sed, P, N	MEDIUM	Potentially suitable for some areas given the nature of the landscape – some of the riparian areas are wide and marshy (see wetland attenuation zones above)
Ensure runoff from tracks/lanes is not channelled into streams near crossings	Bugs, sed, N, P	LOW	No evidence of track runoff to streams was sighted
Ensure there are no major leaks in the effluent irrigation system (e.g pipe joins).	N	LOW	Not applicable
Invest in a high efficacy effluent treatment/disposal system (e.g. digesters)	N, bugs, P	LOW	Not applicable
Ensure runoff from yards, feed pads, etc. does not go directly into waterways	Bugs, N, P, sed	HIGH	There is evidence of yard runoff entering open watercourses
Ensure effluent storage ponds are sealed	N, bugs	LOW	Not applicable
Ensure effluent storage ponds are of a sufficient size	N	LOW	Not applicable
Store leakable supplementary feeds (e.g. silage) on a sealed base with an effluent collection/storage/disposal system	N	LOW	Not applicable

** When pastures are higher than 25mm or 1000kg DM/ha, are actively growing, when soil temp >6degrees*

*** See formulas in Spreadmark code of practice*

**** **N**= nitrogen loss, **P**= phosphorus loss, **bugs** = faecal microbes, **sed** = sediment*

5.2.2 Control yard runoff

It is not uncommon for NZ sheep yards to be located in close proximity to waterways. This is a legacy problem, where close proximity was once considered useful for the quick disposal of used sheep dip and wash. There are two major sheep yards on the Day property. The first is a recent construction with covered yards, and only a minor risk that a small proportion of yard runoff would ever reach open water. Of greater concern is an older set of yards that is located (almost completely) within a small catchment area, such that the catchment drainage channel (a creek) begins where the yards end (see photo below). Put another way, the yard area in its entirety is effectively the catchment headwater of the creek. These yards could therefore represent a sizeable potential source of contaminants every time a runoff event occurs.

There are few low-cost mitigation options available to curb the risk. The ideal solution would be to relocate the yards, but few farmers would consider this a valid option. Alternatives include building an oxidation pond system to treat yard runoff/effluent before discharge, or converting them to covered yards to intercept rainfall. However, both may be perceived as being overly excessive in this particular case.

In the interests of balancing potential effectiveness with practicality, we propose that the establishment of an elongated wetland system could be a more valid option to achieve an effective degree of mitigation (nitrogen, phosphorus, bugs, sediment) without excessive expenditure or loss of production.

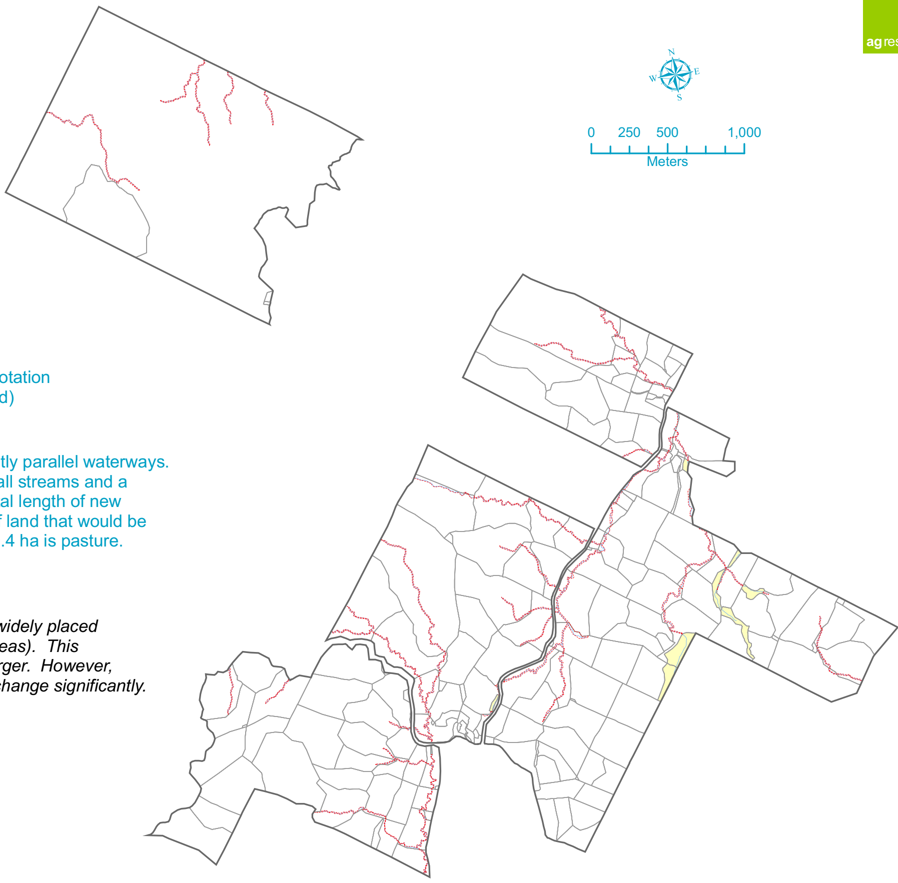
Proposal: Establish a receiving wetland that runs the length of the adjacent holding paddock. This would require 170 m of new fence, retirement of 1708 m^2 (wetland size), damming the culvert (creek appearance already suggests slow flow dynamics – damming the culvert would further reduce flow and increase residence times), and the establishment of riparian/wetland vegetation.

Effectiveness: It is difficult to estimate contributions from yard runoff without knowing when and how many stock pass through the yards in question. However, consider a once-off situation where 800 ewes are penned for half a day. If each ewe urinated once, then there would be around 1 kg N deposited on what is essentially an impervious surface (at 1.2g N/urine patch or an equivalent rate of 500 kg N/ha. N contribution from dung not included). If this occurred over a runoff event, then it is not unreasonable to propose that the full 1 kg of N would enter the adjacent waterway. Even if runoff events were infrequent and atmospheric losses were high (say 70%), then there would still be the potential loss of around 0.3 kg N for every 800 stock units that are in the yards long enough to urinate. Depending annual stock flow volumes, this could easily amount to several kilograms of N-loss from the yards each year. Also of concern is the risk of faecal microbes, phosphorus and sediment – both the source potential and transport mechanism associated with the yards would likely facilitate high contaminant loads entering the receiving creek.

Little relevant research has been done regarding the effectiveness of wetlands for mitigating sheep-yard runoff. Based on similar work for dairy effluent, it is likely that effectiveness would be greatest for attenuating solids (sediment, organic P & N) and bugs, and least for the mobile fraction (e.g. dissolved reactive phosphate). Ideally, a sequential pond/wetland system would be more effective (Ross Monaghan *personal communication*) but perhaps less practical in this case. Guidelines for the construction of dairy effluent wetlands (where the wetland is installed as an additional treatment after oxidation ponds) suggest that a well designed 1708m2 wetland would sufficiently attenuate <u>post-oxidation pond effluent</u> for the equivalent of 500 cows (with slow flows and long residence times).

Implications & cost: Cost of new fencing is estimated at $2550 (170m x going rate of $15/m for 8 wire conventional) and the establishment of wetland vegetation species at $140 (at rate of $800/ha). Damming the culvert with a wooden gate/cover would have negligible cost. Likewise, as the wetland would only decrease the size of a holding paddock, effect on production would be small. Total cost is estimated at around $2,700.

Recommendation: That a receiving wetland be established if the farm qualified under Rule 13-1 of the One Plan. However, also note that a consent may be required under Rule 13-27 (discharges to land or water not covered by other rules) irrespective of the FARM Strategy rule. This is a discretionary rule.



FENCING STREAMS

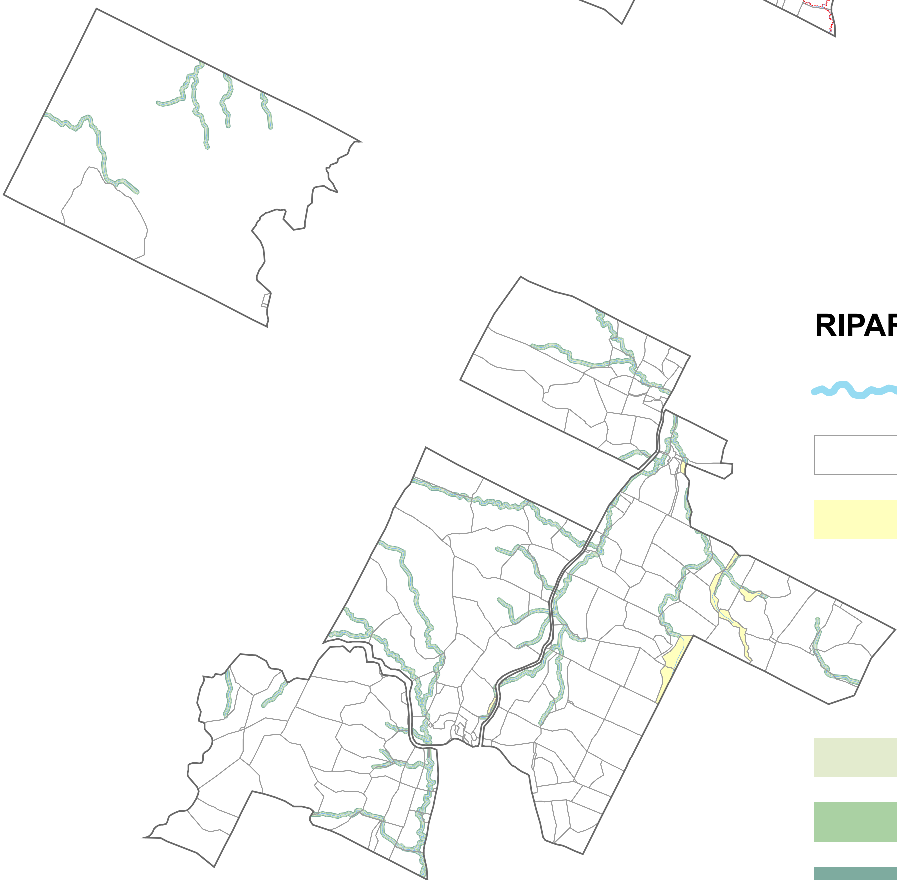
Streams, rivers and waterways

Existing fences

Areas excluded from the grazing rotation with streams (i.e. already protected)

Recommended new fences to tightly parallel waterways. Assuming a uniform 1m width for all streams and a 2m buffer to place fences, then total length of new fencing required is 40 km. Area of land that would be retired is 14 ha. Approximately 10.4 ha is pasture.

NOTE: Riparian fence widths would likely be more widely placed in practice (owing to steepland, gullies & wetland areas). This means the area retired to riparian would likely be larger. However, total length of fencing required would probably not change significantly.



RIPARIAN BUFFER STRIPS

Sreams, rivers and waterways

Existing fences

Areas excluded from the grazing rotation with streams (i.e. already protected)

10 metre wide buffer strip. Grazing reduced by 18 ha, but traps majority of contaminants.

20 metre wide buffer strip. Grazing reduced by 36 ha but trapping efficiency increased.

30 metre buffer strip. Grazing reduced by 54 ha. Generally traps all contaminants most of the time.

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WATERWAY PROTECTION

Andrew Day

Balance Valley Road, Pahiatua

Perennial waterways interpreted of orthophotography by farm manager, then buffered to a uniform 1m width. Recommended fencing and riparian strips created by assigning increasing buffer widths. Results generalised using Douglas-Poiker alogorithm to approximate linearity associated with fencing practice. Recommended fences further edited to better align with high stream banks, existing fences, and low value land.

5.2.3 Fence waterways

Direct access of stock to waterways increases the risk of contamination by faecal microbes, and to a lesser extent, the contribution of nutrient to water. Likewise, stock may induce or accelerate stream bank erosion, and cause stream bed disturbance and increased turbidity. Under the One Plan stock must be physically prevented from entering targeted waterways. A targeted waterway is defined as 'wider than a stride and deeper than a redband gumboot', and presumably flowing all year round (perennial). This definition is taken from the Dairy Industry's Clean Streams Accord. Currently there is 21.4 km of unfenced perennial streams on the Day property that qualify as being targeted.

Proposal: To fence all targeted waterways using an electrified four-wire fencing system that minimises the loss of productive land. Four wires is recommended as a minimum to exclude sheep.

Effectiveness: Many variables influence how much, and how often, stock may defecate or urinate in waterways (e.g. stock type, paddock size & design, stocking rate, access to alternative stock water, season). One study reported up to 4% of beef cattle daily-defecations occurred in or near streams. Sheep, on the other hand, are known to exhibit a lower tendency towards spending time in or around streams, and therefore probably contribute comparatively little in the way of dung and urine directly to water (depending on flock numbers). Research gaps means that it would be difficult to robustly quantify effectiveness specifically for the Day farm. However, many studies have concluded that stock exclusion can have a significantly favourable impact on water quality and stream health.

Implications & cost: Total required fence length is estimated at 40 km. Local fencing costs for erecting a four-wire electric fencing system are estimated at $10/m. Excluding gates and other peripherals, cost of fencing waterways would be approximately $400,000. Total area of retired land would be 14 ha (includes water, trees, etc). Loss of effective grazed area is 10.4 ha, which could result in a pasture yield reduction of 73 tonnes DM/yr, and an equivalent loss of $6,000 in farm gate returns each year (Table 7 below). A loss of 73 tn DM pasture represents a reduction of 100 stock units (at 75% utilisation and 550 kg DM/su intake requirement).

Recommendation: The recommendation would be to exclude stock from all targeted waterways using a four wire electric fence system. While costs may be high, this would be a non-negotiable requirement if the Day property was categorised as an intensive sheep and beef farm under the One Plan.

5.2.4 Planted riparian buffers

Planted riparian buffers are considered here as the next step-up from fencing-off waterways. Purpose would be to trap nutrients, sediment, and faecal microbes associated with runoff (in addition to excluding stock from waterways). Generally the first 10m is the most important, with effectiveness increasing with width out to 30m where most contaminants get trapped/attenuated most of the time. Planted riparian buffers are effective where runoff is a key contaminant transport mechanism.

Proposal: Evaluate cost of creating fenced and planted riparian buffer strips around targeted waterways at 10m, 20m and 30m widths.

Effectiveness: Trapping/attenuation of riparian buffer widths could not be robustly evaluated for the Day property. Specific research is currently being undertaken to build such effects into the next release of the *Overseer* model. Even so, many other studies have demonstrated planted buffers as being generally effective in trapping/attenuating sediment, phosphorus, and faecal microbes. Reductions in N-loss tend to be lower, because leaching rather than runoff is often the key N-loss transport factor on many farms. However, it could be safely assumed that riparian buffers would benefit the farm's environmental performance in most cases.

Implications & cost: Main implications include establishment costs (planting, fencing) and lost production (Table 7). Farm stock units would be reduced by approximately 170, 350, and 520 stock units for 10m, 20m and 30m buffer widths respectively (to maintain the existing 9.5 su per hectare stocking rate).

Table 7: Production and financial implications of fencing and/or planting different width riparian buffers

Practice	New fence[1] (km)	Area retired (ha)	Establishment costs		Production change		
			Fencing[2] ($)	*Plants[3] ($)*	*Effective area retired (ha)*	*Pasture[4] (tn DM/yr)*	*Gross income[5] ($/yr)*
Fence waterways	40	14	$400,000	-	10.4	-73	- $6000
10m buffer	39.3	22	$393,000	$14,400	18	-127	- $10,400
20m buffer	37.9	43	$379,000	$28,800	36	-254	- $20,800
30m buffer	36.2	62	$362,000	$43,200	54	-381	- $31,250

1 Required length of fencing generally decreases with increasing buffer width (less angles & intersects more existing fences)
2 At $10/m for 4 wire electric (sheep proof)
3 Native species at $800/ha targeting the retired effective area.
4 Based on current 7050 kg DM/ha/yr.
5 Based on ratio of Gross Farm Income to annual pasture yield (8.2c/kg DM)

Recommendation: Not to establish planted riparian buffers at this stage. Other recommendations in this report will help improve environmental performance considerably, and the cost of establishment and lost production may impact on farm viability.

5.2.5 Install new culverts

Culverts are thought to discourage stock from entering water, thereby reducing the risk of direct dung and urine deposition. Under the One Plan, 'all points where stock cross waterways' need to be bridged or culverted. Currently the Day property has an estimated 30 culverted crossings across targeted waterways. If the riparian fencing programme was adopted, then a further 45 culverts would be required. This high number is required to link the many paddocks that would be dissected under a riparian fencing programme.

Proposal: Install 28 new culverts. It is estimated to require x8 900mm culverts and x20 450mm culverts.

Effectiveness: Effectiveness cannot be robustly quantified for the Day farm, due in part to research gaps, the need for paddock-by-paddock stock inventories, and the degree of effectiveness would be part-and-parcel with riparian fencing.

Implications & cost: Cost of purchasing and installing the 28 culverts has been estimated at $15,000 (at $1000 per 900mm culvert and $350 per 450mm culvert).

Recommendation: The recommendation would be to install 28 new culverts if the farm qualified under Rule 13-1 of the One Plan.

5.2.6 Ensure all paddocks have adequate stock water from troughs or dams

Like culverts, troughs (and artificial dams) are thought to discourage stock from entering natural waterways. Currently the Day farm has approximately 4 dams and 70 troughs. There are 63 sizeable paddocks (excludes holding paddocks and lanes) that currently rely on creeks and streams for stock water. Under the One Plan, the Day property would require an additional 63 troughs or dams. We estimate that 45 paddocks can be served through an upgraded reticulation system (45 new troughs plus 10 km of new pipe), and the remainder (18 paddocks) is hill and steepland that may be better served with new dams.

Proposal: To install 45 new troughs and 18 new dams.

Effectiveness: The effect of an expanded stock-water reticulation system cannot be robustly estimated.

Implications & cost: Total cost is estimated at $37,475. This includes the purchase and installation of 45 new troughs (@$230/trough for sheep plus $25/trough installation), 10 km of pipe ($8,000 for low volume pipe installed), and 18 small dams ($1,000/dam). Costs would be higher if larger cattle troughs were also required ($420/trough), or if large dams were required ($2,500 per dam).

Recommendation: The recommendation would be to the 63 extra sources of stock water if the farm qualified under Rule 13-1 of the One Plan.

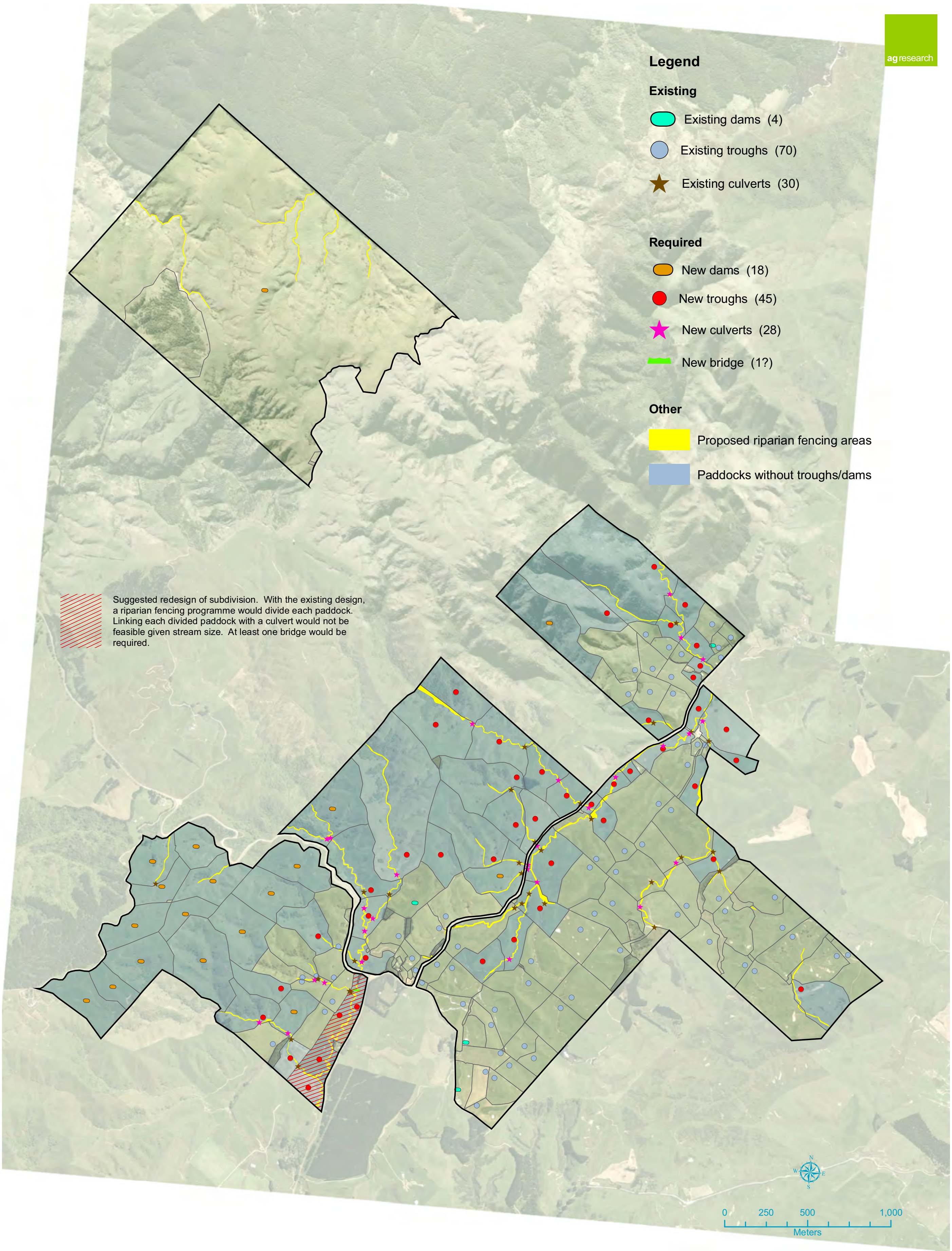
5.3 Achieving N-targets

Before summarising, it is important to reiterate that the Day property is not located within a priority catchment, nor does it qualify as an intensive sheep and beef operation under the One Plan. In short, a FARM Strategy is not required for this property. The farm is being examined solely as a research exercise, and any findings or recommendations regarding N-targets will not be a compliance requirement.

However, even if the farm did qualify as being intensive, N-loss from the current operation (10 kg N/ha/yr) is comfortably within the farm's N-loss target of 11 kg N/ha/yr for Year 1. No special mitigation practices would be needed, and N-losses could increase by 1 kg N/ha/yr (885 kg N/yr over the whole farm) without breaching the 11 kg N/ha/yr limit.

Several potential mitigation options have been evaluated as part of the study. While there is no current requirement for adoption (see above), at least two could be considered further as voluntary practices that would go a long way towards improving environmental performance without incurring a substantial cost. This includes switching to a urease-treated urea product which promises reduced N-loss (at least 1 kg/ha/yr) with response rates that would maintain and perhaps even increase farm returns, and establishing a receiving wetland to treat sheep yard runoff at an estimated cost of $2,700.

Other suggested mitigations would also improve environmental performance, but taken together they would represent a substantial cost. Installing the proposed riparian fencing, troughs and culverts would cost approximately $473,500. While potential effectiveness could not be quantified, it is likely that (in this particular case) the level of cost would far outweigh the level of achievable benefit (i.e. a disproportionate cost-benefit ratio). Voluntary uptake is therefore not recommended, but note that these 'improvements' would become a non-negotiable requirement if the farm qualified under the One Plan.



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TROUGHS AND CULVERTS

Andrew Day

Ballance Valley Road, Pahiatua

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

TABLE 8: Day's status of controlled and permitted activities under the One Plan (2007)

CONSENTABLE ACTIVITY	REQUIREMENTS	STATUS 07	NOTES
Farming within N-loss target?	1. Farm N-loss must be within N-loss targets	Compliant	1 kg N/ha/yr within N-loss limit
Produce animal effluent?	1. No direct discharge of effluent to water from yards or pads	Requires attention	Control of sheep yard discharge to water required under Rule 13-1 (i.e. needing to have a FARM Strategy). Outside this exercise a consent may be required under discretionary Rule 13-27 (discharges to water not covered by other rules)
Store animal effluent?	1. No direct discharge of effluent to water from ponds & sumps	na	
	2. Ancillary storm water must not discharge into pond or sump	na	
	3. Effluent storage must be sealed and not leaking	na	
	4. Effluent pond or sump must have capacity to hold 2-days of effluent between applications (if applied to land)	na	
Apply effluent to land?	1. No substantial leaks in irrigation pipes or equipment	na	
	2. Spray application must be > 20m from surface water bodies, bores, or the CMA	na	
	3. Spray application must be > 20m from public areas & roads, or residences	na	
	4. Spray application must be > 50m from protected archaeological or biodiversity areas	na	
	5. Must have a nutrient budget (emphasis on N)	na	
	6. Must not apply on days when drift will cause problems for neighbours	na	
	7. Annual N-loadings of the effluent block should not be in excess of 150 kg N ha^{-1} yr^{-1}	na	
	8. Surface ponding longer than 5hrs after application must be avoided	na	
Active farm dump or offal hole?	1. Only organic waste & dead animal matter. No dumping of chemicals, metal, plastic, household rubbish, animal remedies, sprays, fuel, poisons, sewage, plastic twine, silage wrap.	Compliant (assumed) *	Farm manager assures that there is no active farm dump. There is an offal hole (see Areas With Restrictions map).
	2. No discharge to water	Compliant	
	3. Must not be sited within 150m from residences or public areas	Compliant	
	4. Must not be sited within 10m of the farm boundary or river floodplain	Compliant	
	5. Must not be sited within 50m from protected archaeological or biodiversity areas	Compliant	Two sites are identified by the farm manager but are not recorded in any official register. Both, however, are located some distance from the offal hole.
	6. Must not be sited within 100m from bores, surface water bodies, or CMA	Requires attention	Both the current and proposed offal hole sites are likely to fall within 100m of a perennial waterway. The current hole is definitely within 100m of a significant ephemeral waterway.
	7. Must manage pests	Compliant (assumed) *	Pests managed as required
	8. There will be no objectionable smell	Compliant (assumed) *	
Stock have direct access to waterways?	1. Stock must have adequate (reticulated) trough water (or dams) available in each paddock	Requires attention	Currently a high reliance on waterways for stock water
	2. Stock must be physically prevented from entering targeted waterways	Requires attention	Currently there is 21.4 km of perennial waterways requiring protection
	3. Stock crossings must have a bridge or culvert	Requires attention	Likely a high number of new culverts will be required
	4. Runoff from bridges and culverts must be directed to land rather than water	Compliant	Runoff is redirected to land where practicable
Apply fertiliser?	1. No application of fertiliser directly to water bodies	Compliant (assumed) *	Compliant as far as practicable. A large proportion of perennial streams are found in areas where aerial topdressing is the only valid application option.
	2. No application into protected biodiversity areas	na	
	3. Must be applied in accordance with industry Code of Practice	Compliant (assumed) *	
	4. N-fertiliser use requires a nutrient budget	Compliant	
	5. Must not apply on days when drift will cause problems beyond the farm boundary	Compliant (assumed) *	
Surface water take?	1. Total take must be <15m3 per day	na	
	2. Total take rate must be <0.5 litres per second	na	
	3. Total farm water take must be below local Allocation Limits	na	
	4. Take must not affect wetland water levels	na	
	5. Take must not be from protected wetland	na	
	6. Water intake must have a screen	na	
	7. Intake velocity must be low enough to avoid harming small fish	na	
	8. Water take must not adversely affect legal water takes of existing users	na	
	9. Extracted water must be used efficiently	na	
	10. Must report take particulars to Horizons RC	na	

* Level of compliance cannot be assessed conclusively within project limits. Full compliance is assumed until proven otherwise.

6.0 ONE PLAN REQUIREMENTS

Controlled and permitted activities relevant to the Day farming operation have been assessed to identify current levels of compliance under the One Plan (Table 8 opposite). **The assessment is made under the pretext that the farm does qualify under Rule 13-1** (i.e. an intensive farm in a targeted catchment requiring a FARM Strategy). Note that the list and terminology only applies to the Day property. Non-compliant activities are further evaluated to identify actions or options required to become compliant (Section 6.3). There is an unavoidable degree of overlap with recommended N-loss mitigations (previous section) and recommendations to become fully compliant under One Plan rules.

6.1 Existing consents

Currently there are no active resource consents for the Day farming operation. If there was, then they would be replaced by a Whole Farm Consent associated with this FARM Strategy (except for consents concerning large ground water takes, construction of bores, and any other type of consent not covered in the FARM Strategy workbook).

6.2 Planning period

This FARM Strategy is designed for a 5-year planning period. However, it is recognised that the viability of some mitigation practices are strongly dependent on seasonal factors (cost, payout, climate, etc), and it is conceivable that the most suitable options for mitigating environmental impact will fluctuate annually. It is therefore recommended that the nutrient budget be reassessed each year, and mitigation practice adjusted accordingly. Note that objectives are recommendations – setting specific objectives with defined timeframes and levels of priority would involve consultation with a regional council representative.

6.3 Five-year strategy to achieve One Plan compliance

6.3.1 Maintaining existing mitigations

Existing mitigations have been reported in Section 5.1. Change with any of the listed activities may affect N-loss, and would therefore necessitate a nutrient budget reassessment. Accordingly, existing best-practice activities should be maintained for the first year, and reassessed with a new nutrient budget in the second year.

Objective 1: Retain and maintain the number of culverts and troughs.

Objective 2: Retain and maintain areas already retired for riparian protection purposes.

Objective 3: Maintain the same stocking rate, use of supplements, fertiliser use (particularly N fertilisers) and grazing strategies for 2007/2008. Any change will necessitate a new nutrient budget and comparison against N-loss limits.

6.3.2 Exclude stock from targeted waterways

There is currently 21.4 km of targeted waterway requiring protection under Rule 13-1 of the One Plan. Length of new sheep-proof fencing is estimated at 40 km. Cost is estimated at $400,000. It is recommended that a portion of fencing be undertaken each year for five years, beginning with the most intensely used parts of the farm.

Objective 4: Achieve One Plan requirements by fencing waterways with an electrified four-wire fencing system over the next five years.

- **4a**: Erect 7.5 km of riparian fencing around Makaretu Creek adjacent to the road.
- **4b, 4c, 4d, 4e**: Aim to erect 5.9 km, 9.9 km, 8.5 km, and 8.9 km of fencing over the successive four year period.

Note: The map on page 23 highlights an area where the redesign of existing subdivision is recommended. Two options are feasible. Either retire the land located across the stream (representing a loss of 3 ha and an equivalent annual loss of 45 tn pasture DM or $3,700 in gross margin per year, every year at 8.2c/kg DM), or to subdivide the area into one or two paddocks with bridge access (cost of installing a new bridge estimated at $20,000 based on similar bridges quoted for the dairy conversion – see Report RMS #3B).

6.3.3 Stock effluent discharge from sheep yards

Discharge of stock effluent from yards to waterways is not permitted according to the FARM Strategy workbook. Effluent exiting from the farm's older set of sheep yards represents a discharge to water. A receiving wetland is proposed as the most practical and cost effective mitigation option. Wetland establishment is estimated at $2,700.

Objective 5: Initiate the establishment of a receiving wetland by installing 170m of fencing, planting 1708m^2 with riparian/wetland species, and damming the culvert over the 2008/09 summer.

ONE PLAN separation distances

No farm dump or offal hole is permitted within 10 m of the property boundary.

No farm dump or offal hole is permitted within 150 m of residences, marae, schools, public buildings and public recreation areas.

No farm dump or offal hole is permitted within 50 m of any recognised* archaeological site.

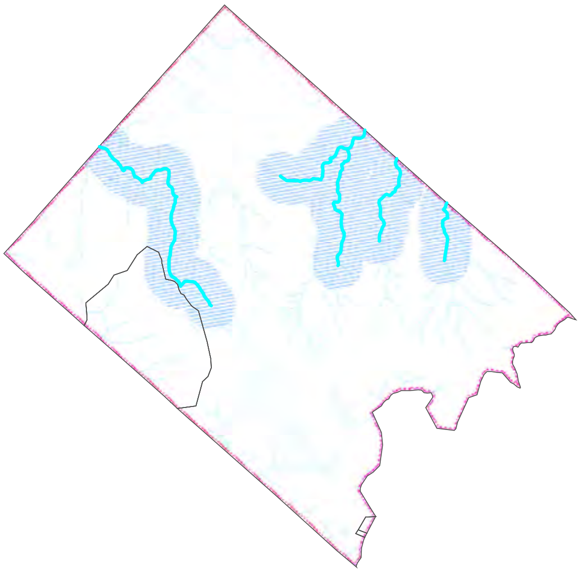
No farm dump or offal hole is permitted within 100 m of bores or surface water bodies.

** Recognised in district plans, NZAA database or Historic Places Trust.*

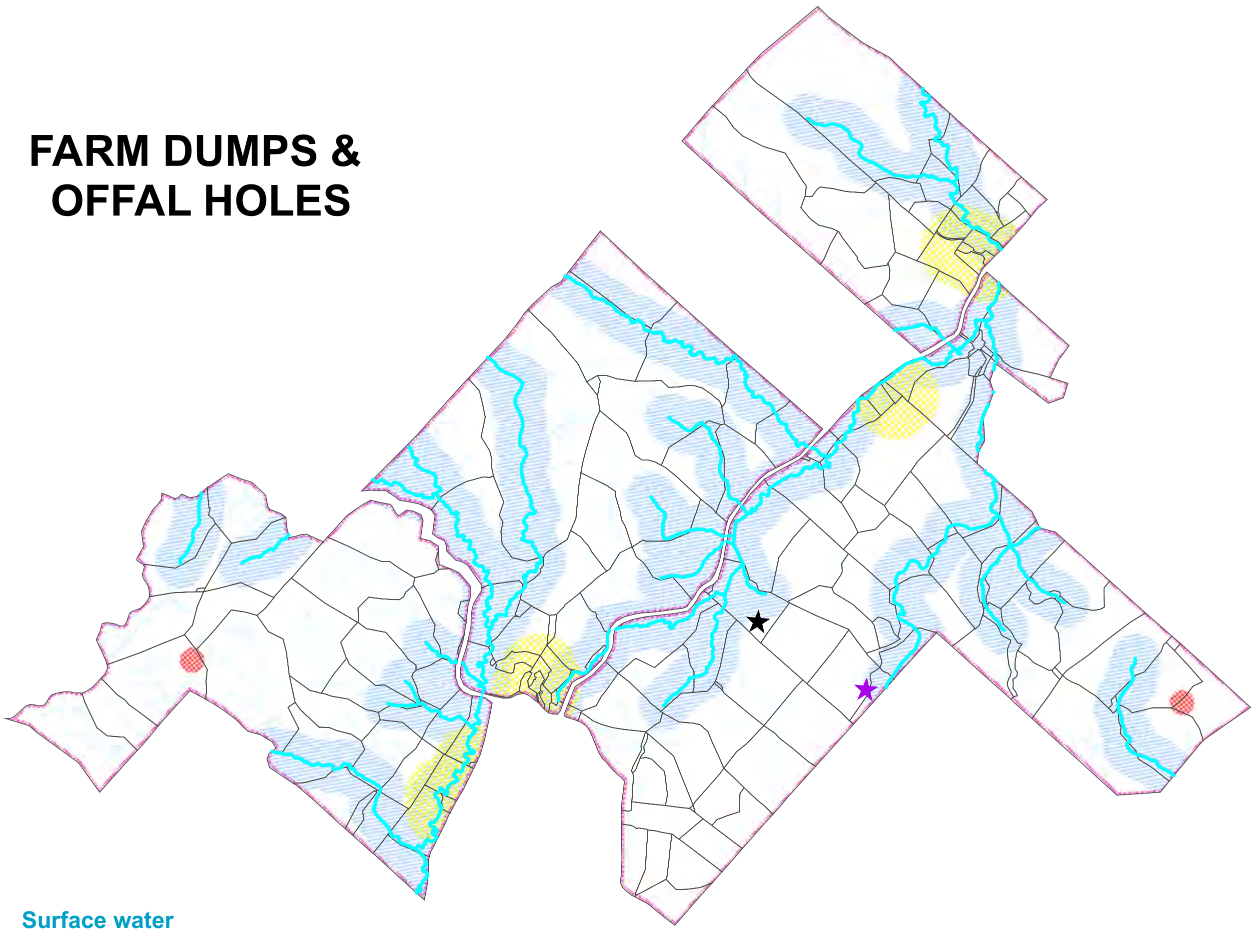
Offal hole sites

★ Current farm offal hole

★ Proposed site for new offal hole



FARM DUMPS & OFFAL HOLES



Surface water

Ephemeral waterway

Perennial stream

0 250 500 1,000
Meters

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

AREAS WITH RESTRICTIONS

Andrew Day

Ballance Valley Road, Pahiatua

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

6.3.4 Farm offal hole

The current offal hole site is unlikely to be compliant under the One Plan because of its proximity to a surface water body. Likewise, the proposed site for a new offal hole is similarly too close to water. Fortunately there are many other opportunities for locating a new offal hole site on the Day property (see Areas With Restrictions map). Cost is not considered because a new offal hole was going to be established irrespective of this FARM Strategy.

Objective 6: Establish a new offal hole site within a permitted part of the farm as soon as possible (Jan 2008).

6.3.5 New culverts

All points where stock cross targeted waterways are required to be culverted or bridged under Rule 13-1. With implementation of the riparian fencing programme, an additional 28 new culverts would need to be installed. Total cost is estimated at $15,000.

Objective 7: Aim to install around six new culverts each year for five years.

6.3.6 New troughs and dams

In being a sheep and beef property there is heavily reliance on waterways as a natural source of stock water. Excluding stock access through riparian fencing would necessitate 63 alternative sources. An estimate is provided as 18 new dams and 45 new troughs (plus 10 km of new pipe). Total cost is estimated at $37,475.

Objective 8: Aim to install 12 new dams each year for the final three years of the FARM Strategy implementation period.

Objective 9: Aim to install around six new troughs each year for five years.

6.4 Summary of compliance cost estimates

6.4.1 Direct costs

Cost estimates are generated from local prices at time of writing and are therefore subject to change. Most have been compiled through Sheppard Agriculture. Full cost could not be established in all cases (particularly secondary costs), and it is likely that a canny farmer could make substantial savings (cost of services is based on contract rates). **Total cost to become compliant with the One Plan estimated at $455,175**. If a new bridge was required, total cost would increase by at least $20,000 to $475,175.

Table 9: Cost estimate summary

Exclude stock from targeted waterways (Obj 4)	$400,000
Establish receiving wetland to mitigate yard runoff (Obj 5)	$2,700
New offal hole (Obj 6)	$0
Install 28 new culverts (Obj 7)	$15,000
Install 18 new dams (Obj 8)	$18,000
Install 45 new troughs (Obj 9)	$19,475
TOTAL	**$455,175**
New bridge? Add $20,000 (see note for Obj 4)	$475,175

6.4.2 Implication for farm returns

Retiring land under the riparian fencing programme is the only significant revenue implication for compliance. An estimated 10.4 ha of grazed land would be retired, with a potential and permanent production loss of 73 tonnes of pasture dry matter. This represents a substantial loss of production capability. Financially, **revenue could be decreased by $6,000 each year, for every year.** Further, if the bridge option was declined in favour of retiring land (see objective 4 page 25), then gross returns could be reduced by a further $3,700. Under this scenario revenue would be decreased by $9,700 each year, for every year.

TABLE 10: Five-year strategy for compliance with One Plan requirements

OBJECTIVES	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Maintain existing mitigations					
1. Retain and maintain the number of troughs & culverts*	→	→	→	→	→
2. Retain and maintain areas already retired to riparian*	→	→	→	→	→
3. Maintain same policies for stocking rate, supplements, and fertiliser*	→	→	→	→	→
Fencing streams					
4. Exclude stock from targeted waterways	Erect 7.5 km riparian fencing around Makaretu Creek (4a)	Erect 5.9 km riparian fencing (4b)	Erect 9.9 km riparian fencing (4c)	Erect 8.5 km riparian fencing (4d)	Erect 8.9 km riparian fencing (4e)
Stock effluent discharge from yards					
5. Establish receiving wetland	-	Initiate fencing, planting & damming of culvert over summer	-	-	-
Offal hole					
6. Establish a new offal hole	Decommission current offal hole and construct new one ASAP	Manage pests & odour	Manage pests & odour	Manage pests & odour	Manage pests & odour
New culverts					
7. Install 28 new culverts	Purchase and install 6 culverts	Purchase and install 6 culverts	Purchase and install 6 culverts	Purchase and install 6 culverts	Purchase and install 4 culverts
New dams					
8. Construct 18 new dams	-	-	Construct 6 new dams	Construct 6 new dams	Construct 6 new dams
New troughs					
9. Install 45 new troughs	Install9 troughs (first troughs to go into paddocks dissected by riparian planting)	Install 9 troughs	Install 9 troughs	Install 9 troughs	Install 9 troughs

* Objectives depend on maintaining existing farm management strategies. Any substantial change in stock policy, feeding policy, fertiliser policy, or any related N-use will require a reassessment of farm N-loss against N-targets (i.e. a new nutrient budget).

6.5 Other considerations

6.5.1 Council assistance

Fencing and planting waterways and wetlands will be eligible for consideration of an environmental grant from Horizons Regional Council. Grants are available for enhancing 'water quality by retiring and planting stream banks'. Costs for fencing, plants and labour are all eligible under the grant scheme. Further, the Day farm would likely attract a higher grant rate (30% to 40% of costs) because this FARM Strategy is, for all intensive purposes, an 'environmental farm plan'. Contact your local HRC representative for more information.

6.5.2 Follow up

Contacts for follow-up and further information include your Horizons Regional Council representative, and the farm business development consultant involved in this project

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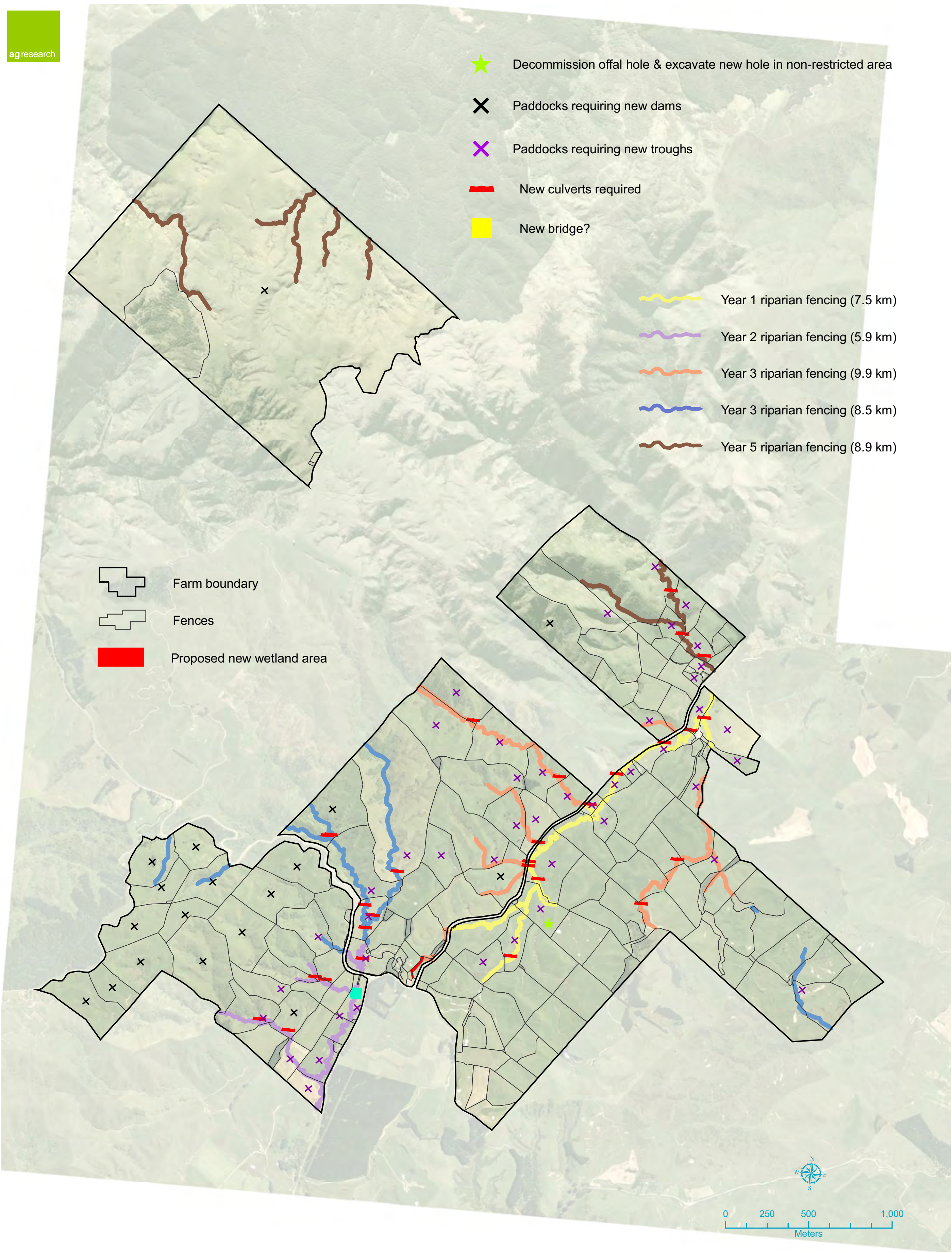


The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

REQUIRED WORKS

Andrew Day

Ballance Valley Road, Pahiatua

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

APPENDIX 1: INFORMATION CHECK

Assessment of current N-loss through Overseer Nutrient Budgets can only be as robust as the information used in the model. This appendix is provided as an assurance that the best information available was used for the Day property at the time of assessment. Most information collected by farmer interview and a review of accounts by the farm consultant. Fertiliser receipts were not sighted.

Production inputs

- 6083 sheep stock units.
- 2286 beef stock units.
- 52% of beef are male.
- See table for sheep:cattle ratios by block.
- Wool production @ 28,000 kg/yr.
- No supplements conserved or purchased. No crops.

Resource information

- Farm located 46 km from coast.
- See table for pasture development status and relative yield (RY).
- Average annual rainfall is 1,471mm.

Block	Ha	RY[2]	Rain (mm)	Topo	Sheep: cattle	Pasture	Soil	Soil test results May 2006						
								Olsn P	Qt Ca	Qt mg	QT K	Qt Na	SO_4-S	Org-S
Easy country	64	1.00	1493	Flat	20:80	Dvlpd rye/clov	Raumati silt loam	50	8	18	6	7	8	8
Easy rolling[1]	68	0.90	1521	Rolling	50:50	Dvlpd rye/clov	Matamau silt loam	25	4	10	5	4	7	7
Easy rlng beef[1]	38	1.00	1523	Rolling	20:80	Dvlpd rye/clov	Matamau silt loam	25	4	10	5	4	7	7
Rolling hill[1]	119	0.9	1491	Easy hill	90:10	Dvlpd rye/clov	Matamau silt loam	25	4	10	5	4	7	7
Utiku	36	0.6	1482	Steep hill	90:10	Dvlping brwntp	Matamau silt loam	17	5	13	7	5	4	6
Greywacke rolling	107	0.75	1514	Easy hill	90:10	Dvlpd rye/clov	Matamau silt loam	20	5	15	8	8	12	11
Steep hill	168	0.50	1499	Steep hill	95:05	Dvlping brwntp	Ruahine silt loam	23	5	24	8	8	8	9
Top farm	67	0.70	1524	Easy hill	90:10	Dvlpd rye/clov	Ramiha silt loam	20	6	17	9	7	15	15
Windfarm	206	0.20	1374	Easy hill	25:75	Dvlping brwntp	Ramiha silt loam	5	3	15	9	7	13	13
Non grazeable	100	0	1471	-	-	-	-	-	-	-	-	-	-	-

[1] All rolling blocks taken from one soil test.

[2] RY = Relative Yield.

Fertiliser inputs (2004/2006)

- No fertiliser on Windfarm block.
- 22 kg N/ha/yr across the main farm (excludes Windfarm block).
- Additional 46 kg N/ha/yr for Easy Country and the three rolling blocks (289 ha).
- 35 kg P/ha/yr across main farm.
- Estimated 12 kg S/ha/yr across main farm (adjusted to be representative for most years)

Other

- Option for FINISHING checked for Easy Country and Easy Rolling Beef blocks.
- Default Overseer pasture utilisation values used (range 70-78%).
- Default clover levels used (MEDIUM) for most blocks. Windfarm and Steep Hill blocks set to LOW clover levels.

Assurance statement:

To the best of our knowledge, the information provided above is true and correct at the time the Overseer analysis was undertaken (December 2007).

Farm owner, operator or manager	***Nutrient management consultant***
Name: Andrew Day	*Name:* Andrew Manderson
Date:	*Date:*
Signed:	*Signed:*

ACKNOWLEDGEMENTS

Key people involved in the preparation of this report include:

Andrew Day
Balance Valley Road,
Pahiatua

Alec Mackay &
Andrew Manderson
AgResearch

Sarah Dudin &
Lachie Grant
LandVision Ltd.

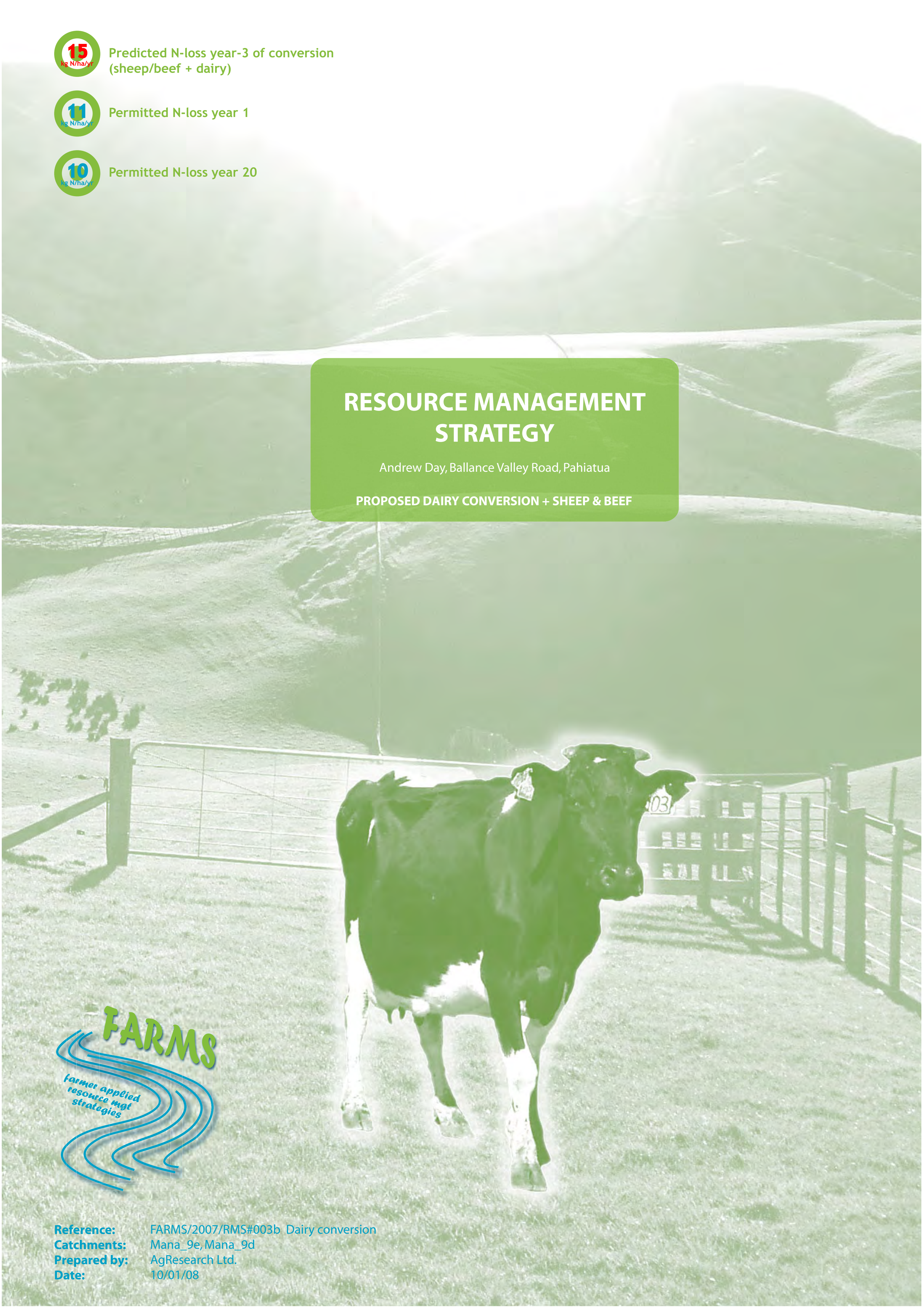
Rachel Rogers &
Greg Sheppard
Sheppard Agriculture Ltd.

7.19 CASE STUDY 5 REPORT (PROPOSED PAHIATUA DAIRY CONVERSION)

15 kg N/ha/yr Predicted N-loss year-3 of conversion (sheep/beef + dairy)

11 kg N/ha/yr Permitted N-loss year 1

10 kg N/ha/yr Permitted N-loss year 20



RESOURCE MANAGEMENT STRATEGY

Andrew Day, Ballance Valley Road, Pahiatua

PROPOSED DAIRY CONVERSION + SHEEP & BEEF

FARMS
farmer applied resource mgt strategies

Reference: FARMS/2007/RMS#003b Dairy conversion
Catchments: Mana_9e, Mana_9d
Prepared by: AgResearch Ltd.
Date: 10/01/08

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BACKGROUND

THE ONE PLAN & RULE 13*x*: At present eleven important catchments in the Manawatu-Wanganui Region have nutrient levels far in excess of what is desirable. To help address this issue Horizons have proposed a Rule in the One Plan that aims to lessen the nutrient-impact from activities associated with intensive farming. Resource consents concerning irrigation takes, fertiliser, stock feed, biosolids, soil conditioners, dumps, offal holes, and effluent, will be necessary for dairy farming, cropping, market gardening, and intensive sheep and beef farming. The Rule will come into effect at different times for each of the eleven catchments.

ONE FARM; ONE CONSENT: A new consent process will be available under the One Plan. The traditional approach of having several separate consents for a farm is replaced with a single whole-farm consent. This means only one consent – not many – is needed for the entire farm. This promises to make the process simpler, quicker and considerably less expensive. A *FARM Strategy* is a necessary prerequisite for a whole-farm consent.

FARM STRATEGY: A FARM Strategy (Farmer Applied Resource Management Strategy) represents an assessment of permitted and controlled activities for a farm, and a strategic plan to ensure those activities comply with One Plan specifications and water quality targets. It combines a nutrient budget, a comparision of farm nutrient-loss against catchment water-quality targets, an evaluation and recommendation of mitigation options (if the farm is operating outside of catchment water-quality targets) including cost and effectiveness, an assessment of eligibility for relevant consents, and a farm plan of works that spells out the where, when and how much of achieving sustainable land use within the given catchment of interest.

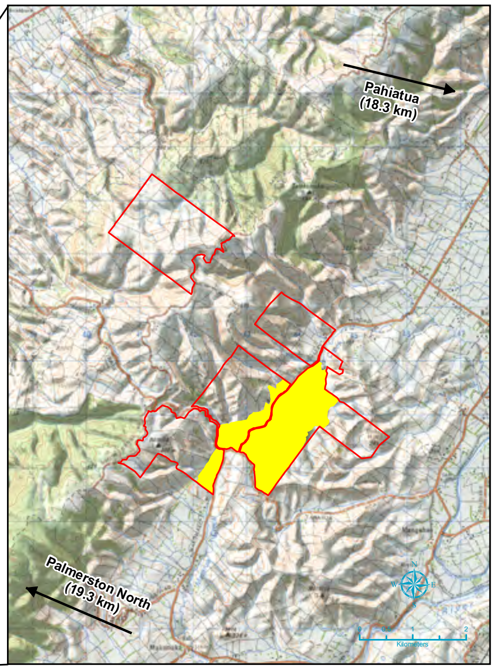
This report summarises a FARM Strategy for a 264 ha dairy conversion on a 973 ha sheep and beef property located near Pahiatua and managed by Andrew Day. The proposed area for conversion straddles two Water Management Subzones (Mana_9e and Mana_9d), neither of which are classified as priority catchments under the One Plan. However, dairy conversions are targeted under Rule 13, meaning a FARM Strategy is required irrespective of Water Management Zone priorities. This report (RMS #3b) supports the main FARM Strategy prepared for the Day sheep and beef operation (RMS #3a), both of which represent the third application of the FARMS framework.

1.0 PLAN SUMMARY

- **Purpose:** Purpose is to evaluate One Plan nutrient-loss implications of converting 264 ha of land, currently farmed as sheep and beef, into a seasonal-supply dairy farm (while retaining the balance as sheep and beef).
- **Existing farm:** A 973 ha (885 ef ha) sheep/beef breeding and finishing farm located hard up against the eastern side of the Tararua Ranges producing 7,050 kg pasture DM/ha/yr and running 8369 stock units. Topography is predominantly hill country (60%), steepland (30%) and a small proportion of flat to undulating land (10%). Rainfall is seasonally reliable (1,470mm/yr), and farm performance is well above average. Current N-loss is estimated at 10 kg N/ha/yr, while the One Plan's permissible N-loss is calculated at 11 kg N/ha/yr for the whole farm (i.e. current N-loss is within One Plan limits). The property is fully compliant from an N-loss perspective, and no special N-reductions or mitigation practices are currently required.
- **Proposed dairy conversion:** To convert 264 ha of the most productive part of the sheep and beef farm into a dairy running 656 cows (2.7 cows/ha). The balance is retained as sheep and beef. The conversion would be incremental over three years, requiring an investment of approximately $5.8 million. Farm surplus is predicted at $535,000 (year 3) using a conservative $5.40 payout. Debt servicing of $367,000 would reduce this surplus to $168,000. Surplus gain over the current sheep and beef is estimated at a modest $16,300. However, this gain in income from dairying would be much higher at the current payout of $6.90 (~$324,720), and capital gain from the conversion would be significant consideration (estimated at $557,000 for Andrew Day). From a purely financial perspective, the dairy conversion appears to be marginally viable using a payout of $5.40/kg MS with the real financial gain stemming from capital gain. Under the current payout level of $6.90/kgMS, the conversion is an attractive investment option.
- **Nutrient loss:** Overseer Nutrient Budgets was used to estimate nutrient loss implications for the conversion. On a whole farm basis **current N-loss is estimated at 15 kg N/ha/yr**. N-loss for the Dairy Unit and Sheep/beef Unit is calculated at 30 kg N/ha and 10 kg N/ha respectively. Low whole-farm N-loss is largely attributable to the averaging effect of including total farm area in the budget. P-loss risk is rated HIGH for the whole farm (EXTREME for dairy, MEDIUM for sheep/beef).
- **One Plan N-loss limits:** Land Use Capability (LUC) mapping was undertaken to link One Plan water-quality targets to the Day farm. **Permissible N-loss is calculated at 11 kg N/ha/yr for the first year**, and reduces slightly over the 20-yr implementation period to 10 kg N/ha/yr. For the Dairy Unit it is 13 kg N/ha and 10 kg N/ha for the Sheep/beef Unit. The limit is particularly low for the Dairy Unit, because only 30% of the conversion area is represented by land commonly associated with dairy farming (LUC classes 1-4), while the bulk (70%) is land more commonly associated with sheep and beef farms (LUC class 6).
- **Required N-reduction**: On a whole farm basis, **the farm needs to reduce N-loss by 4 kg N/ha/yr for the conversion proposal to be compliant with One Plan targets**. However, this is dependent on the coexistence of the sheep and beef enterprise to average dairy N-loss down to an achievable level. If the dairy unit was farmed as a separate entity, then a more challenging N-reduction of 17-18 kg N/ha/yr would be required.
- **Mitigations evaluation:** Five mitigations were considered in detail for the dairy conversion proposal. Mitigations such as riparian fencing, reticulated water to all paddocks, and bridges/culverts across all crossings are built into the design by default.

Option	N, P & bug effectiveness	Cost	Practicality	Rating
N-inhibitors	N-loss ↓ **1.9 kg N/ha/yr**	$71,200 net cost but only a 7.5% yield increase needed to break even; scope for much higher increases	High	✓✓✓
Off-farm winter grazing + reduced supplements	N-loss ↓ **1 kg N/ha/yr**, bug risk↓ & P-loss risk↓	$61,430 but tentative potential to offset by utilising ungrazed winter pasture ($20,000 - $40,000 revenue)	Low	×
Increase effluent area + feeding pad time	N-loss risk↓ & P-loss risk↓ & bug risk↓ (modelled N-loss reduction is minor)	$2,000 per year for spreading effluent solids across whole farm	Low	×
Wintering barn or herd home	N-loss ↓ **2 kg N/ha/yr**, bug risk↓ & P-loss risk↓	$240,000 cost for wintering barn and $411,000 cost for herd home	Medium	✓✓
Replace Triticale crop	N-loss ↓ **2.7 kg N/ha/yr**	$27,700 cost of purchasing equivalent silage	High	✓✓✓

- **Recommended mitigations:** Adopt N-inhibitors (treated urea product to replace N-fertiliser, and spray most the dairy area with nitrification inhibitor) and opt for purchased Triticale silage rather than growing it on-farm. Adopting both mitigations is estimated to reduce N-loss to levels that would be compliant with One Plan targets. Constructing a wintering barn or herd home is also suggested for consideration, on the basis that the level of N-loss reduction (an additional 2-3 kg N/ha/yr) is a way of managing uncertainty around future N-losses associated with the conversion.
- **Compliance requirements and costs:** Reducing farm N-loss by 4 kg N/ha/yr is the only compliance consideration, which can be achieved with inhibitors and a replacement crop. Inhibitors are unlikely to incur any additional net cost, and may even increase farm revenue. Purchasing Triticale silage rather than making it on-farm is estimated to cost $27,700 but this will be seasonally variable, and may be significantly higher. **Total base cost is estimated at $27,700**. The optional wintering barn would increase this by an estimated $240,000 (or $411,000 for a herd home).
- **Compliance implications for conversion feasibility:** Viability would be jeopardised by incorporating compliance requirements at a $5.40 payout, particularly if a wintering barn or herd home were included. Higher payouts would likely generate greater income than the existing sheep and beef operation, thereby improving viability and offsetting compliance costs to a degree. A repeat of the financial analysis integrating alternative mitigation strategies is recommended.



This property is located 18.3 km north west of Pahiatua township, and 19.3 km south east of Palmerston North.

Red outline is the existing farm, and the solid yellow fill is the area for proposed dairy conversion.

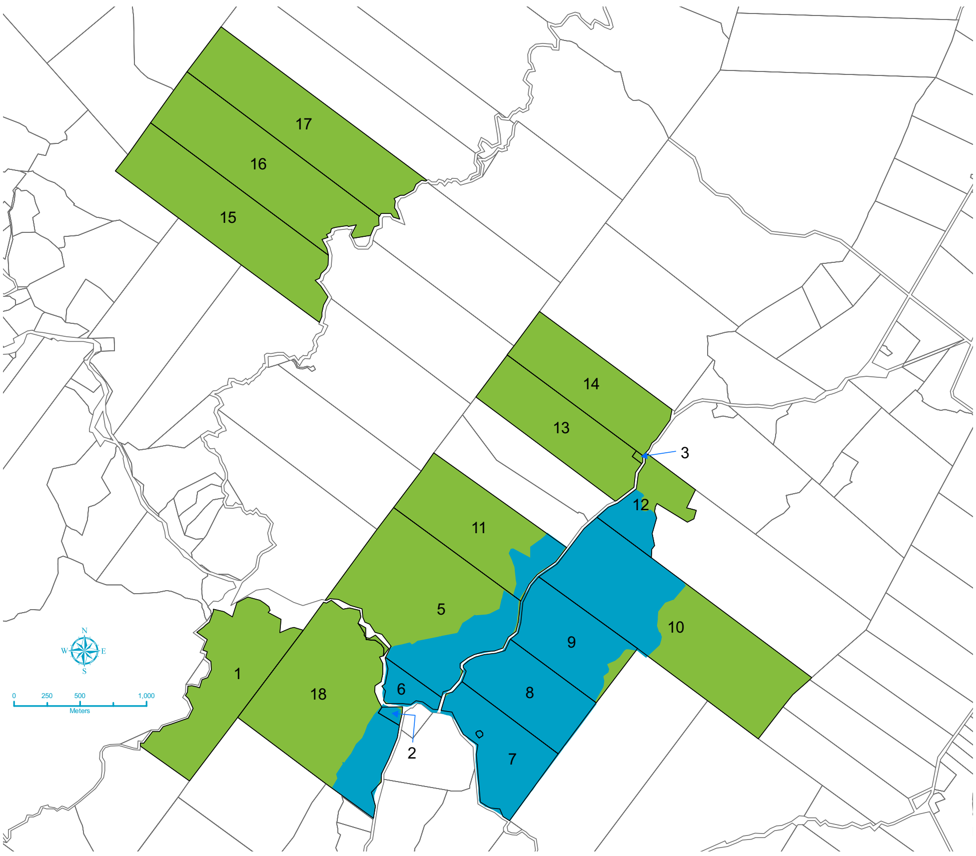
The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

FARM LOCATION & ACCESS

Andrew Day, Balance Valley Rd, Pahiatua

Prepared for Horizons Regional Council by AgResearch Ltd, as part of the FARMS initiative.
September 2007.

agresearch



ID	LEGAL DESCRIPTION	AREA
1	SECT 12 Blk XIX Mangahao Survey District, Pt SBDN 1	62.4584 ha
2	Blk VI Mangahao Survey District, SECT 117	1.6946 ha
3	Blk VI Mangahao Survey District, SECT 119	0.4046 ha
5	WN87/25, Blk VI Mangahao Survey District, SECT 79	106.0782 ha
6	WN87/26, Blk VI Mangahao Survey District, SECT 116	8.9030 ha
7	WN39A/678, Blk VI Mangahao Survey District, SECT 72	40.2662 ha
8	WN21A/646, Blk VI Mangahao Survey District, SECT 71	43.5037 ha
9	WN115/76, Blk VI Mangahao Survey District, SECT 70	44.6165 ha
10	WN57/165, Blk VI Mangahao Survey District, SECT 67	125.756 ha
11	WN100/235, Blk VI Mangahao Survey District, SECT 80	63.5356 ha
12	WN52A/46, DP 84455, LOT 1	24.250 ha
13	WN71/228, Blk VI Mangahao Survey District, SECT 114	52.4067 ha
14	WN105/284, Blk VI Mangahao Survey District, SECT 115	53.0138 ha
15	WN245/277, Blk II Mangahao Survey District	81.1394 ha
16	WN241/185, Blk II Mangahao Survey District, SECT 5	81.0383 ha
17	WN238/220, Blk II Mangahao Survey District, SECT 3	81.1394 ha
18	WN69/221, Blk VI Mangahao Survey District, SECT 78	106.584 ha
		976.7884 ha

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LEGAL TITLES AND PARCELS

Andrew Day, Balance Valley Rd, Pahiatua

Prepared for Horizons Regional Council by AgResearch, as part of the FARMS initiative, July 2007. Please note that legal areas for rural parcels can be imprecise. Total farm area for this report has been calculated at 973 ha using orthophotography.

agresearch

2.0 CURRENT FARM

A more complete description is available as report RMS #3a. A summary is provided below to lend context to the dairy conversion.

2.1 Farm description

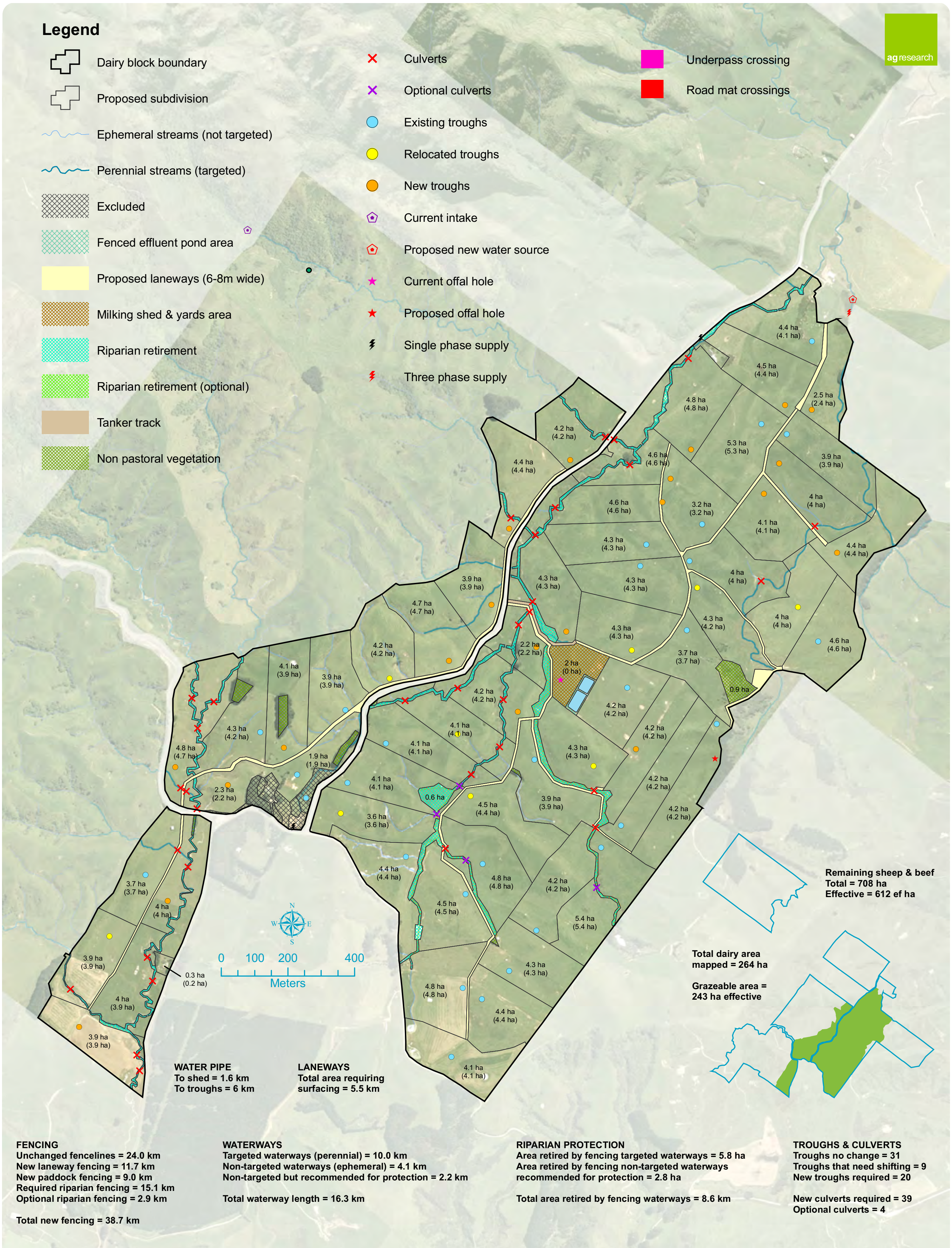
- The farm is located on the south east side of the Tararua Ranges approximately 18.3 km north west of Pahiatua township, and within two Water Management Zones (*Middle Manawatu* and *Upper Gorge*) neither of which are classed as priority catchments under the One Plan.
- Farm area is mapped at 973 ha (885 ef ha), including a 243 ha lease block (undeveloped). Predominantly a hill-country property with 584 ha as steepland and high rolling-country (Tararua Ranges), and a balance of 363 ha of easy hill and 30 ha of alluvial flats. Annual rainfall is 1470mm, and a high proportion of streams dissect the landscape (22 km perennial and 55 km ephemeral).
- Managed as a partnership focused on sheep/beef breeding and finishing with some dairy heifer grazing. Total stock units wintered is 8369 su at a 70:30 sheep:cattle ratio, giving a stocking rate of 9.5 su/ha for the whole-farm, or 11.3 su/ha for the main farm (excluding the lease block). Benchmarking against industry indicators suggests financial and physical performance is high.

2.2 Nutrient loss and water quality

- **Nutrient loss**: Overseer Nutrient Budgets model was used to estimate N & P losses. Current N-loss to water was calculated at 10 kg N/ha/yr. P-loss to water was calculated at 2.4 kg P/ha/yr (classed as HIGH risk).
- **One Plan N-loss limits**: Farm-scale mapping of Land Use Capability (LUC) was used to link One Plan N-leaching values to identify permissible N-loss for the farm over a twenty-year period. For the first year, the Day operation has a permissible N-loss of 11 kg N/ha/yr. Over twenty years this decreases to 10 kg N/ha/yr.
- **Implications**: Currently the farm is operating within its permissible N-loss limit (N-loss limit cf. current N-loss = 1 kg N/ha/yr in credit). No special N-input reductions or N-mitigation practices are required. Likewise, assuming N-loss can remain unchanged over the 20 year period, then the farm will remain compliant under the One Plan (N-loss is consistently equal to, or less than, permissible N-loss limits). However, under an intensification scenario where N-loss increases 1kg N/ha every five-years, then N-loss would exceed N-limits by year 10, and reductions and mitigations would be required. Reductions would be small and easily accommodated.

2.3 One Plan compliance

- **One Plan N-loss limits**: N-loss for the farm is currently within permissible N-limits and will remain so if N-loss remains unchanged. No special mitigations are required.
- **Voluntary N-mitigations**: While not required, the adoption of urease-treated urea to replace current N-fertiliser use could decrease farm N-loss by 1 kg N/ha/yr. Cost would likely be offset by increased pasture production.
- **Other compliance**: A very literal interpretation of One Plan requirements was applied to the farm. Items needing attention include: physically excluding stock from targeted waterways with 40 km of new riparian fencing; controlling stock-effluent discharge from sheep yards by constructing a receiving wetland; decommission existing offal hole and excavate a new offal hole in an area compliant with One Plan specifications; install 28 new culverts at points where stock cross targeted waterways; and install 18 new dams and 45 new troughs. Riparian fencing will isolate a sizeable strip of land that can either be retired (3 ha representing $3,700 lost gross revenue) or subdivided and bridged (at an estimated $20,000 cost).
- **Compliance cost**: Estimated at $455,000 or $475,000 if a new bridge is installed for the whole farm. Greatest cost incurred from the waterway protection programme. A less literal and more pragmatic interpretation of One Plan requirements reduces potential cost significantly down to $50,700 (or $70,500 if a bridge is installed). Cost is still elevated, but the Day Farm is considered an extreme case because of a high incidence of waterways, and because the farm is ‘extensive’ rather than ‘intensive’. An intensive sheep and beef farm would be expected to have more development in terms of subdivision, culverting, and water reticulation, and should therefore incur substantially lower compliance costs.



FARMS

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PROPOSED DAIRY CONVERSION

Andrew Day

Balance Valley Rd, Pahiatua

Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

3.0 PROPOSED DAIRY CONVERSION

A dairy conversion can be a lucrative option for some sheep and beef farms, and now is a good time to be considering a conversion if the land and climate is suitable. "If you are thinking about converting, think hard, because you won't get another chance like this" is the advice of Andrew Watters, current director of a company specialising in dairy conversions since the early 1990s (as reported in Country-Wide Northern, October 2007). "There are a number of positive reasons for conversion right now; a strong payout outlook, rising land prices, a reasonable import environment for many farm development items and rising dairy company share prices".

Andrew Day has been considering the possibility of converting a proportion of his better land to dairy. This would have implications for N-loss, P-loss and faecal coliform risks, which is part of the reason why all new dairy conversions will now require a FARM Strategy under the One Plan. Sheppard Agriculture were approached to design and evaluate a dairying system for the Day operation. Production parameters where extracted from the analysis, and used as a basis of predicting future N-loss through Overseer Nutrient Budgets.

3.1 The proposal

- To convert 264 ha (243 effective) of the more productive areas of the farm to a seasonal-supply dairy farm producing 216,480 kg MS (891 kg MS/ha) from 656 cows (2.7 cows/ha), over a gradual three-year period. The balance of the sheep and beef unit would be kept (708 ha total, 612 ha effective).
- A graphical model of the conversion is presented as the map opposite, where fencing is reconfigured to achieve 56 paddocks at an average size of 4.2 ha. A better design would reflect topographical limitations, but the overall design would remain unchanged in terms of total fence length, tracks, troughs, culverts, etc (all of which were used to help estimate conversion cost).

3.1.1 Stock assumptions

- Dairy herd to be built up gradually over three years beginning with 608 purchased cows for year 1, then successively up to 656 cows by year 3 (Table 1). Herd attrition assumed to be 15% (10% empty, 3% deaths, 5% culls).
- Herd replacements at 20% and grazed off farm from 12 weeks of age. Replacements brought back 4-weeks before calving begins (as R2 heifer cows). Calving date 1st August for main herd and 20th July for R2 heifers.
- Stocking rate for the balance of the farm (i.e the sheep and beef unit) is estimated by Sheppard Agriculture at 8.7 su/ha or 5818 su in total. Dedicating the best land to dairy decreases enterprise options for sheep and beef (particularly finishing options), and coming up with a viable enterprise requires further evaluation. However, for the purposes of the Overseer modelling, it is proposed that current stock ratios remain unchanged (73:27 sheep: beef), which equates to 1589 beef stock units, 4229 sheep stock units, and 19,465 kg wool produced (at 4.6 kg wool per sheep stock unit). Likewise, it is assumed that the sheep and beef unit can operate as a viable standalone entity.

3.1.2 Production assumptions

- Milksolid yield is estimated at 280 kg MS/cow in year one, 305 kg MS/cow in year two, and 330 kg MS/cow in year three. Total milksolid production after three years is targeted at 216,480 kg MS or 891 kg MS/ha.

Table 1: Key dairy conversion parameters

Year	Year 1	Year 2	Year 3
Peak cow numbers	608	632	656
Replacements	122	126	131
Milk yield per cow (kg MS/cow)	280	305	330
Milk yield per ha (kg MS/ha)	701	793	891
Milk yield total (kg MS/yr)	170,240	192,760	216,480
Pasture yield (kg DM/ha/yr)	9,146	9,146	9,146
Extra pasture from urea (kg DM/ha/yr)	1,000	1,000	1,000
Total pasture yield (kg DM/ha/yr)	10,146	10,146	10,146
Hay conservation (tn DM fed)	88	88	88
Purchased hay (tn DM)	0	39	46
Total hay fed (tn DM)	75	140	134
Triticale as fodder (tn DM fed)	86.1	87.4	87.4
Triticale as silage (tn DM fed)	390	441	608
Urea-N (kg N/ha/yr)	100	100	100
Lime (kg/ha/yr)	208	208	208
Potash super 20% (kg/ha/yr)	627	627	627

3.1.3 Feed budgeting

- 209 ha dedicated to pasture and 33.6 ha cropped each year (note that modelled areas for cropping and hay are slightly different to conform with paddock areas – see Section 3).
- Pasture renewal across 170 ha before commencement of dairy operation. Pasture growth rate data taken from a Dexcel-monitored dairy farm near Eketahuna and adjusted by -25% to approximate growing conditions on the Day property. Annual production with 170 ha new grass estimated at 9146 kg DM/ha/yr. Two dressings of 50 kg/ha urea-N at a 10:1 response would add a further 1,000 kg DM/ha/yr, bringing total annual pasture production to 10,146 kg DM/ha/yr.
- Approximately 22 ha cropped for hay over summer (harvest in February) with an expected 88 tn DM yield. Shortfalls in year 2 & 3 made up by purchasing additional hay (39 and 46 tn hay DM, respectively).
- Crop 33.6 ha annually in Triticale as part of pasture development. Graze twice with non-dairy stock, once in April and once in July, and harvest the balance as silage. Grazing accounts for 86-87 tn DM (included in the Overseer model because grazing is in situ) while silage accounts for 390 kg DM (feed demand balance for years 2 & 3 made up by purchasing 41 tn and 218 tn of Triticale silage),
- Silage fed out on a feed pad (100% of herd when milking, 1 hr per day, 270 days per season). Feed pad used as a wintering pad for the herd in May and June (6 hrs per day).

3.1.4 Soil fertility and fertiliser

- Current soil test values taken from lamb and beef finishing areas suggest soil fertility levels that are already near sufficient for a dairying operation (Table 2). However, if a conversion is implemented then we recommend engaging a farm consultant or fertiliser representative to discuss future soil fertility needs in greater detail.
- Fertiliser and lime inputs are estimated for both the pastoral and cropping blocks at 151 tn/yr of 20% potash super (627 kg/ha over 243 ha), 50 tn of lime per year (208 kg lime /ha/yr), and 100 kg/ha of urea-N applied in April and August with an expected 10:1 response (no urea on effluent block).

Table 2: Soil test parameters

	Olsen P	Mg	K	SO4-S	Org-S
Current (flat)	50	18	6	8	8
Current (rolling)	25	10	5	7	7
Target	25-30	8-10	6-8	10-12	15-20

3.1.5 Management requirements

- It is envisaged that three full-time equivalent labour units would be required to operate the dairy platform. One option is that Andrew Day continues to run the sheep and beef unit while overseeing dairy operations, and a variable order sharemilker be contracted to run the dairy unit with assistance from a Dairy Farm Assistant.
- Dairy cows grazed and managed as a split herd.
- State of the art effluent treatment system with a holding pond of sufficient size to achieve deferred irrigation (sprayed at optimal times) across an effluent block of 28.7 ha. Pond sludge applied to the main block once per year. Liquid fraction of the feed pad directed into the shed effluent holding pond, and solids spread to the main block also.

3.1.6 One Plan and Clean Streams Accord compliance

- Initially it was proposed that costs incurred under both the Clean Streams Accord and the One Plan be assessed as a way of estimating compliance costs. However, such an extensive farm redesign provides the opportunity to in-build full compliance from the outset, which is what most new dairy conversions aim to achieve. Consequently, compliance requirements have been integrated into the Day dairy-conversion design (e.g. troughs in all paddocks, modern effluent system, riparian fencing, culverted and bridged crossings), and it would be difficult to isolate them as separate compliance costs. As such, full compliance is assumed by default.

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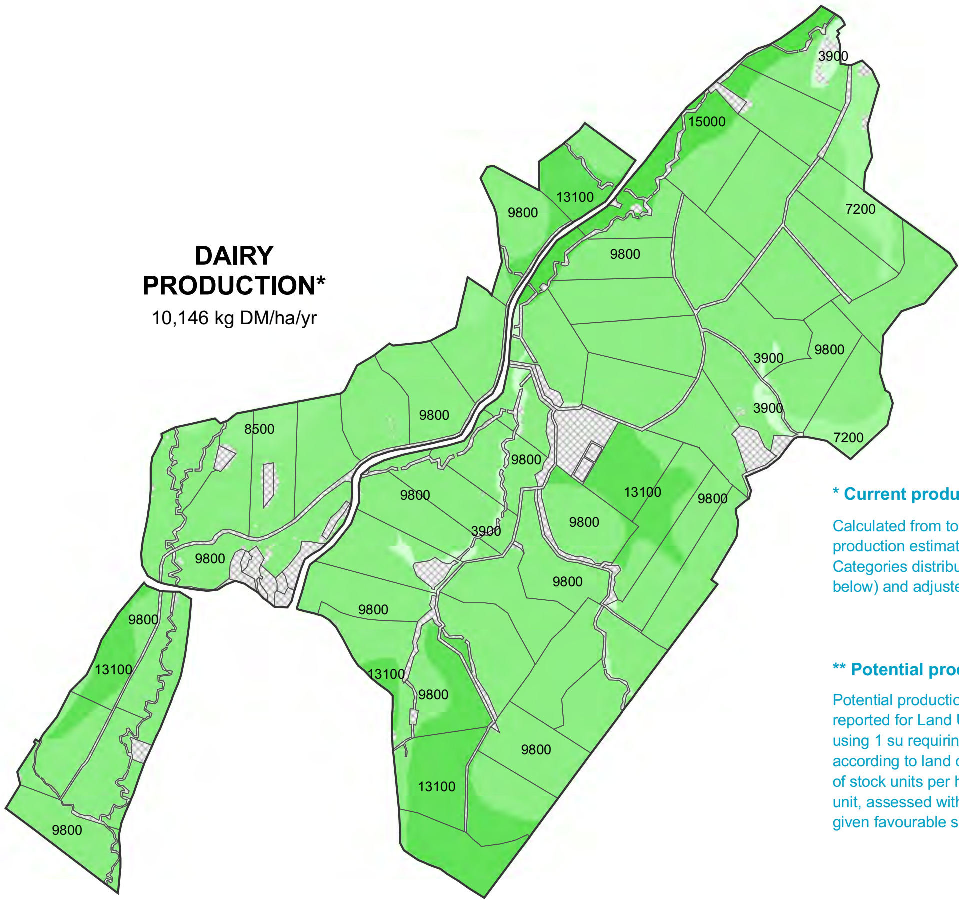
DAIRY PRODUCTION*

10,146 kg DM/ha/yr



*** Current production estimate**

Calculated from total annual pasture production based on pasture production estimate provided by Shepherd Agriculture.
Categories distributed according relative production potentials (see below) and adjusted according to relative yields used in Overseer.

**** Potential production estimate**

Potential production calculated from potential stocking rates reported for Land Use Capability (LUC) units in LRG (1981), using 1 su requiring 550kg DM/ha/yr & a variable pasture utilisation according to land class. Potential stocking rate defined as "the number of stock units per hectare capable of being carried on a particular LUC unit, assessed within the limits of present technology and given favourable socio-economic conditions" (LRG, 1981).

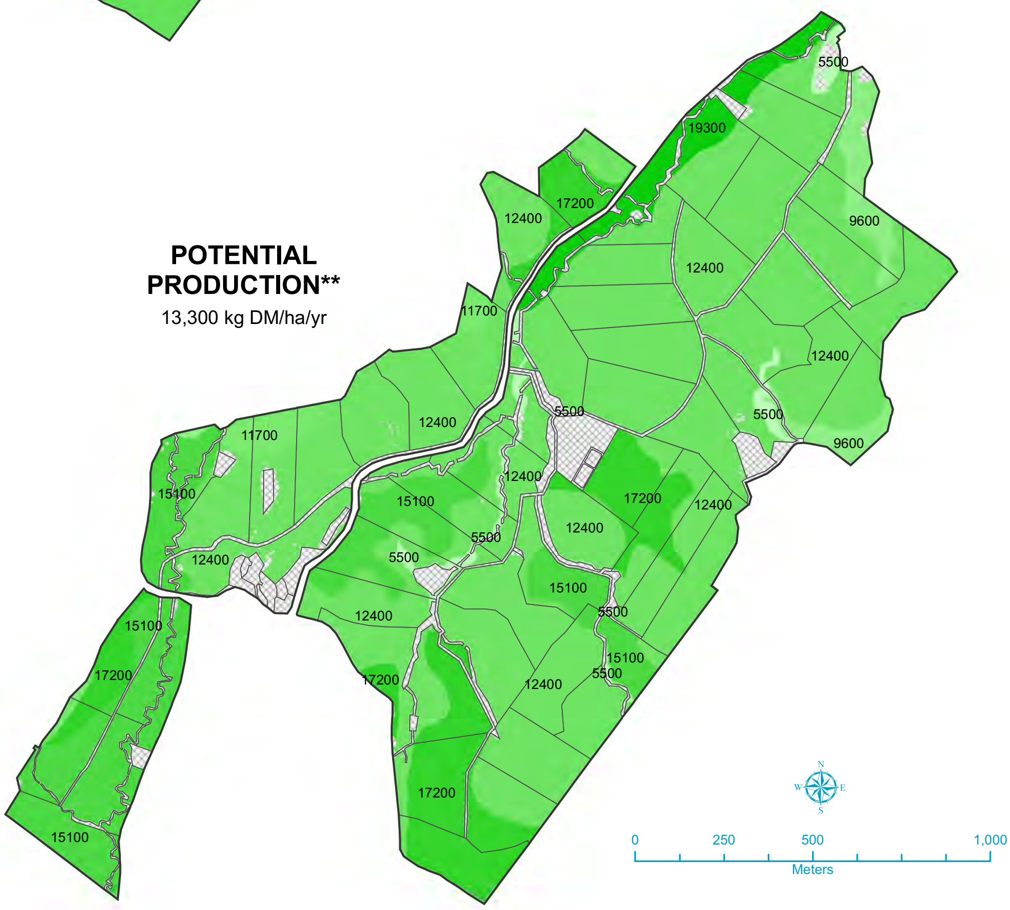
Pasture yield categories

Kg DM/ha/yr

- 3900 - 4000
- 4001 - 5000
- 5001 - 6000
- 6001 - 7000
- 7001 - 8000
- 8001 - 9000
- 9001 - 10000
- 10001 - 11000
- 11001 - 12000
- 12001 - 13000
- 13001 - 14000
- 14001 - 15000
- 15001 - 16000
- 16001 - 17000
- 17001 - 18000
- 18001 - 19000
- 19001 - 20000
- Not grazed

POTENTIAL PRODUCTION**

13,300 kg DM/ha/yr



Reference
Land Resources Group. 1981. Stock carrying capacities and fertiliser data for the North Island. Internal report No.22. Aokautere Science Centre, Ministry of Works & Development, Palmerston North, New Zealand.

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PASTURE YIELD GAP 2

Andrew Day

Ballance Valley Road, Pahiatua

FOR COMPARITIVE PURPOSES ONLY. Current production estimated by Shepherd Agriculture and distributed according to Land Use Capability (LUC) classes for the property adjusted to relative yield. Potential production estimated from carrying capacities reported in LRG (1981), using 1 su requiring 550 kg DM/ha/yr and variable utilisation rates according to land class.

3.2 Financial implications

While not directly critical to this report, cost estimates for the conversion were prepared by Sheppard Agriculture for comparison against potential returns. The comparison is tailored with assumptions and should be used only for indicative purposes (we suggest a more in-depth sensitivity analysis given current interest in conversions, projected payouts, fertiliser price volatility, and demand for dairy stock).

3.2.1 Development costs

- Infrastructure required for the Day conversion is listed in Table 3. GST-inclusive price estimates were obtained from various contractors and service providers from around the Manawatu-Wanganui Region. Most are estimates rather than quotes. Total development cost is estimated at $5.8 million. This aligns well with cost estimates of similar conversions.

Table 3: Development costs

Item	Units	Specification	Cost
Stock	628	$2,500/cow	$ 1,570,000
Pasture development	170 ha		$ 107,950
Cow shed + site	1	60 bail	$ 865,000
Calf shed		6 bay, includes labour	$ 13,800
Implement shed		3 bay, includes labour	$ 8,200
Hay shed		9 bay, includes labour	$ 23,000
Refrigeration unit	1		$ 16,500
Feed pad	1		$ 245,000
Silage bunker	2		$ 180,000
Effluent treatment & application system			$ 130,000
Fencing	38.7 km	3 wire electric @ $1850/km	$ 71,595
Lanes	5.5 km	Surfacing @ $2.80/m^2 , 8m width	$ 123,200
Bridge	2		$ 40,000
Under pass	1	3 x 2 x 12m	$ 70,000
Culverts 900mm	10		$ 10,000
Culverts 450mm	29		$ 10,150
Electricity connection			$ 50,000
Water supply line	7.6 km	Includes fittings for 20 troughs	$ 25,425
Troughs	20		$ 8,400
Tractors	2		$ 20,2500
Hay fed out wagon	1		$ 9,563
Silage wagon	1		$ 28,125
Calf milk feeders			$ 10,198
Calf pellet feeders			$ 2,350
Fonterra shares			$ 1,469,900
Contingency		(10% of total development cost)	$ 529,086
Total cost			**$ 5,819,942** ($5.8 million)

3.2.2 Financial performance

- Budgets were prepared by Sheppard Agriculture to evaluate gross margins as EBIT (Earnings before Interest and Tax). A summary for all three years is presented as Table 4 opposite.
- A key assumption is using a payout of $5.40 per kg MS rather than the $6.90 which is the current payout for this season. However, from a lender's perspective, a more conservative estimate of potential income is preferred, with some commentators even suggesting that $5.00 per kg MS should be used for long-term budgeting.
- Expenses in the first two years will be high, owing to the need to purchase stock and build up herd numbers. Similarly, income from milk solids will initially be low as the farm goes through the development phase. Taken together, farm surplus for year one is predicted to be modest at $48,300, doubling to $102,600 in year two, and growing to $534,800 by year 3 (which is more indicative of the surplus that can be expected over the medium term).
- Viability will be challenged by the actual payouts received for milk over the next 10 years and the need to service a sizeable debt to finance development. In addition, the costs to mitigate N losses to meet One Plan requirements also represent real factors in determining the viability of this conversion.

3.2.3 Feasibility

- **Debt servicing**: Based on standard banking criteria for debt servicing to be approximately 30% of Gross Farm Income (GFI) the farm business should have an interest cost not exceeding $367036 in year 3. This would lead to a cash surplus from dairying of $167,740.
- **Investors**: In limiting interest costs to $367,036 the minimum amount that could be borrowed equates to 4.1 million. Given a total investment required of 5.8 million an investor contributing 1.8 million would be required. This will have implications regarding ownership, decision making and profit sharing.
- **Comparison with sheep and beef**: Current farm surplus from 264 ha under sheep and beef is estimated at $151,442. Based on year-3 farm surplus under dairying ($534,775) less debt servicing ($367,036), then the cash flow gain would be modest at $16,297. Put another way, $5.8 million would be invested to achieve a cash surplus gain of $16,297 per year.

Table 4: Operational budgets for 3 years			
	Year 1 (608 cows)	Year 2 (632 cows)	Year 3 (656 cows)
INCOME			
Milk	$919,296	$1,040,904	$1,168,992
Stock	$50,540	$52,690	$54,460
TOTAL INCOME	**$969,836**	**$1,093,594**	**$1,223,452**
EXPENSES			
Stock Purchases	$332,500	$345,000	$0
Farm Working Expenses			
Wages	$183,860	$217,181	$245,599
Animal Health	$31,008	$32,232	$33,456
Herd Improvement	$18,240	$18,960	$19,680
Electricity	$21,888	$22,752	$23,616
Calf Rearing (pellets)	$4,800	$4,953	$5,169
Cowshed Expenses	$13,376	$13,904	$14,432
Freight (replacement cartage 160Km)	$1,220	$1,260	$3,286
Weed & Pest	$4,864	$5,056	$5,248
Feed			
Hay (round bales)	$10,000	$10,000	$10,000
Silage (Triticale)	$11,908	$11,908	$11,908
Grazing replacements	$ 47,376	$61,352	$63,712
Cropping (Triticale)	$18,043	$18,043	$18,043
Re-grassing	$21,336	$21,336	$21,336
Calf milk	$14,445	$14,915	$15,509
Fertiliser	$76,257	$76,257	$76,257
Repairs & Maintenance	$41,344	$42,976	$44,608
Vehicles	$16,416	$17,064	$17,712
Administration	$40,736	$42,344	$43,952
Standing charges	$10,214	$11,566	$12,989
General Expenses	$1,702	$1,928	$2,165
TOTAL FARM EXPENSES	**$921,533**	**$990,987**	**$688,677**
FARM SURPLUS (EBIT)	**$48,303**	**$102,607**	**$534,775**

- **Capital gain**: The capital gain from converting the land use to dairy is estimated to be $1,272,039 (based on year 3 production levels and current dairy farm prices). Offsetting this is accumulated losses from years 1 & 2 (due to servicing interest) of $415,000. Therefore, the net expected capital gain is &857,000.

  With Andrew being a 65% shareholder, (assuming an equity partner can be found), his net capital gain after 3 years is $557,000 ($185,000 per year over three years). With the estimated level of cash surplus ($151,000) being generated under the current sheep & beef enterprise on the 264ha. The question must be asked "is this a worthwhile investment"?
- **Sensitivity analysis**: The costs of the conversion are based on current market prices and therefore the financial analysis has to take into account the variation in the market and be able to be profitable at lower milk solid prices (see Table 5: Sensitivity analysis). As a point of reference the current equity of the 250ha is $3,338,220. With an EBIT of $151,442 the current ROE is 4.5% (assumes no borrowing exists). With a $5.40 payout the ROE from dairying is lower at 3.3% from dairy farming.

Table 5: Sensitivity analysis					
$ Payout	**Income**	**Expenses**	**EBIT**	**ROC**	**ROE**
$7.40	$1,656,412	$688,677	$967,735	9.3%	11.8%
$6.40	$1,439,932	$688,677	$751,255	7.2%	7.6%
$5.40	$1,223,452	$688,677	$534,775	5.1%	3.3%
$4.40	$1,006,972	$688,677	$318,295	3.1%	-1.0%
$3.40	$790,492	$688,677	$101,815	1.0%	-5.2%

Sensitivity analysis notes

EBIT (Earnings Before Interest & Tax) is GFI (Gross Farm Income) less FWE (Farm Working Expenses).

ROC (Return On Capital) & ROE (Return On Equity) are based on budgeted production figures in 3 years time.

- ROC = EBIT/Total Capital Employed after year three
- ROE = (EBIT - Interest Cost)/Opening Equity

The future (3 year) value of the dairy farm is based on status quo market value for dairy farms (ie. No appreciation of land values accounted for).

Appreciating land values in the dairy sector of 10% per year make the conversion more attractive from a financial perspective.

- The conversion would depend on the finances available to convert the 264ha are and the expectations of the equity partner required to make it happen. The equity partners need for cash flow, control etc. would significantly determine the financial feasibility of the conversion.
- **Conclusion**: The financial viability of a dairy conversion is a decision that needs to be made by the Day partnership. From the discussion above, a conversion appears to be marginally viable using a payout of $5.40/kg MS with the real financial gain stemming from capital gain. However, viability as an investment option becomes more attractive under increasing levels of payout.
- Viability of the Day's dairy conversion proposal will also be affected by compliance requirements under the One Plan. Land classes nominated for conversion do not rate as having a high capacity for sustaining intensive land uses, and will therefore have lower permissible N-loss limits. Implications require consideration before deciding on viability of the conversion. One Plan requirements and N-mitigation options are examined in the following sections, and are summarised on Page 18.

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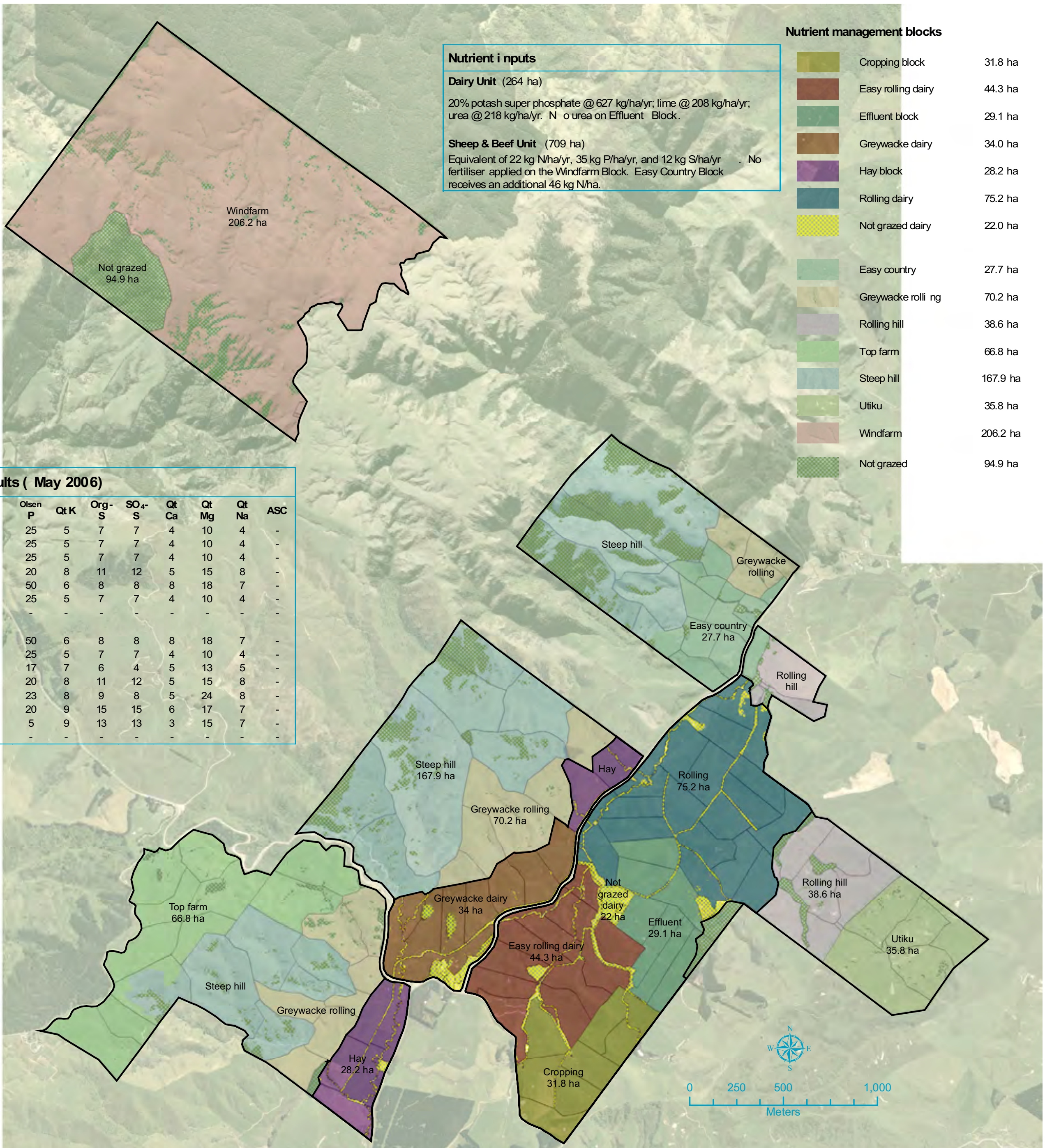


Nutrient i nputs

Dairy Unit (264 ha)

20% potash super phosphate @ 627 kg/ha/yr; lime @ 208 kg/ha/yr; urea @ 218 kg/ha/yr. N o urea on Effluent Block.

Sheep & Beef Unit (709 ha)

Equivalent of 22 kg N/ha/yr, 35 kg P/ha/yr, and 12 kg S/ha/yr . No fertiliser applied on the Windfarm Block. Easy Country Block receives an additional 46 kg N/ha.

Nutrient management blocks

Cropping block	31.8 ha
Easy rolling dairy	44.3 ha
Effluent block	29.1 ha
Greywacke dairy	34.0 ha
Hay block	28.2 ha
Rolling dairy	75.2 ha
Not grazed dairy	22.0 ha
Easy country	27.7 ha
Greywacke rolli ng	70.2 ha
Rolling hill	38.6 ha
Top farm	66.8 ha
Steep hill	167.9 ha
Utiku	35.8 ha
Windfarm	206.2 ha
Not grazed	94.9 ha

Soil test results (May 2006)

Block	Olsen P	Qt K	Org-S	SO_4-S	Qt Ca	Qt Mg	Qt Na	ASC
Cropping block	25	5	7	7	4	10	4	-
Easy rolling dairy	25	5	7	7	4	10	4	-
Effluent block	25	5	7	7	4	10	4	-
Greywacke dairy	20	8	11	12	5	15	8	-
Hay block	50	6	8	8	8	18	7	-
Rolling dairy	25	5	7	7	4	10	4	-
Not grazed dairy	-	-	-	-	-	-	-	-
Easy country	50	6	8	8	8	18	7	-
Rolling Hill	25	5	7	7	4	10	4	-
Utiku	17	7	6	4	5	13	5	-
Greywacke rolling	20	8	11	12	5	15	8	-
Steep hill	23	8	9	8	5	24	8	-
Top farm	20	9	15	15	6	17	7	-
Windfarm	5	9	13	13	3	15	7	-
Non grazed	-	-	-	-	-	-	-	-

Nutrient Budget (NPK only)

	DAIRY ($kg\ ha^{-1}\ yr^{-1}$)			SHEEP & BEEF ($kg\ ha^{-1}\ yr^{-1}$)			WHOLE FARM ($kg\ ha^{-1}\ yr^{-1}$)		
INPUTS	N	P	K	N	P	K	N	P	K
Fertiliser	81	33	43	17	20	0	34	24	12
Effluent	0	0	0	0	0	0	0	0	0
Atmospheric/Clover N	65	0	2	34	0	2	42	0	2
Irrigation	0	0	0	0	0	0	0	0	0
Slow release	0	3	16	0	3	31	0	3	27
Supplements	17	3	20	0	0	0	5	1	5
OUTPUTS									
Product	52	9	12	8	1	0	20	3	3
Transfer	0	0	0	0	0	0	0	0	0
Supplement removed	0	0	0	0	0	0	0	0	0
Atmospheric	78	0	0	13	0	0	31	0	0
Leaching/ru noff	30	4	14	10	2	13	15	3	13
Immoblisation/absorption	4	12	0	21	11	0	16	11	0
Change in inorganic soil pool	0	14	54	0	9	19	0	10	28

Nutrient loss and greenhouse gas emissions [1]

Parameter	Flock House Dairy	Flock House Sheep beef	Flock House Farm	Average NZ Farm
N leaching loss	34 kg N/ha	10 kg N/ha	17 kg N/ha	5-20 kg sheep/beef 30-50 kg N/ha dairy
P run-off risk	Extreme	Medium	High	
Greenhouse gas es [2]				
Methane	4576	2130	2,794	2000-3000 sheep/beef 4200-5000 dairy
N_2O emissions	2073	676	1,055	400-1400 sheep/beef 2500-3500 dairy
CO_2 emissions	688	83	247	30-130 sheep/beef 400-900 dairy
Forestry equivalents [3]	176	186	183	

Notes
1. Greenhouse losses are indicative only because all non -pastoral land was classified as 'trees' for Overseer analysis
2. Units = kg CO_2 equivalents/ha
3. Approximate area of forest to absorb total CO^2 equivalents (net 1 rotation)

FARMS

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

NUTRIENT MANAGEMENT 2

Andrew Day

Ballance Valley Road, Pahiatua

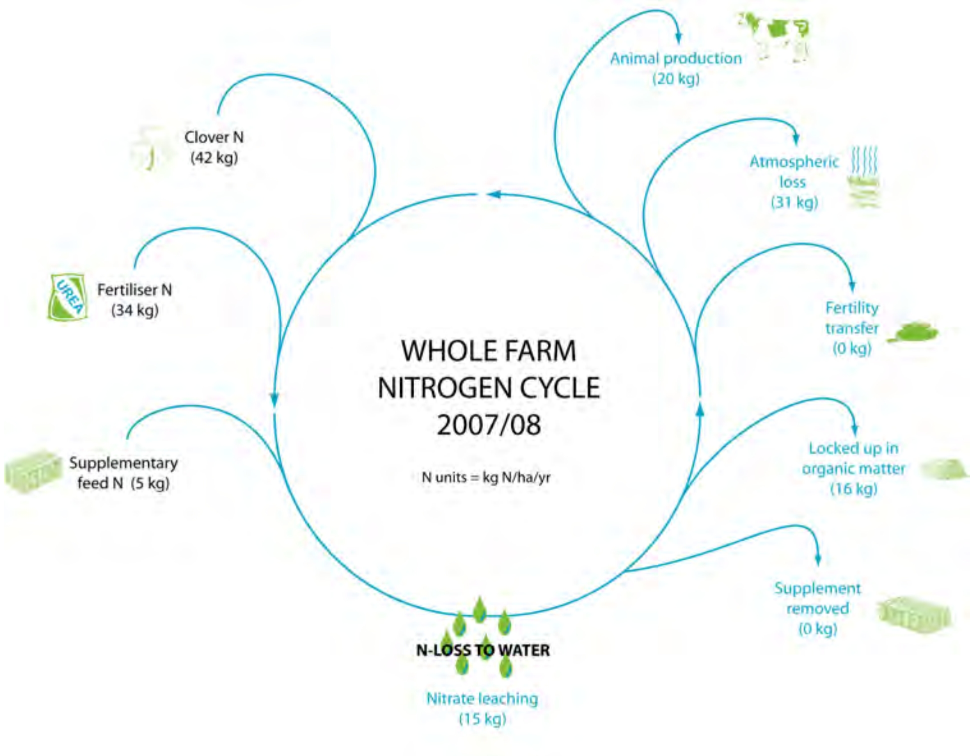
Survey and classification by AgResearch Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

4.0 NUTRIENT RISK ANALYSIS

- Two models were set up using Overseer Nutrient Budgets (v 5.2.6.0) – one model for the new dairy conversion, and the other for the remaining sheep and beef unit. The dairy model was set-up for year-three of the proposed conversion.
- **Dairy unit**: The proposed dairy unit was divided into seven nutrient management blocks, most of which represent carry-over blocks from original sheep and beef model (see report RMS #3a), but with the addition of a cropping block (31.8 ha), effluent block (29.1 ha), and a hay block (28.2 ha). New blocks are distributed arbitrarily on the nutrient management map opposite.
- **Sheep & Beef**: The same model used for report RMS #3a was adjusted to accommodate recalculated areas of existing blocks, the removal of the 'best land' blocks, and a new stocking rate. No other parameters were changed.

4.1 Nitrogen loss to water

- **Dairy Unit**: **N-loss from the Dairy Unit is estimated at 30 kg N ha^{-1} yr^{-1}**. Compared with other dairy farms this is low (NZ average for dairy = 30-50 kg N/ha/yr), primarily because of the feed pad (N-loss is estimated at 34 kg N/ha/yr without a pad). However, use of the feed pad results in a greater proportion of effluent directed into the holding ponds, and a 54 ha effluent application area is required to achieve a 150 kg N/ha loading (currently 29 ha. Area required if no feed pad was used is 33 ha).
- **Sheep & Beef Unit**: **N-loss from the Sheep & Beef Unit is estimated at 10 kg N ha^{-1} yr^{-1}**, which aligns well with NZ averages (sheep & beef average = 5-20 kg N/ha).
- **Whole farm**: **N-loss across the entire farm is estimated at 15 kg N ha^{-1} yr^{-1}**. This is low for what would essentially be an intensive farming operation. This demonstrates the effect of averaging N-loss across an extensive area.



4.2 Phosphorus loss to water

- Overseer rates P-loss risk as MEDIUM for the Sheep and Beef Unit, and EXTREME for the Dairy Unit. This is partly explained by the effect of slope, where steeper slopes will have a greater degree of surface runoff, and associated higher levels of particulate-P loss. P-loss risk averages out at HIGH when applied across the whole farm.

4.3 Faecal microbes and waterway contamination

- The dairy conversion design would help minimise most risks associated with faecal microbes entering water (installing bridges, culverts and riparian fences to exclude direct defecation to water, deferred effluent application to minimise runoff to water risk).

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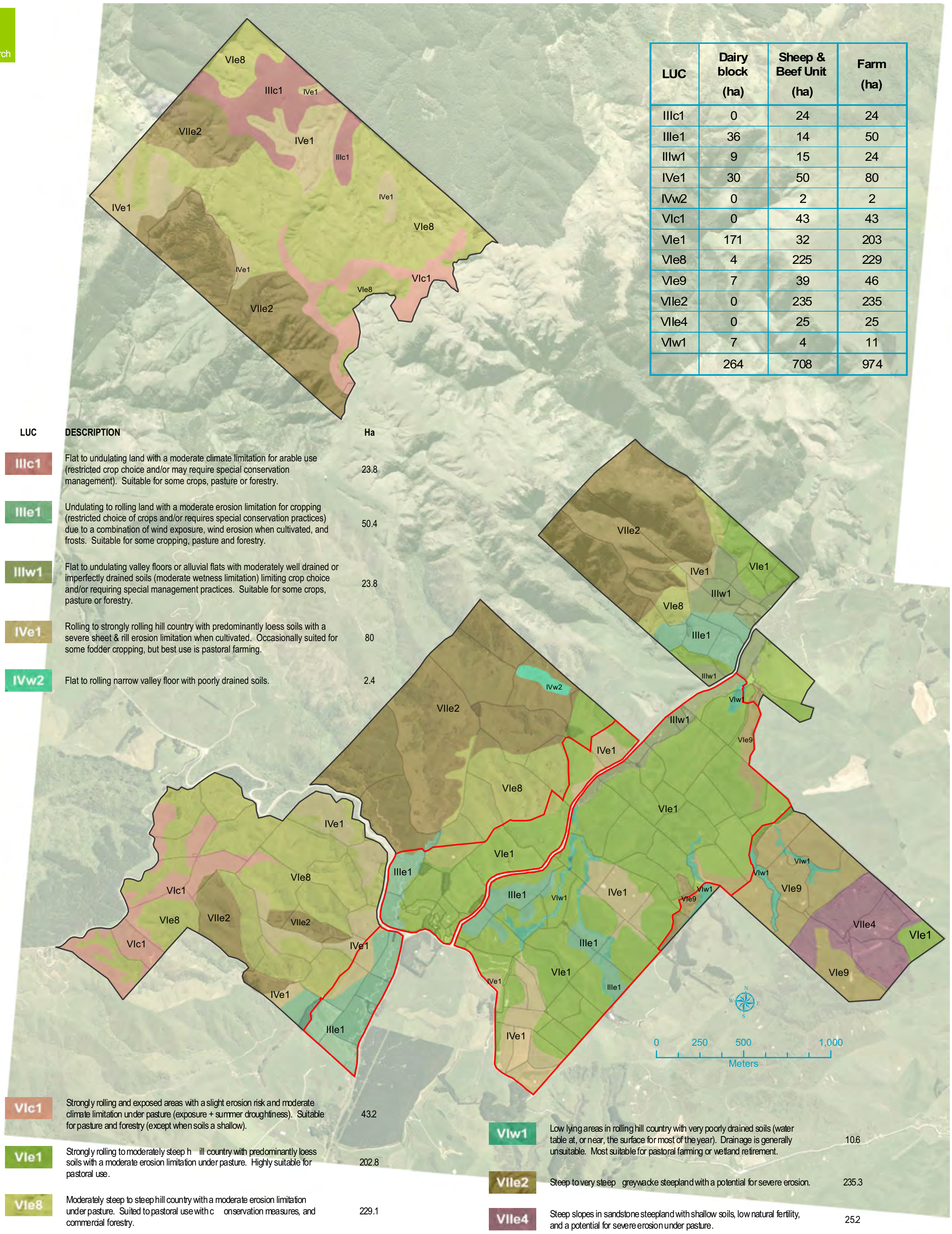

LUC	Dairy block (ha)	Sheep & Beef Unit (ha)	Farm (ha)
IIIc1	0	24	24
IIIe1	36	14	50
IIIw1	9	15	24
IVe1	30	50	80
IVw2	0	2	2
VIc1	0	43	43
VIe1	171	32	203
VIe8	4	225	229
VIe9	7	39	46
VIIe2	0	235	235
VIIe4	0	25	25
VIw1	7	4	11
	264	708	974

LUC	DESCRIPTION	Ha
IIIc1	Flat to undulating land with a moderate climate limitation for arable use (restricted crop choice and/or may require special conservation management). Suitable for some crops, pasture or forestry.	23.8
IIIe1	Undulating to rolling land with a moderate erosion limitation for cropping (restricted choice of crops and/or requires special conservation practices) due to a combination of wind exposure, wind erosion when cultivated, and frosts. Suitable for some cropping, pasture and forestry.	50.4
IIIw1	Flat to undulating valley floors or alluvial flats with moderately well drained or imperfectly drained soils (moderate wetness limitation) limiting crop choice and/or requiring special management practices. Suitable for some crops, pasture or forestry.	23.8
IVe1	Rolling to strongly rolling hill country with predominantly loess soils with a severe sheet & rill erosion limitation when cultivated. Occasionally suited for some fodder cropping, but best use is pastoral farming.	80
IVw2	Flat to rolling narrow valley floor with poorly drained soils.	2.4
VIc1	Strongly rolling and exposed areas with a slight erosion risk and moderate climate limitation under pasture (exposure + summer droughtiness). Suitable for pasture and forestry (except when soils a shallow).	43.2
VIe1	Strongly rolling to moderately steep hill country with predominantly loess soils with a moderate erosion limitation under pasture. Highly suitable for pastoral use.	202.8
VIe8	Moderately steep to steep hill country with a moderate erosion limitation under pasture. Suited to pastoral use with conservation measures, and commercial forestry.	229.1
VIe9	Moderately steep to steep slopes in sandstone hill country. Can have moderate soil slip & tunnel gully erosion limitations under pasture. Generally requires conservation plantings under pastoral use, and has a medium site index value for forestry.	46.2
VIw1	Low lying areas in rolling hill country with very poorly drained soils (water table at, or near, the surface for most of the year). Drainage is generally unsuitable. Most suitable for pastoral farming or wetland retirement.	10.6
VIIe2	Steep to very steep greywacke steepland with a potential for severe erosion.	235.3
VIIe4	Steep slopes in sandstone steepland with shallow soils, low natural fertility, and a potential for severe erosion under pasture.	25.2
	Dairy unit	

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LAND USE CAPABILITY 2

Andrew Day

Ballance Valley Road, Pahiatua

Survey and classification by LandVision Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

5.0 ONE PLAN N-TARGETS

5.1 Land Use Capability

The area targeted for conversion generally represents the best land on the farm, and ranks highly in terms of suitability for sheep and beef grazing. However, relative to high producing diary units in the local area, it would likely be regarded as having marginal suitability under intensive dairy. This is reflected in Land Use Capability for the Dairy Unit, which indicates that only 30% of the area is represented by land more commonly associated with dairy farming (LUC classes 1-4), whereas the bulk of the unit (70%) is represented by LUC class 6 land more commonly associated with sheep and beef grazing.

5.2 One Plan permitted N-loss

Farm survey undertaken to classify the Day property according to Land Use Capability (map opposite), with LUC classes then being linked to One Plan permitted 'N-leaching values' to identify N-loss limits for Day farm over the next 20-years. Calculation of N-loss limits used the same area of land used for the Overseer analysis. To remain compliant under the One Plan, the Day property is required to operate within the N-loss limits described below (Table 5).

Table 5: Permissible N-loss limits for Day farm (N-targets)

	Year	*Year 1*	*Year 5*	*Year 10*	*Year 20*
N-target (kg N/ha/yr)	*Dairy Unit*	13	13	12	12
	Sheep & Beef Unit	10	10	9	9
	Whole farm	**11**	**11**	**10**	**10**

5.3 Implications

Estimated N-loss using Overseer is compared against permissible N-losses as Table 6. The level of required reduction across the dairy platform is substantial (17-18 kg N/ha reduction required), owing mostly to the low permissible N-loss associated with a high proportion of LUC class 6 land. However, when averaged across the entire farm, the difference reduces to a level that, while still being high, is definitely more achievable. Accordingly, **N-leaching losses must be reduced by 4 kg N/ha/yr if the dairy conversion is to be compliant under the One Plan**.

Table 6: N-loss reductions required

	Year	*Year 1*	*Year 5*	*Year 10*	*Year 20*
Sheep & Beef Unit	Overseer N-loss (kg N/ha/yr)	10	10	10	10
	Permissible N-loss (kg N/ha/yr)	10	10	9	9
	Required reduction (kg N/ha/yr)	***Nil*** *(balanced)*	***Nil*** *(balanced)*	***1 kg N/ha*** *reduction required*	***1 kg N/ha*** *reduction required*
Dairy Platform	Overseer N-loss (kg N/ha/yr)	30	30	30	30
	Permissible N-loss (kg N/ha/yr)	13	13	12	12
	Required reduction (kg N/ha/yr)	***17 kg N/ha*** *reduction required*	***17 kg N/ha*** *reduction required*	***18 kg N/ha*** *reduction required*	***18 kg N/ha*** *reduction required*
Whole farm	Overseer N-loss (kg N/ha/yr)	15	15	15	15
	Permissible N-loss (kg N/ha/yr)	11	11	10	10
	Required reduction (kg N/ha/yr)	***4 kg N/ha*** *reduction required*	***4 kg N/ha*** *reduction required*	***5 kg N/ha*** *reduction required*	***5 kg N/ha*** *reduction required*

6.0 REDUCING N-LOSS

An N-loss reduction of 4 kg N/ha/yr is required for the Day dairy-conversion to be compliant under the One Plan. Several mitigation options have the potential to achieve this level of reduction. Assessment is based on a herd of 656 cows. It is also important to note that whole farm N-loss reductions are calculated **from total N-loss from each respective unit**, rather than simply averaging N-loss reductions on a per hectare basis.

6.1 Mitigation options

6.1.1 Urease and nitrification inhibitors

Urease and nitrification inhibitors interrupt nitrogen transformation processes. Recent studies report significant leaching-loss reductions of 30-80%, and improved pasture yields of around 5-20%.

Proposal: Replace current fertiliser-N with urease-inhibitor urea (UI urea) for both the dairy (equates to 21.4 tn N over 214 ha or 88% of fertilised area) and the sheep/beef unit (12 tn N over 407 ha or 66% of grazed area). Spray the dairy blocks currently receiving urea with nitrification inhibitor (214 ha or 88% of fertilised area).

Effectiveness: Inhibitors are a relatively new technology in New Zealand, and it is difficult to predict confidently how effective they may be under different farming conditions. For the interim, and specifically for the Day farm given its location and climate, we suggest a conservative 10% N-leaching reduction for either urease or nitrification inhibitor, and a 20% reduction when used together. This would represent a 10% reduction in N-leaching for 66% of the grazed sheep and beef unit (i.e. 0.66 * 10 kg N/ha * 0.10), and a 20% reduction for 88% of the dairy unit. This equates 0.7 kg N/ha and 5.3 kg N/ha reductions in N-leaching for both units respectively. Accordingly, **adopting the use of inhibitors is estimated to decrease whole farm N-loss by 1.9 kg N ha^{-1} yr^{-1}**.

Implications & cost: Urea equivalents are used for simplicity. Current fertiliser N-use is estimated to cost $47,700 for 33.4 tn urea N (@ $1.43/kg N applied), while a shift to UI urea is estimated to cost an additional $8,005 (@ $1.67/kg N applied = $55,700). Spraying with nitrification inhibitor twice per year across 214 ha would increase cost to $63,200 (@ $148/ha/ application). Total additional cost of adopting inhibitors is estimated at $71,200.

Assuming an average value of $0.15 per kg DM produced, then a 7.54% pasture response would be necessary to break even. Given that research trials have reported yield increases of 5-20%, then it is likely that the cost of inhibitors would pay for itself, and there is the additional promise of higher responses generating an increased farm surplus.

Recommendation: Build the use of inhibitors into the dairy conversion design. At a potential reduction of 3 kg N/ha/yr, this will go a long way towards balancing N-loss against N-limits to achieve compliance under the One Plan.

6.1.2 Off-farm winter grazing and supplement use reduction

Grazing off-farm in winter can have a substantial impact on N-loss because it essentially removes urine-N contributions at a time when the leaching risk is high, and decreases the need to purchase and feed winter supplements. Under the current design, 656 cows are wintered on farm with the use of a wintering/feed pad over May and June, receiving 160 tn of triticale silage (at 4 kg silage/cow/day over 61 days).

Proposal: Graze the herd off-farm in May and June. This means 160 tn less silage needs to be purchased.

Effectiveness: Overseer suggests that N-loss on the Dairy Unit could be reduced by 2 kg N/ha/yr. This is lower than what can normally be expected because of the current proposed use of the feed pad to winter cows (which results in a reduced N-loss to begin with). Expressed on a whole-farm basis, **grazing the herd off-farm during winter could reduce whole farm N-loss by 1 kg N/ha/yr**.

Implications & cost: Off-farm winter grazing is estimated at $94,464 (assuming $18/cow/week over 8 weeks) plus cartage at $7,216 ($0.11/cow/km at a 50 km radius x 2 trips), giving a total cost of $101,680. Money saved by not having to purchase 160 tn of triticale silage is estimated at $40,250 (at $0.25/kg DM). At first glance, wintering off could reduce N-loss by 1 kg N/ha/yr but cost the farm **$61,430**. HOWEVER, few farmers would waste the extra pasture grown on-farm while cows are grazed elsewhere. Three options are considered:

1. **Extend milking season,** either by calving earlier or milking longer, or a combination of both. An additional two weeks at the margins could represent an extra $28,000 in gross revenue (at a return of $2,000 for every extra day milked). However, pushing the margins can increase risks associated with calving.
2. **Increase next season's stocking rate:** If an extra 12 cows could be milked (2.75 cows/ha), then gross returns could increase by $21,384 (at 330 kg MS/cow and $5.40/kg MS). For 24 cows (2.8 cows/ha) it could be doubled. However, increasing stocking rate has implications for current infrastructure, purchasing supplements, and other considerations that all incur an additional cost. Net returns would be considerably lower.
3. **Making hay for sale off-farm**: Assuming the surplus can be carried over until late spring/early summer as an equivalent yield, then approximately 280,112 kg DM could be harvested (feed budgets prepared by Sheppard Agriculture suggest 7 kg pasture DM/cow/day would be consumed over May and June). Assuming a farmgate price of $0.30 per kg hay DM ($84,034) less a harvesting cost of $0.13 per kg DM for conventional bales ($36,414), and $7,470 for fertiliser to replace exported nutrients (280 tn hay = 1401 kg P, 4202 kg K, 840 kg S), then revenue generated from haymaking could be worth $40,150. However, in truth it would be difficult to push an equivalent yield into early summer.

Recommendation: Not to adopt off-farm grazing to winter cows. N-loss reductions would likely be small and costs high. While some of the cost could be offset by utilising the pasture not grazed on-farm, the three options considered are not particularly lucrative, and each has its own degree of uncertainty about feasibility. Add to this the seasonal volatility of grazing prices, risks associated with having someone else manage your cows, and the need to find a grazing location where N-loss is not a concern (i.e. outside any One Plan priority catchment), then grazing cows off-farm during winter becomes even less attractive.

6.1.3 Increase effluent area and feeding-pad time

For the current conversion design, the feed pad is used by 100% of the herd (split milking) during the milking season (271 days) for 1hr per day (plus 6 hrs per day over May and June as a wintering pad). All effluent generated is assumed to enter holding ponds (i.e. total effluent = feed pad effluent + milking shed effluent), and the required effluent application area to achieve a 150 kg N/ha loading is 56 ha. More time spent on the feeding pad, separation of effluent solids, and a larger effluent application area, may combine to reduce N-loss from the Dairy Unit.

LARGER EFFLUENT AREA + MORE FEED PAD TIME

Proposal: Double the time spent on the feeding pad to 2hrs/d over the milking season, separate effluent solids for application across the dairy platform, and optimise effluent application area to achieve an N-loading no greater than 150 kg N/ha.

Effectiveness: **The proposed mitigation appears to have little impact on modelled N-loss**. Volume of effluent applied to the effluent block decreases from 61 kg down to 42 kg N/ha, but N-loss is only reduced by 1 kg N/ha (i.e. just for the effluent block). This reduction is too small to influence N-loss reported for the Dairy Unit let alone the whole farm (Overseer averages reported N-loss to the nearest whole number).

Implications & cost: Cost would be minimal. Required effluent area is 51 ha to achieve a 150 kg N/ha loading, and it is assumed the existing design can accommodate this. There may, however, be an extra cost associated with spreading effluent solids across the farm once per year (e.g. $1,000 to $2,000).

Recommendation: The recommendation is to increase effluent area, but not to increase the time spent on the feed pad unless there are other reasons for doing so.

6.1.4 Wintering barn

A wintering barn is essentially a large covered feed-pad with sufficient room for cows to lie down. Effluent volumes are reduced because of less rainfall mixing with the effluent (in principle).

WINTERING BARN

Proposal: Enlarge and cover the current feed pad design. Store effluent and apply in late spring.

Effectiveness: Overseer was set up to utilise a wintering barn as a 'feed pad' between April to September (100% of herd on + 11hrs grazing/d), and as a 'wintering pad' for wintering cattle in May & June (100% herd on pad 6hrs/d). Supplement fed out was redistributed according to time spent on the pads. Overseer suggests that N-loss could be reduced by 4 kg N/ha/yr for the dairy unit, and the area required to achieve a 150 kg N/ha loading would reduce from 56 ha down to 40 ha. On a whole farm basis, **replacing the feed pad with a wintering barn is estimated to reduce N-loss by 2 kg N/ha/yr** (note that the way Overseer was set up is as a close approximation of a herd home, which differs by storing effluent under slats in a basement).

Implications & cost: Cost of the current (proposed) feed pad is estimated at $245,000 (~$375/cow). A wintering barn requires substantially more area than a feed pad (~7-10m^2/cow), a robust cover, and the facilities to collect and store effluent. Cost is estimated at $484,130 for a wintering barn (at $738/cow), and $411,000 for a herd home (at $1,000/cow). Net cost (i.e. taking off the $245,000 saving of not building a feed pad) equates to $239,130 and $411,000 respectively.

Recommendation: To consider a wintering barn or herd home in greater detail. N-loss reductions are likely to be respectable, possibly more so if a herd home was constructed (N-loss implications of a herd home are not accommodated in the current release of Overseer). While cost may be high, constructing a barn or herd home as part of the conversion represents an efficient use of money (compared with having to install a herd home in addition to the feed pad five-years hence). However, having to borrow an additional $240,000 - $411,000 will have implications regarding the viability of the conversion.

6.1.5 Replace Triticale crop

Under the current proposal, 31.8 ha is cropped in Triticale as part of the pasture development programme, producing 390 tn DM as silage (feed balance is made up by purchasing an additional 218 tn DM). The crop is sown in autumn, grazed in April and July, and harvested for silage in January the following year. The fodder cropping model in Overseer pastoral does not span years, so the crop was modelled for one month less (i.e. harvested in December rather than January). Even so, Overseer reports a disproportionately large N-loss for the cropping block, most of which is coming from mineralised-N associated with cultivation.

ALTERNATIVE SUPPLEMENTS

Proposal: Replace Triticale crop with pasture. Conserve pasture as silage, and purchase additional Triticale silage to balance feed demand and energy requirements. 390 tn DM Triticale silage provides approximately 3.9 x 10^6 MJ ME (at 10 MJME/kg DM). Overseer was set up for two crops of silage (at 3.1 tn DM/ha per cut) giving a total annual yield of 197.2 tn DM. As good quality pasture silage, energy content is estimated at 1.87 x 10^6 MJ ME (at 9.5 MJ ME/kg DM), leaving a shortfall of 2 x 10^6 MJ ME. Additional Triticale silage required to meet the shortfall would be 202.7 tn DM.

Effectiveness: The modelled N-loss reduction for the Dairy Unit is 10 kg N/ha/yr. However, on a whole farm basis, **replacing the Triticale crop with pasture and buying in extra supplement is estimated to reduce N-loss by 2.7 kg N/ha/yr**. Total whole farm N-loss decreases by 2640 kg N/yr (2640 kg over 974 ha = 2.7 kg N/ha).

Implications & cost: Savings from not cropping 31.8 ha in Triticale is estimated at $17,077 ($537/ha), and $11,908 for not having to make it into silage ($30.5/tn). Cost of establishing new pasture is already built into the conversion (i.e. sown into pasture after the Triticale crop), while turning pasture into silage is estimated at $6,021 ($30.5/tn). Purchasing in 202.7 tn of Triticale silage is estimated to cost $50,675 (at $0.25/kg DM). Total savings ($28,985) less total costs ($56,700) equates to a net cost of $27,710.

Recommendation: To replace cropped Triticale silage with pasture silage from the same area, and purchase 203 tn DM Triticale silage to make up the supplement shortfall (or equivalent as maize or other high energy supplement). While growing the crop on-farm readily appears to be more cost-effective than purchasing, the potential reductions in N-loss would be substantial if Overseer is correct. However, the variable cost of purchased supplement is highly seasonal, and may cost significantly more than the estimated $27,710.

6.2 Achieving N-targets

The dairy conversion can achieve compliance under the One Plan's nutrient targets by adopting the use of inhibitors and opting for purchased Triticale silage rather than cropping it on-farm. An N-inhibitor reduction of 1.9 kg N/ha and a cropping reduction of 2.7 kg N/ha is sufficient to achieve the required 4 kg N/ha N-loss limit for the property. However, there is always a degree of uncertainty around the degree of impact that a dairy conversion may have on the environment. For this reason, we suggest N-loss risk should be managed as any other farm business risk, by building in an N-loss buffer going into the future. One option is to install either a wintering barn or herd home. This would put the farm N-budget 2-3 kg N/ha in credit, thereby providing sufficient buffering for unforeseen problems and future developments.

6.3 Financial implications

An estimated 7.54% yield increase would be required to offset the cost of spraying nitrification inhibitor and shifting to a UI urea product. This is a modest yield response relative to increases being achieved at some research sites. Given the elevation and climate of the Day property, it is not unrealistic to predict yield increases that could be significantly higher than 7.5%. In short, it is our view that adopting inhibitors is unlikely to convey any additional cost to the conversion because of increased pasture yield, and there is a good outlook that inhibitors would likely help increase farm returns.

The full financial implications of replacing the Triticale crop and building a wintering barn require further analysis if they are to be integrated into the conversion proposal. Viability of importing supplement rather than conserving it on-farm will be largely dependent on year-to-year price fluctuations and the availability of feed. This is quite evident this year with supplement feed being considerably costly to purchase due to the drought conditions experienced by most of New Zealand.

The proposed dairy unit is only viable (under the One Plan regulations) as part of the sheep & beef property, due to the ability to spread N leaching losses over a larger area. This factor has significant implications for the future saleability of the Dairy unit as a separate entity – achieving compliance as a standalone dairy farm would be more challenging. In reality the prospect of being able to realise capital gain from the development of a dairy unit is unlikely due to One Plan regulations, unless the whole farm were to be sold.

7.0 CONCLUSIONS

- Converting 264 hectares of the farm into dairy appears to be marginally viable using a payout of $5.40/kg MS with the real financial gain stemming from capital gain. Under the current payout level of $6.90/kgMS, the conversion would be a more attractive investment option.
- Leaching N-loss from the conversion is modelled at 30 kg N/ha/yr which is moderately low for a dairy farm. This reduces to 15 kg N/ha when combined with N-loss from the remaining sheep and beef unit (10 kg N/ha/yr) as an average across the entire farm.
- P-loss risk is rated at EXTREME for the proposed dairy unit and MEDIUM for the sheep and beef unit. On a whole farm basis this averages out to a HIGH risk.
- Environmental consequences of a conversion are partly offset by the in-building of mitigations into the conversion design from the outset (riparian retirement and fencing, reticulated water supply to all paddocks, culverts and bridges at all crossings, optimal effluent system design, etc.). Such mitigations will go a long way towards reducing risks associated with P-loss and faecal microbe contamination, and to a lesser extent minor reductions in N-loss. It is assumed that the proposed design would also achieve full compliance with the Clean Streams Accord and other non-nutrient/pathogen related requirements of the One Plan.
- The rate of N-loss permitted under the One Plan is calculated at 13 kg N/ha for the dairy unit, 10 kg N/ha for the sheep and beef unit, and 11 kg N/ha for the whole farm (further decreasing over 20-years to 12, 9 and 10 kg N/ha respectively). These are quite low N-loss rates, particularly for dairying. This reflects land type, with only 30% of the conversion area represented as land commonly associated with dairy farming (LUC classes 1-4), with the greater balance being less versatile land more commonly associated with sheep and beef (LUC class 6). **To be compliant under the One Plan, the dairy conversion would need to reduce N-loss by 4 kg N/ha/yr**.
- An N-loss reduction of 4 kg N/ha/yr is not unachievable. From the mitigations considered, this level of N-loss reduction can be accommodated by adopting N-inhibitors (urease-urea to replace N-fertiliser use, and spraying most of the Dairy Unit with nitrification inhibitor twice each year), and opting for the purchase of Triticale silage rather than cropping it on-farm. Individually, these mitigations are estimated to reduce N-losses by 1.9 and 2.7 kg N/ha respectively (combined effect might be slightly less than the suggested 4.6 kg N/ha reduction).
- Many processes can change as a result of converting to dairy, and predicting future N-loss is difficult. For this reason we suggest in-building a degree of risk management with a higher N-loss reduction. One option considered here is the construction of a wintering barn or herd home, which carries the potential of reducing N-loss by a further 2-3 kg N/ha/yr.
- Adopting an inhibitor programme is unlikely to incur any additional cost, and may even result in revenue gains. Purchasing Triticale silage rather than making it on-farm is estimated to cost $27,700 in the first year of the conversion, but actual cost will be variable according to seasonality and feed demand. If a wintering barn was constructed, then the additional cost would be $240,000 (or $411,000 for a herd home) bringing total cost to $267,700 (or $438,700 with a herd home).

- **Conservative summary**: Without One Plan requirements, converting part of the farm to a dairy operation appears to be a marginally viable proposition at a $5.40 payout. In being marginal, including base compliance costs ($27,700) is enough to make the proposition less viable, while a wintering barn (optional) may very likely push viability beyond the realms of a sound investment. Further, compliance costs would be considerably higher if the dairy farm was established as a standalone entity. High dairy N-loss spread across the sheep and beef unit incurs only a small compliance cost; high dairy N-loss confined to the dairy unit alone would incur substantially higher costs, thereby making the proposal completely unviable under One Plan requirements.

- **Optimistic summary**: A dairy conversion is much more viable under higher payouts, as higher returns would likely be sufficient to offset any base compliance cost. While a full analysis is outside this project's purpose and resources, greater returns could be sufficient to manage debt incurred from optional or additional mitigations (e.g. wintering barn). However, this is speculative, as higher payouts tend to alter many economic and supply facets of dairy farming, and a repeat analysis is recommended taking into account longer-term payout predictions (>5 years).

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Key people involved in the preparation of this report include:

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Sheppard Agriculture Ltd.

7.20 CASE STUDY 6 REPORT (MARTON MIXED-ENTERPRISE AGRIBUSINESS)

16 kg N/ha/yr Tutu Totara N-loss (2007)

25 kg N/ha/yr Initial N-loss target

20 kg N/ha/yr 20 year N-loss target

RESOURCE MANAGEMENT STRATEGY

Tutu Totara Farm
Marton

FARMS
farmer applied resource mgt strategies

Reference: FARMS/2007/RMS#005
Catchments: Rang_3a, Rang_4c
Prepared by: AgResearch Ltd.
Date: 10/01/08

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BACKGROUND

THE ONE PLAN & RULE 13.1: At present eleven important catchments in the Manawatu-Wanganui Region have nutrient levels far in excess of what is desirable. To help address this issue Horizons have proposed a Rule in the One Plan that aims to lessen the nutrient-impact from activities associated with intensive farming. Resource consents concerning irrigation takes, fertiliser, stock feed, biosolids, soil conditioners, dumps, offal holes, and effluent, will be necessary for dairy farming, cropping, market gardening, and intensive sheep and beef farming. The Rule will come into effect at different times for each of the eleven catchments.

ONE FARM; ONE CONSENT: A new consent process will be available under the One Plan. The traditional approach of having several separate consents for a farm is replaced with a single whole-farm consent. This means only one consent – not many – is needed for the entire farm. This promises to make the process simpler, quicker and considerably less expensive. A *FARM Strategy* is a necessary prerequisite for a whole-farm consent.

FARM STRATEGY: A FARM Strategy (Farmer Applied Resource Management Strategy) represents an assessment of permitted and controlled activities for a farm, and a strategic plan to ensure those activities comply with One Plan specifications and water quality targets. It combines a nutrient budget, a comparision of farm nutrient-loss against catchment water-quality targets, an evaluation and recommendation of mitigation options (if the farm is operating outside of catchment water-quality targets) including cost and effectiveness, an assessment of eligibility for relevant consents, and a farm plan of works that spells out the where, when and how much of achieving sustainable land use within the given catchment of interest.

This report summarises an exploratory FARM Strategy for Tutu Totara Farm – a 778 ha combined dairy, sheep/beef and cropping farm located 11 km north-east of Marton township. This places the property within two Water Management Zones – the *Lower Rangitikei* (Rang_3) and *Coastal Rangitikei* (Rang_4). Rule 13-1 is due to come into effect on the 1st April 2014 for the *Coastal Rangitikei* catchment. No initiation date has yet been set for the *Lower Rangitikei* catchment (i.e. not yet a priority catchment under the One Plan). Tutu Totara Farm represents the sixth application of the FARM Strategy framework.

1.0 PLAN SUMMARY

- **Purpose:** Purpose is to identify how Tutu Totara Farm can remain compliant under Rule 13-1 of the proposed One Plan. Emphasis is on identifying best options that achieve requirements without placing unnecessary strain on farm performance.

- **Farm overview:** A 778 ha (596 ha effective) multiple-enterprise farming operation located 14 km north-east of Marton township. The 373 ha Dairy Platform (305 ef ha) runs 800 Friesian cows at 2.6 cows/ha producing 347,301 kg MS from pasture (11.6 tn DM/ha), pasture silage (300 tn DM) and maize grain (374 tn). 92 hectares are irrigated. The 297 ha Sheep & Beef Unit (183 ef ha) is used primarily for rearing Kelso breeding rams (8.1 su/ha), maize cropping (27 ha yielding 18 tn/ha), and dairy support (wintering 50% of herd and rearing 50% of replacements at 5.5 su/ha). The 108 ha Cropping Unit is producing 17 tn/ha maize grain. Average annual rainfall is 1141 mm, and the farm encompasses some of the best land found in the Rangitikei District.

- **Clean Streams Accord:** All targeted streams and crossings are Clean Streams compliant (dairy only). The effluent system breaches existing consent conditions, and therefore requires attention to become Accord-compliant. Recommendations include installing a 420 m^3 holding pond, a larger effluent area, and reduced water consumption. Capital costs are estimated at $16,680, much of which will be offset by nutrient-use efficiency improvements valued at $12,000 per year.

- **Nutrient loss and water quality:** **Current N-loss for the whole farm is calculated at a low 16 kg N/ha/yr** (dairy = 17 kg N/ha, sheep/beef = 12 kg N/ha, cropping = 24 kg N/ha), due to generally low stocking rates, many N-reducing options are already practiced, and the 'dilution' of N-loss by including less intensive and non-pastoral areas. P-loss risk for the whole farm is LOW, although the dairy and cropping units rate as MEDIUM. The Effluent block and River Block both have EXTREME P-loss risks.

- **Permissible N-loss:** **Permissible N-loss is calculated at 25 kg N/ha/yr for 2014**, and becomes gradually tighter over the 20-yr implementation period (permitted N-loss by 2034 is 20 kg N/ha/yr). Compared with current N-loss, **Tutu Totara Farm is operating well within its N-loss limits, and no N-reductions or special mitigations are required**. The farm actually has a comfortable buffer extending out for the full 20 years of consideration. Further, even under an intensification scenario of 1100 cows, the property would still remain within its N-leaching allowance.

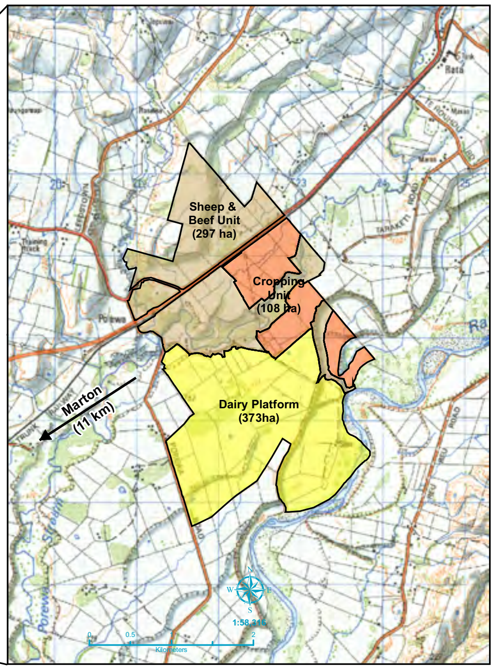
- **Mitigations evaluation:** While no N-loss mitigations are required, several options were evaluated either for interest, or because they are a requirement under a different part of the FARM Strategy workbook.

Option	Whole farm effectiveness	Financial implications	Recommended
N-inhibitors	N-loss ↓ **1.4 kg N/ha/yr**	Only 5.4% yield response needed to break even; potentially more profitable	✓
Control sheep-yard runoff	Bug risk↓ & N-loss risk↓ & P-loss risk↓	$5,000 - $10,000 for effluent storage system	?
Fence waterways	Bug risk↓ & N-loss risk↓ & P-loss risk↓	$12,300 - $17,000 cost. Production losses negligible	✓
Decommission stock fords	Bug risk↓ & N-loss risk↓ & P-loss risk↓	Fencing costs are built into fencing waterways. No other costs because bridges are already in place	✓
Improved dairy effluent system	N-loss ↓ **<1 kg N/ha/yr** for whole farm (↓ **37 kg N/ha/yr** for the Effluent Block)	Capital investment of $16,680 but offset by nutrient use improvements worth +$12,000 per year	✓
Stop use of urea in winter	N-loss ↓ **1 kg N/ha/yr**	Estimated $69,000 lost revenue	×

- **Compliance requirements and costs**: Cost to implement this FARM Strategy is estimated at $36,000 – $45,900. Cost comprises Clean Stream Accord obligations ($16,680) and One Plan compliance costs ($19,500 - $29,200). Impacts on production are likely to be minor. FARM Strategy cost reduces to $24,200 – $33,900 if nutrient-use efficiencies are included (valued at ~$12,000/yr), and further down to $19,200 - $23,900 if the sheep-yards do not require an effluent system.

Requirement	To comply with...	Recommendation	Financial implications
Operate within N-loss limits	One Plan	No N-reductions necessary so no special mitigations required	
No stormwater discharge to dairy yards	One Plan	Install guttering & pipe to direct stormwater to land	$500 cost
Exclude stock from waterways	One Plan & Clean Streams	Sheep-proof 1.2 km existing fence; erect 1.6 km new fence around Porewa Stream; consider 0.9 km new fence around 'suspect' stream	$12,200-$14,600 cost.
No stock fords or crossings	One Plan & Clean Streams	Decommission stock fords	-
No offal hole within 100m of surface water	One Plan	Relocate offal holes	$1,700
No direct discharge of effluent to water from the sheep yards	One Plan	Clarify if sheep-yard effluent requires special management. If yes, design and implement an effluent collection and storage system	$5,000 - $10,000
No dump if watertable is within 1m of the dump base	One Plan	Decommission farm dump	-
Maximum effluent disposal rate @ 35m^3/day and must have 2 days effluent storage	Clean Streams (existing consent condition) and One Plan	Enlarge effluent area (62 ha), adopt water conserving wash-down practices, and install small effluent holding pond (420m^3)	$16,680 capital cost offset by ~$12,000/yr fertiliser saving

- **Compliance strategy:** Recommendations to achieve full compliance are made as 8 specific objectives for successive implementation over a five-year period. Any appreciable change in stock policy, feeding policy, or fertiliser will require a reassessment of farm N-loss against N-targets (i.e. a new nutrient budget).



This property is located 11 km north east of Marton township.

(Distances calculated by road between farm boundary edge and town centre).

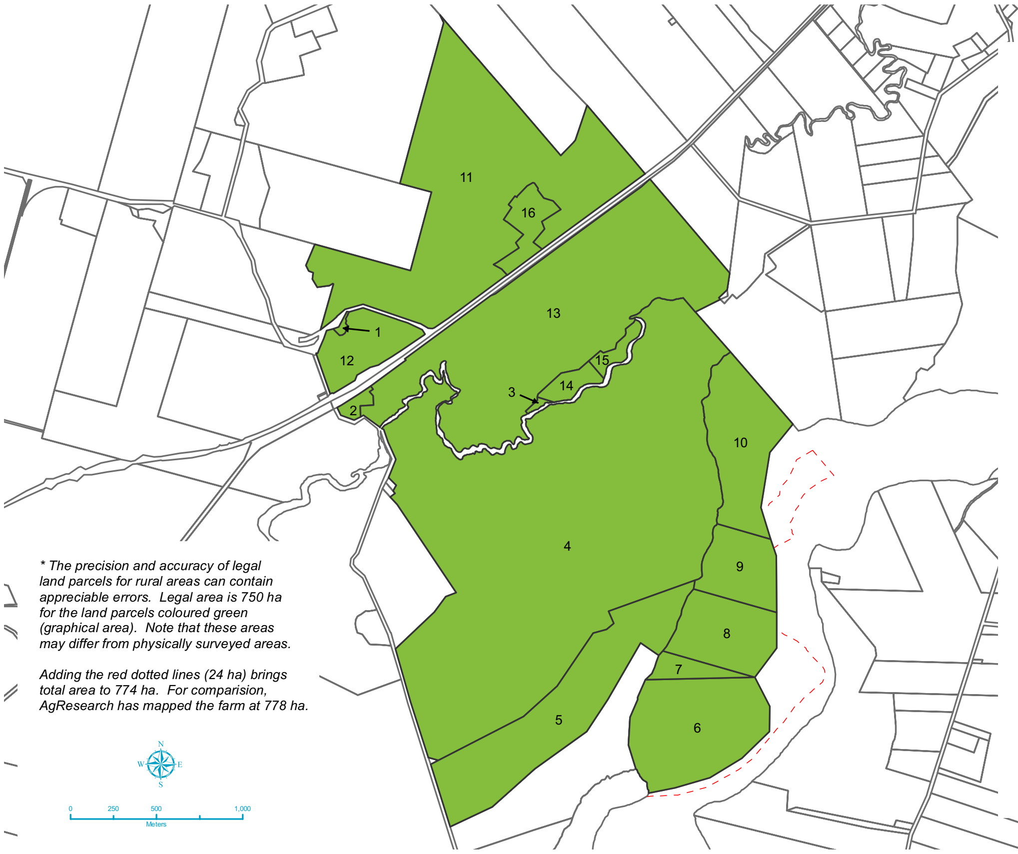
The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

FARM LOCATION & ACCESS

Tutu Totara Farm, Marton

Prepared for Horizons Regional Council by AgResearch Ltd, as part of the FARMS initiative.
December 2007.

agresearch



** The precision and accuracy of legal land parcels for rural areas can contain appreciable errors. Legal area is 750 ha for the land parcels coloured green (graphical area). Note that these areas may differ from physically surveyed areas.*

Adding the red dotted lines (24 ha) brings total area to 774 ha. For comparision, AgResearch has mapped the farm at 778 ha.

ID	Legal Description	Graphical Area
1	Pt Block XXVIII	0.4867 ha
2	DP 26114, WND1/1099	1.9871 ha
3	Pt Block XXVIIA RANGITIKEI District	0.5046 ha
4	Pt Block XIX	287.8277 ha
5	Lot 1 Deposited Plan 82656, WN49A/840	55.4644 ha
6	Section 412 RANGITIKEI District, WN22D/54	42.3395 ha
7	Block CCXIX RANGITIKEI District	5.1943 ha
8	Block CCXX RANGITIKEI District	22.2075 ha
9	Block CCXXI RANGITIKEI District	17.1046 ha
10	Block CCXXII RANGITIKEI District	31.8991 ha
11	Lot 2 Deposited Plan 88969	127.9585 ha
12	Lot 3 Deposited Plan 88969	15.9857 ha
13	Lot 4 Deposited Plan 88969	125.3187 ha
14	Pt Block XXVIII RANGITIKEI District	4.2476 ha
15	Pt Block XX RANGITIKEI District	3.0512 ha
16	Lot 1 Deposited Plan 88969	8.2553 ha
		750 ha*

Land that is part of the farm unit but is legally viewed as river land (not owned). 24.1 ha

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

LEGAL TITLES AND PARCELS

Tutu Totara Farm, Marton

Prepared for Horizons Regional Council by AgResearch Ltd, as part of the FARMS initiative.
December 2007.

agresearch

2.0 FARM DESCRIPTION

2.1 Existing farm business

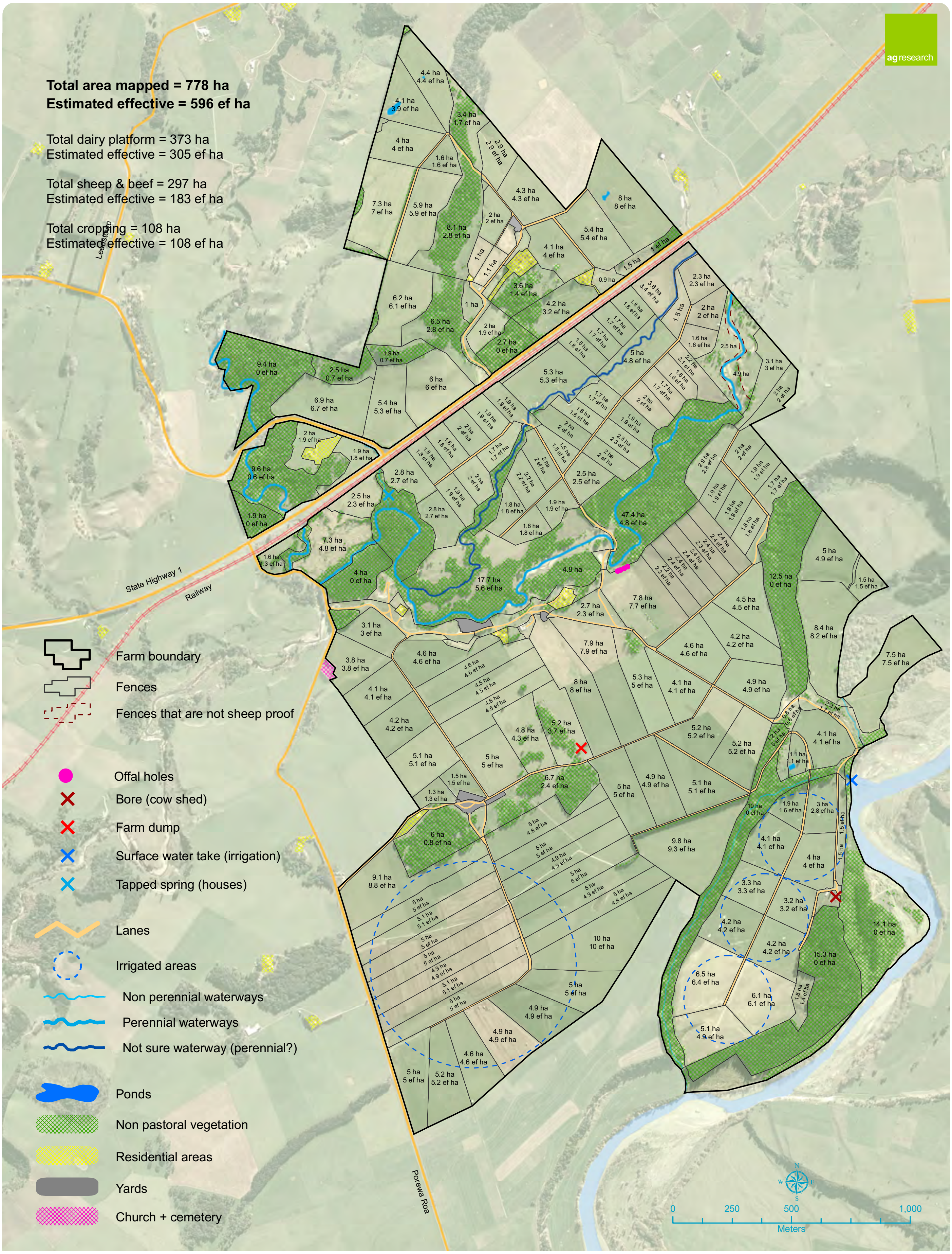
2.1.1 The physical resource

- The farm is located near Porewa settlement 11 km north-east of Marton. This places it within the One Plan's *Coastal Rangitikei Water Management Zone* (Rang_4) and *Lower Rangitikei Water Management Zone* (Rang_3). Two subzones are implicated, including the *Porewa* (Rang_4c) and *Lower Rangitikei* (Rang_3a). From April 1st 2014, all intensive farms in the *Coastal Rangitikei Water Management Zone* are required to have a FARM Strategy. While a proportion of Tutu Totora Farm falls within a non-priority catchment (31% of farm area within the *Lower Rangitikei* zone), the greater proportion falls within the *Coastal Rangitikei* zone (61%). A FARM Strategy is therefore required for Tutu Totara, and N-loss, N-limits and One Plan compliance are assessed for the whole property.
- The property encompasses some to the best land farmed in the Rangitikei District, predominantly as flat to gently undulating middle terraces with Tokorangi, Ashhurst, Kiwitea, Ohakea, and Marton series soils, grading down to recent alluvial terraces dominated by Rangitikei sandy loam and Karapoti sandy loam.
- Total length of perennial streams is estimated at 5.7 km. Several smaller streams and drains are also present, but flow characteristics are more intermittent and seasonal in nature, particularly during the drier months. Deep gullying and established bed characteristics of one particular stream suggested sizeable flow volumes, but at the time of inspection (winter 2008) the stream was effectively dry.
- Annual average rainfall is 1141 mm. Proximity to the coast is 29 km.
- Total area of the property has been mapped at **778 ha** with an estimated **596 ef ha** of open pasture (excludes 182 ha as bush, forestry, river land, roads, ponds, etc.). This includes 373 ha as the **Dairy Platform** (305 ef ha), 297 ha as the **Sheep & Beef Unit** (183 ef ha), and a 108 ha **Cropping Unit**. True effective areas are difficult to gauge because of several intermittently grazed blocks with scattered but extensive tree cover (total area adjusted by a cofactor to estimate effectives for these areas).

2.1.2 Farm system

- Tutu Totara Farm is owned and farmed under Tututotara Ltd (750 legal hectares). A further 24 ha of river land is farmed without title (i.e. not owned). General operations across the whole farm are managed by David Marshall, but specific operations regarding the Dairy Platform are managed by Richard Ash.
- Farm enterprises are in constant development. The description used in this report is the best representation of the property at the current point in time.
- **Dairy Platform**: Seasonal supply dairy farm milking 800 Friesian cows and producing 347,301 kg MS (1140 kg MS/ha and 434 kg MS/cow) from pasture (11.6 tn DM/ha/yr yield), silage (300 tn DM), and maize grain (374 tn DM). Average grazing rotation is 20 days during the milking season, and 120-150 days during winter. Approximately half the herd is wintered off onto the Sheep & Beef Unit, and the remainder are carried over on-farm (includes use of wintering pad).
- **Sheep & Beef Unit**: Dual purpose as a dairy support block (wintering half the main herd and rearing half the dairy heifer replacements) and rearing Kelso ram lambs to be sold as breed rams. Also a degree of lamb finishing.
- **Cropping Block**: Dedicated to maize production, yielding 17 tn DM/ha as maize grain (374 tn) destined for the Dairy Platform, and maize silage.

Dairy	
Breed	Friesian
Live weight	534
Peak number milked	800
Replacements	200
Wintering	50% onto Sheep & Beef Unit
Production	347,301 kg MS/yr
Stocking rate	2.62 cows/ha
Sheep & Beef	
Ewes (non breeding)	20
Lambs	Up to 3600 lambs pass through the property each year
Sheep:Cattle	60:40
Sheep stocking rate	8.1 su/ha
Cattle stocking rate	5.5 su/ha



The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

PROPERTY MAP

Tutu Totara Farm

Porewa, Marton

Survey and classification by Landvision Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

2.1.3 Farm system (continued)

- Approximately 92 hectares are irrigated – 60 ha on the mid-terraces using a 455 m pivot, and 32 ha on the river terraces using three 185 m pivots. Irrigation is used over 75 – 100 days at a rate of 5 mm per day (potentially up to 4,600 m^3/day which is well within the 9,110 m^3/day permitted in the current water take consent).
- Shed effluent passes through a sump and is sprayed via irrigator to land daily. Sump capacity is estimated at 60m^3 (generous estimate). Effluent production is estimated at 28,493 m^3/yr (see Section 5.2.5 for assessment of effluent system). Effluent application area is 13.8 effective hectares.

2.1.4 Infrastructure

- The property has 17.8 km of laneways most of which are separately fenced.
- Farm buildings, yards and other structures are in good serviceable condition, although current shed design is limiting expansion of the dairy unit and may be upgraded or superseded with a new shed.
- The Dairy Platform is recently subdivided into approximately 64 paddocks at an average size of 4.9 ha, while the Sheep & Beef Unit is also well subdivided into approximately 96 paddocks at an average size of 2.9 ha (excluding the grazed bush blocks). Total length of fencing for the farm is **122 km** (boundary fencing = 23 km, internal fencing = 99 km).

2.1.5 *Clean Streams Accord* and Fonterra's *Effluent Indicator System*

The dairy industry entered into the *Clean Streams Accord* in 2003. Under the Accord, dairy farms are obligated to:

- Exclude cattle from lakes, rivers, and perennial streams deeper than a "Red Band" and "wider than a stride".
- Ensure farm races include bridges or culverts where stock regularly cross a watercourse. Regular is defined as more than twice a week.
- Manage dairy effluent appropriately according to regional council specifications.
- Manage nutrients using a nutrient budget.
- Protect regionally important wetlands.

The aim is to have 90 to 100% of dairy farms compliant by year 2012 (only four years away). Fonterra has also recently introduced the *Effluent Indicator System* for the 2007/08 season. Regional councils are invited to notify Fonterra about farmers who are "persistently and critically" non-compliant with effluent management. Failure to remedy non-compliance in the short term may result in payout reductions, or refusal to pick up milk over the longer term (3yrs).

- The farm has 5.7 km of perennial waterways that qualify as 'Clean Streams' streams (excluding the Rangitikei River). Stock are permanently excluded from all streams and the river on the dairy platform, and are therefore clean streams compliant. Several streams on other parts of the farm require attention under the One Plan (see Section 6).
- The property is generally well-served with bridges and culverts. The exception is two fords that are currently used for stock crossing purposes. However, neither are located on the dairy unit, and do not therefore qualify attention under the Accord (but they qualify under the One Plan – see Section 6).
- Tutu Totara is permitted to discharge up to 35 m^3 of effluent to land per day under the existing resource consent. Total effluent production is estimated at 78 m^3/day (see Section 5.2.5 for assessment of effluent system). Consequently**, the effluent system is not compliant with existing consent conditions, and is therefore also non-compliant with the Accord**.
- The farm has an existing nutrient budget prepared by Kieran Cooney (Nutri-Link Ltd).
- Several ponds are present on the farm, but none could be considers as lakes. Similarly, there are several 'boggy patches' across the property that may have once qualified as wetlands, but today they are retired or intermittently grazed pastoral land.

2.1.6 Pasture and grazing management

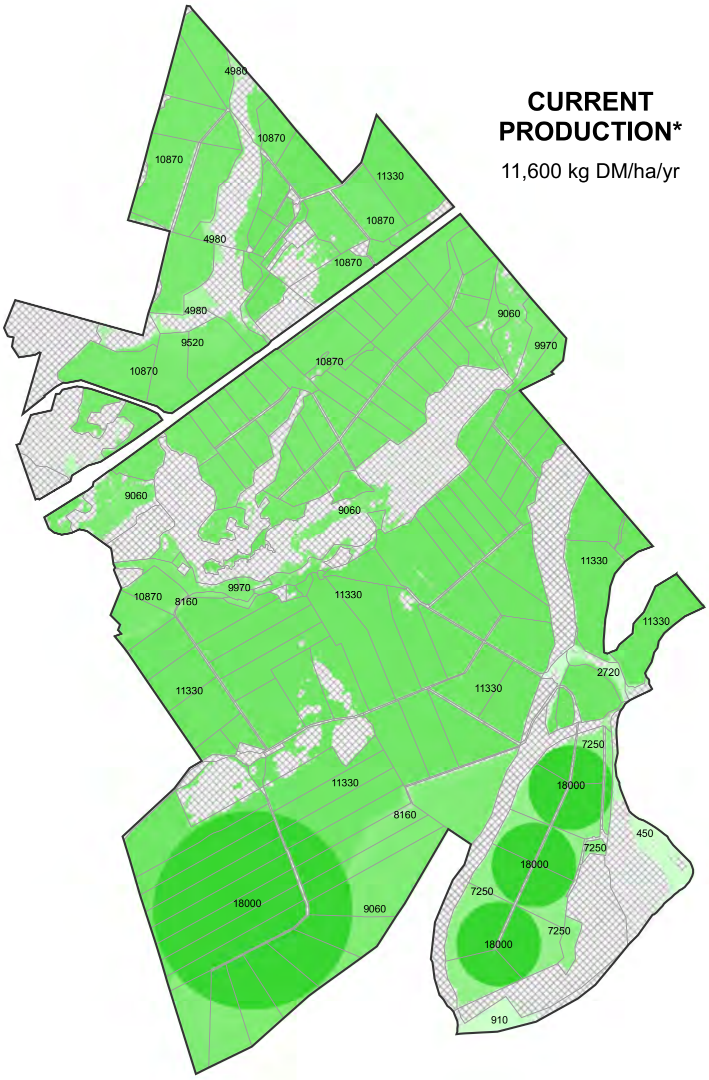
- **Dairy Platform**: The herd is milked over an average 20 day rotation, and a 120-150 day rotation in winter. Half the herd is wintered off the main dairy platform in June and July, and 25% of the herd in August. The remainder are wintered on-farm with the assistance of a wintering pad. 200 heifer replacements are grazed off the Dairy Platform from weaning.
- **Sheep & Beef Unit**: 100 replacement heifers from the Dairy Platform grazed post weaning (other 100 grazed at another location). Kelso ram lambs are brought onto the Unit, and are taken off the unit, at various times of the year and at various weights, ultimately to be sold as breeding rams. There is also a lamb finishing component, and 27 ha is allocated to a maize crop each year.
- Current pasture production is estimated at **<u>11,600 kg DM/ha/yr</u>**. Irrigated blocks are estimated to produce up to 18,000 kg DM/ha/yr. These are estimates provided by the farm manager.
- Pasture production is distributed across the farm (map opposite) using Land Use Capability units (map on page 14) and carrying-capacities for different units reported in LRG (1981). Similarly, potential carrying capacities have been used estimate potential levels of pasture production, if all manageable limitations were overcome (e.g. optimal pH, soil nutrient status, drainage condition, etc.). Upper limit of potential pasture yield is estimated at **18,770 kg DM/ha/yr**. Many generalisations have been made to produce these maps, so they should be used for comparative or indicative purposes only. However, they do suggest that Tutu Totara has a degree of scope for increasing annual pasture yield into the future.

2.1.7 Evaluating Tutu Totara under the One Plan's definition of 'intensive'

Under the One Plan, FARM Strategies are required for intensive farms. The Sheep & Beef Unit of Tutu Totara Farm falls outside this definition, yet it is still an integral part of a predominantly intensive farming operation. This has implications for how N-losses and N-targets are calculated, and the degree of compliance required under One Plan conditions.

On the one hand, including the Sheep & Beef Unit will reduce leaching loss by averaging it across a larger area (see page 10), which could be considered good from the farmer's perspective. On the other, inclusion makes the Sheep & Beef Unit eligible for consideration against the full compliment of One Plan requirements for an intensive farm (e.g. fencing streams, stock crossings, etc). So including the Sheep & Beef Unit could potentially increase compliance costs.

It is proposed that farms running dual intensive/extensive systems be given the option to decide on whether an intensive/extensive distinction is made for the calculation of N-losses, N-targets, and the evaluation of compliance requirements. Towards this end, Tutu Totara has been evaluated both on a 'farm unit' and 'whole of farm' basis. This includes the calculation of N-loss and N-targets separately for the Dairy Platform, Sheep & Beef Unit, the Cropping Unit, and for the farm as a whole.



CURRENT PRODUCTION*

11,600 kg DM/ha/yr

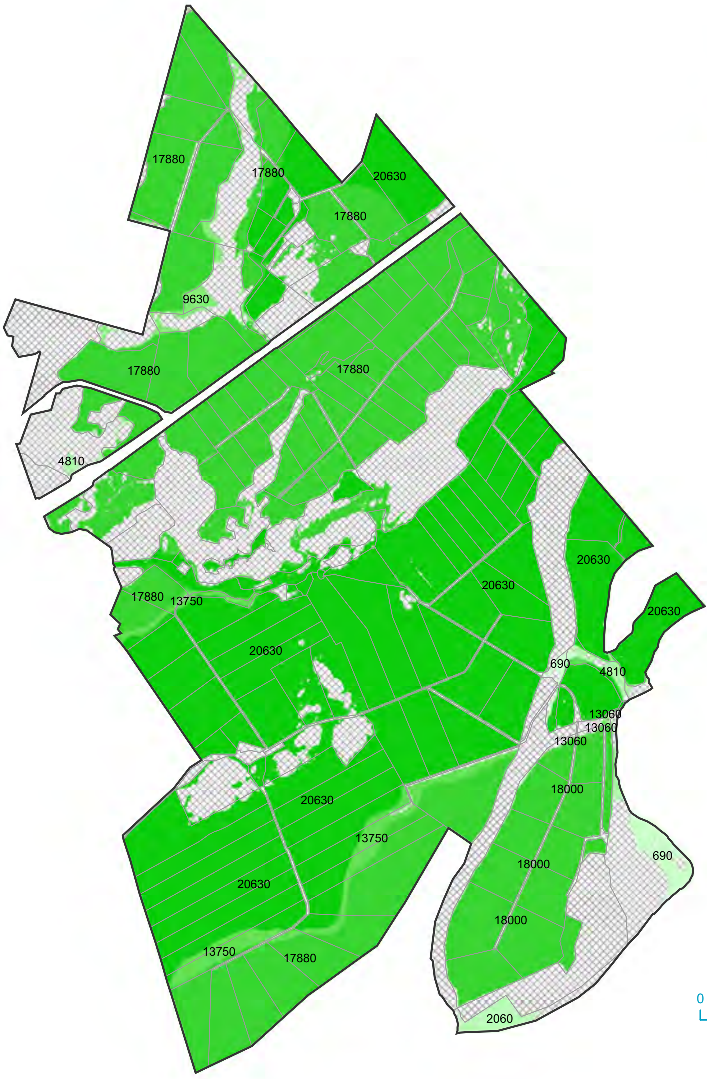
*** Current production estimate**

Calculated from whole farm estimate (dairy and sheep/beef) provided by farm manager. Categories distributed according relative production potentials (see below). Irrigated areas adjusted to 18 tonne DM/ha.

**** Potential production estimate**

Potential production calculated from potential stocking rates reported for Land Use Capability (LUC) units in LRG (1981), using 1 su requiring 550kg DM/ha/yr & 80% utilisation. Potential stocking rate defined as "the number of stock units per hectare capable of being carried on a particular LUC unit, assessed within the limits of present technology and given favourable socio-economic conditions" (LRG, 1981).

Reference
Land Resources Group. 1981. Stock carrying capacities and fertiliser data for the North Island. Internal report No.22. Aokautere Science Centre, Ministry of Works & Development, Palmerston North, New Zealand.



POTENTIAL PRODUCTION**

18,770 kg DM/ha/yr

Pasture yield categories
Kg DM/ha/yr

- 490 - 1000
- 1001 - 2000
- 2001 - 3000
- 3001 - 4000
- 4001 - 5000
- 5001 - 6000
- 6001 - 7000
- 7001 - 8000
- 8001 - 9000
- 9001 - 10000
- 10001 - 11000
- 11001 - 12000
- 12001 - 13000
- 13001 - 14000
- 14001 - 15000
- 15001 - 16000
- 16001 - 17000
- 17001 - 18000
- 18001 - 19000
- 19001 - 20000
- 20001 - 21000

Excluded (non pastoral)

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PASTURE YIELD GAP

Tutu Totara Farm

Powrewa, Marton

FOR COMPARITIVE PURPOSES ONLY. Current production estimate provided by farm manager and distributed according to Land Use Capability (LUC) classes for the property. Irrigated areas adjusted to 18 tn.
Potential production estimated from carrying capacities reported in LRG (1981), using 1 su requiring 550 kg DM/ha/yr and 80% utilisation.

Nutrient Budget (NPK only)

	DAIRY (kg ha^{-1} yr^{-1})			SHEEP & BEEF (kg ha^{-1} yr^{-1})			CROPPING (kg ha^{-1} yr^{-1})			WHOLE FARM (kg ha^{-1} yr^{-1})		
INPUTS	N	P	K	N	P	K	N	P	K	N	P	K
Fertiliser	78	36	35	106	16	17	132	44	60	96	29	32
Effluent	0	0	0	0	0	0	0	0	0	0	0	0
Atmospheric/Clover N	67	0	2	18	0	2	2	0	2	39	0	2
Irrigation	3	0	2	0	0	0	0	0	0	1	0	1
Slow release	0	3	24	0	3	11	0	3	23	0	3	19
Mineralisation (cultivation)	0	0	0	0	0	0	158	0	0	22	0	0
Carry in org residues	0	0	0	0	0	0	163	20	0	23	3	0
Carry in inorganic pool	0	0	0	0	0	0	14	0	0	2	0	0
Supplements	36	5	19	20	2	17	0	0	0	25	3	16
OUTPUTS												
Product	67	11	16	5	1	0	188	43	53	60	12	15
Transfer	0	0	0	0	0	0	0	0	0	0	0	0
Supplement removed	0	0	0	39	6	33	0	0	0	15	2	13
Atmospheric	60	0	0	42	0	0	48	0	0	51	0	0
Leaching/runoff	**17**	1	18	**12**	0	14	**24**	1	12	**16**	1	16
Immoblisation/absorption	39	21	0	44	11	0	0	4	0	35	15	0
Residuals	0	0	0	0	0	0	21	3	20	3	0	3
Organic residues	0	0	0	0	0	0	188	15	326	26	2	45
Change in inorganic pool	0	11	47	0	2	1	0	0	-327	0	6	-22

Nutrient loss and greenhouse gas emissions[1]

Parameter	Tutu Totara				Average NZ Farm
	Dairy	Sheep beef	Crop	Farm	
N leaching loss	17 kg N/ha	12 kg N/ha	24 kg N/ha	16 kg N/ha	5-20 kg sheep/beef 30-50 kg N/ha dairy
P run-off risk	Medm	Low	Medm	Low	
Greenhouse gases[2]					
Methane	4491	2037	2,931	4491	2000-3000 sheep/beef 4200-5000 dairy
N_20 emissions	2453	1038	1,572	2453	400-1400 sheep/beef 2500-3500 dairy
CO_2 emissions	1141	-251	451	1141	30-130 sheep/beef 400-900 dairy
Forestry equivalents[3]	238	148	171	238	

Notes
1. Greenhouse losses are indicative only because all non-pastoral land was classified as 'trees' for Overseer analysis
2. Units = kg CO_2 equivalents/ha
3. Approximate area of forest to absorb total CO^2 equivalents (net 1 rotation)

Fertiliser Inputs

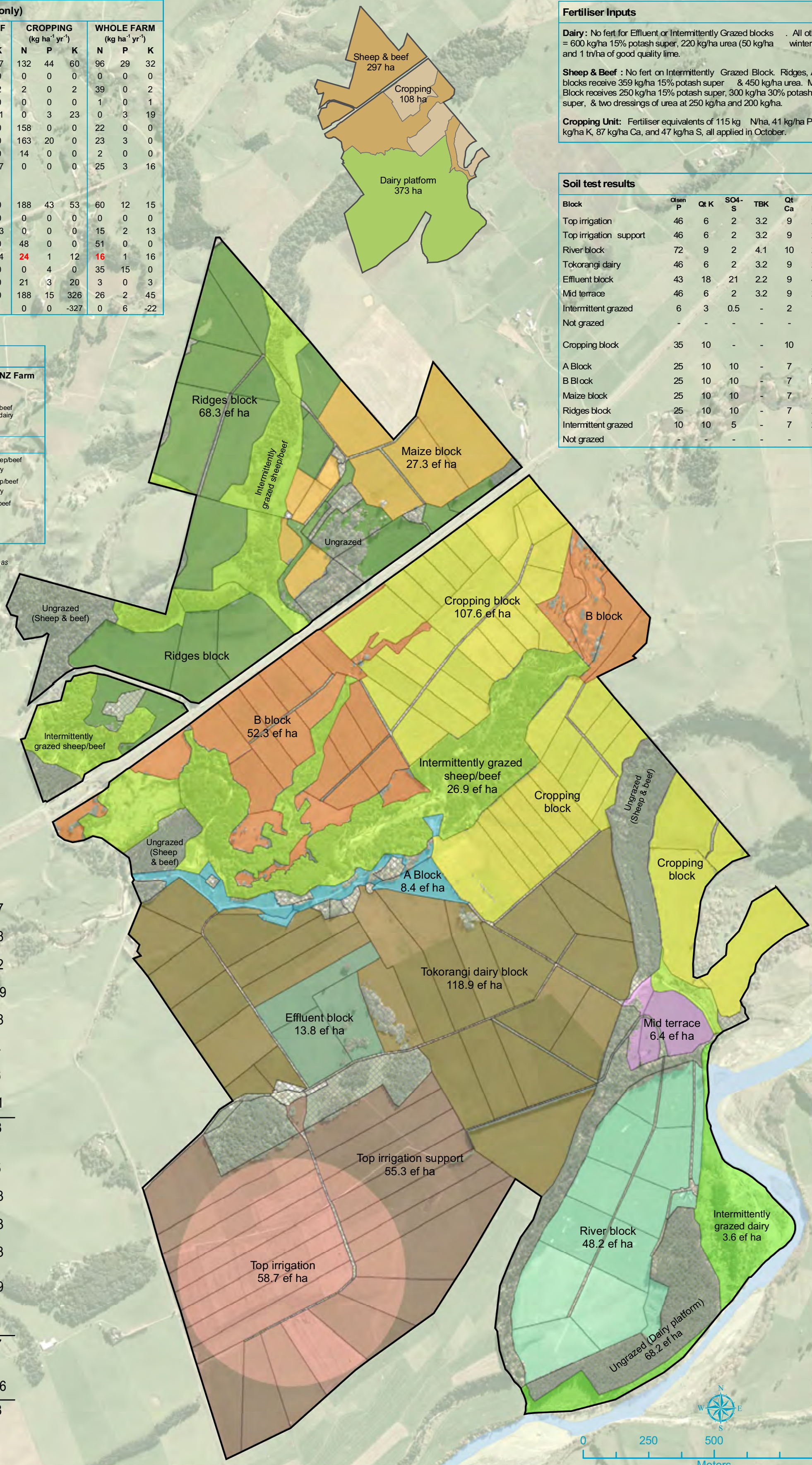
Dairy: No fert for Effluent or Intermittently Grazed blocks . All other dairy = 600 kg/ha 15% potash super, 220 kg/ha urea (50 kg/ha winter urea-N), and 1 tn/ha of good quality lime.

Sheep & Beef : No fert on Intermittently Grazed Block. Ridges, A & B blocks receive 359 kg/ha 15% potash super & 450 kg/ha urea. Maize Block receives 250 kg/ha 15% potash super, 300 kg/ha 30% potash super, & two dressings of urea at 250 kg/ha and 200 kg/ha.

Cropping Unit: Fertiliser equivalents of 115 kg N/ha, 41 kg/ha P, 58 kg/ha K, 87 kg/ha Ca, and 47 kg/ha S, all applied in October.

Soil test results

Block	Olsen P	Qt K	SO4-S	TBK	Qt Ca	Qt Mg	Qt Na
Top irrigation	46	6	2	3.2	9	21	5
Top irrigation support	46	6	2	3.2	9	21	5
River block	72	9	2	4.1	10	23	5
Tokorangi dairy	46	6	2	3.2	9	21	5
Effluent block	43	18	21	2.2	9	44	15
Mid terrace	46	6	2	3.2	9	21	5
Intermittent grazed	6	3	0.5	-	2	2	2
Not grazed	-	-	-	-	-	-	-
Cropping block	35	10	-	-	10	-	5
A Block	25	10	10	-	7	23	8
B Block	25	10	10	-	7	23	8
Maize block	25	10	10	-	7	23	8
Ridges block	25	10	10	-	7	23	8
Intermittent grazed	10	10	5	-	7	23	8
Not grazed	-	-	-	-	-	-	-



ag research

Dairy Platform	**Ha**
Top irrigation block	58.7
Top irrigation support	55.3
River block	48.2
Tokorangi dairy block	118.9
Effluent block	13.8
Mid terrace block	6.4
Intermittently grazed dairy	3.6
Ungrazed dairy	68.1
	373
Sheep & Beef Unit	
A Block	8.5
B Block	52.3
Maize block	27.3
Ridges block	68.3
Intermittently grazed shee/beef	26.9
Ungrazed shee/beef	10
	297
Cropping	
Cropping block	107.6
	108

Note that area of intermittently grazed blocks is calculated on a relative yield basis

FARMS

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NUTRIENT MANAGEMENT

Tutu Totara Farm

Porewa, Marton

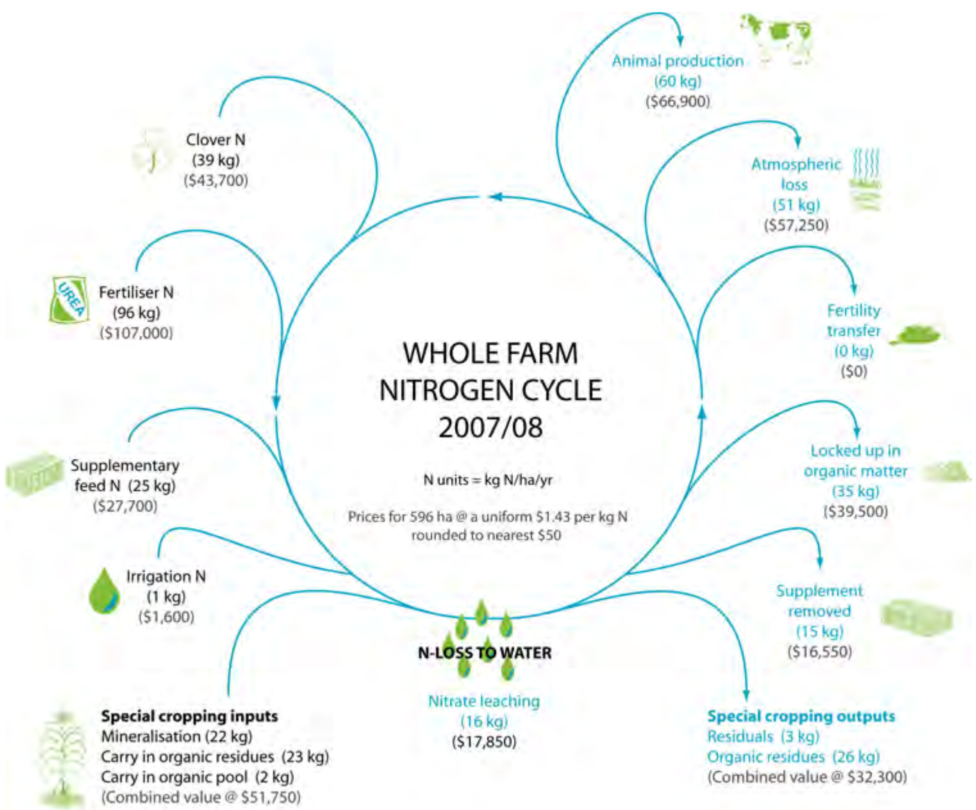
Survey and classification by AgResearch. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

3.0 FARM NUTRIENT BUDGET AND WATER QUALITY

- The farm was divided into eight dairy management blocks, six sheep & beef nutrient management blocks, and one standalone cropping block for analysis using *Overseer Nutrient Budgets* (v 5.2.6.0). Three models were constructed for comparison (Dairy Platform, Sheep & Beef Unit, and Cropping Unit), with whole farm totals calculated by aggregating nutrient quantities on a whole of platform/unit basis. Overseer outputs presented in the Nutrient Management Map opposite.
- Assumptions, settings and inputs for the Overseer model have been signed-off as being true and correct to the best of the farmer's and consultant's knowledge at the time this report was prepared (see Appendices).
- Farm Dairy Effluent (FDE) production was evaluated independently by Dave Horne of Massey University (see Section 5.2.5), and results were used to tune the Overseer model for the Dairy Unit (the default drainage setting for the Effluent Block was increased from 439 mm to 549 mm to better represent volume of applied FDE and the risk of deep drainage).

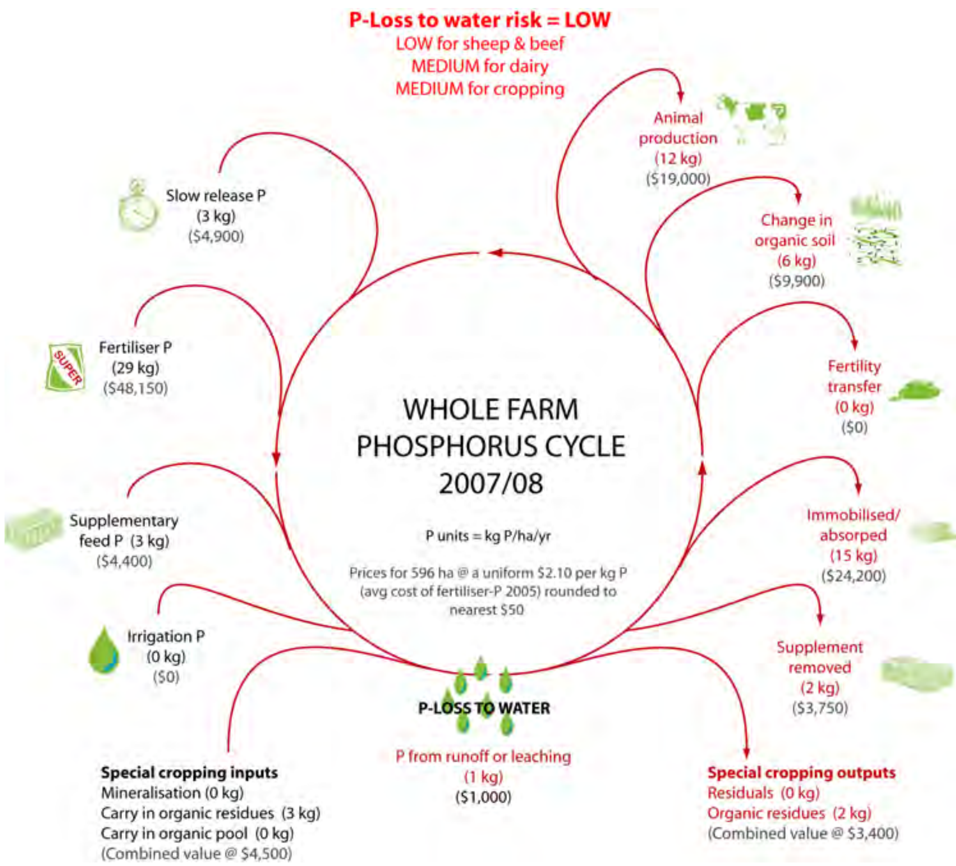
3.1 Nitrogen budget and N-losses

- **Dairy Platform**: **N-loss from the Dairy Platform is calculated at 17 kg N ha^{-1} year^{-1}**. Compared with other NZ dairy farms this is low (NZ average for dairy is 30-50 kg N ha^{-1} yr^{-1}), although it would be increased to 21 kg N/ha/yr if non-pastoral blocks were excluded. All blocks are likely to have drainage-water N concentrations well within drinking water standards (11.3 ppm) with the exception of the effluent block. Because such a large volume of effluent is being directed at such a small area, N-leaching loss is calculated as being high (57 kg N/ha/yr), and drainage-water N concentrations are just within recommended standards (10.1 ppm). Overseer recommends an effluent application area of 76 ha to achieve a 150 kg N/ha loading.
- **Sheep & Beef Unit**: **N-loss from the Drystock Unit is calculated at 12 kg N ha^{-1} year^{-1}**. This fits comfortably within the NZ average for sheep and beef farms (5-20 kg N ha^{-1} yr^{-1}). None of the blocks are likely to have drainage water with N-concentrations that exceed recommended drinking water standards. A low N-loss is partly explained by a low stocking rate (cf. dairy) and a predominance of sheep grazing, and the large area of imperfectly drained Marton soils (more atmospheric N-losses).
- **Cropping Unit**: **N-loss from the Cropping Unit is calculated at 24 kg N ha^{-1} year^{-1}**. This appears to be reasonably low. Likewise, N-concentrations in drainage water is also likely to be well below recommended drinking water guidelines.
- **Whole Farm**: **Whole farm N-loss averages out at 16 kg N ha^{-1} year^{-1}**. This is very low for what is effectively an intensive pastoral grazing system. Key reasons for a low N-loss include the averaging effect of including the Sheep & Beef Unit (see above), and a reasonably low stocking rate on the Dairy Platform (2.6 cows/ha) and the Sheep & Beef Unit.



3.2 Phosphorus budget and P-loss

- Overseer rates the risk of P-loss via runoff as LOW for the Sheep & Beef Unit (0.4 kg P/ha/yr) and MEDIUM for the Dairy Platform (1.4 kg P/ha/yr). P-loss from Overseer's cropping model is not rated, although P-loss via leaching or runoff is reported as 1 kg P/ha/yr (equivalent to MEDIUM risk). Both the River Block and the Effluent Block have EXTREME risk ratings (4.3 kg P/ha/yr) because of either high soil-P concentrations (River Block Olsen P = 72), or high effluent loading.
- On average, the whole farm would have a LOW P-loss risk rating (<1 kg P/ha/yr).



3.3 Faecal microbes and waterway contamination

- Risk of faecal microbes entering water was not assessed for Tutu Totara due to gaps in research understanding. While there is a body of research on the effectiveness of mitigation practices, the preliminary methods and models of quantifying pathogen risk are still in an early stage of development.
- Direct deposition of dung to streams can represent a disproportional and large source of faecal contaminants to surface water (cf. nitrogen). Excluding stock from waterways is therefore widely recommended as a chief mitigation option.
- Effluent application to land and artificial drainage are two indirect mechanisms linked to waterway contamination. Both involve water transporting pathogens to water bodies (either as runoff or drainage). Key mitigations known to be effective include planted riparian buffers, deferred effluent application, and strategic cattle access to poor draining soils (i.e. essentially any practice that minimises runoff or drainage, or avoids land contamination when runoff or drainage is likely to occur).

4.0 RESOURCE ASSESSMENT AND NUTRIENT LOSS TARGETS

4.1 Principles

Several catchments in the Manawatu-Wanganui Region have nutrient loads far higher than those required to meet community expectations. There is general agreement that these loads need to be reduced, but there is much disagreement over how it should be done.

An easy option is to apply a blanket N-cap to every farm in the catchment. However, this fails to recognise farm-to-farm differences in land use, the quality of land (productive potential), and the current use of mitigation practices. Through the FARM Strategy approach, a more equitable approach is proposed. At its heart is the identification of farm-particular nutrient-loss targets based on the capability and productivity of land, and the fact that **better land has a higher capacity to sustain high levels of production (i.e. it is more sustainable), relative to attempting comparable levels of production from low quality land by using excessive inputs inefficiently.**

Water quality targets have been related to land production-potentials using the Land Use Capability (LUC) system of land classification. This ranks land according to eight classes, where class 1 represents the most elite land, and class 8 land has very low productive value (e.g. bluffs, swamps, river beds, etc.). Nitrogen-loss targets by LUC class are included in the One Plan (Table 1 below), designed to be phased in over a twenty-year period. A farm's relative area of different LUC units will determine the level of N-loss that the farm needs to operate within to achieve catchment water quality targets.

Table 1: One Plan N-loss targets for LUC classes

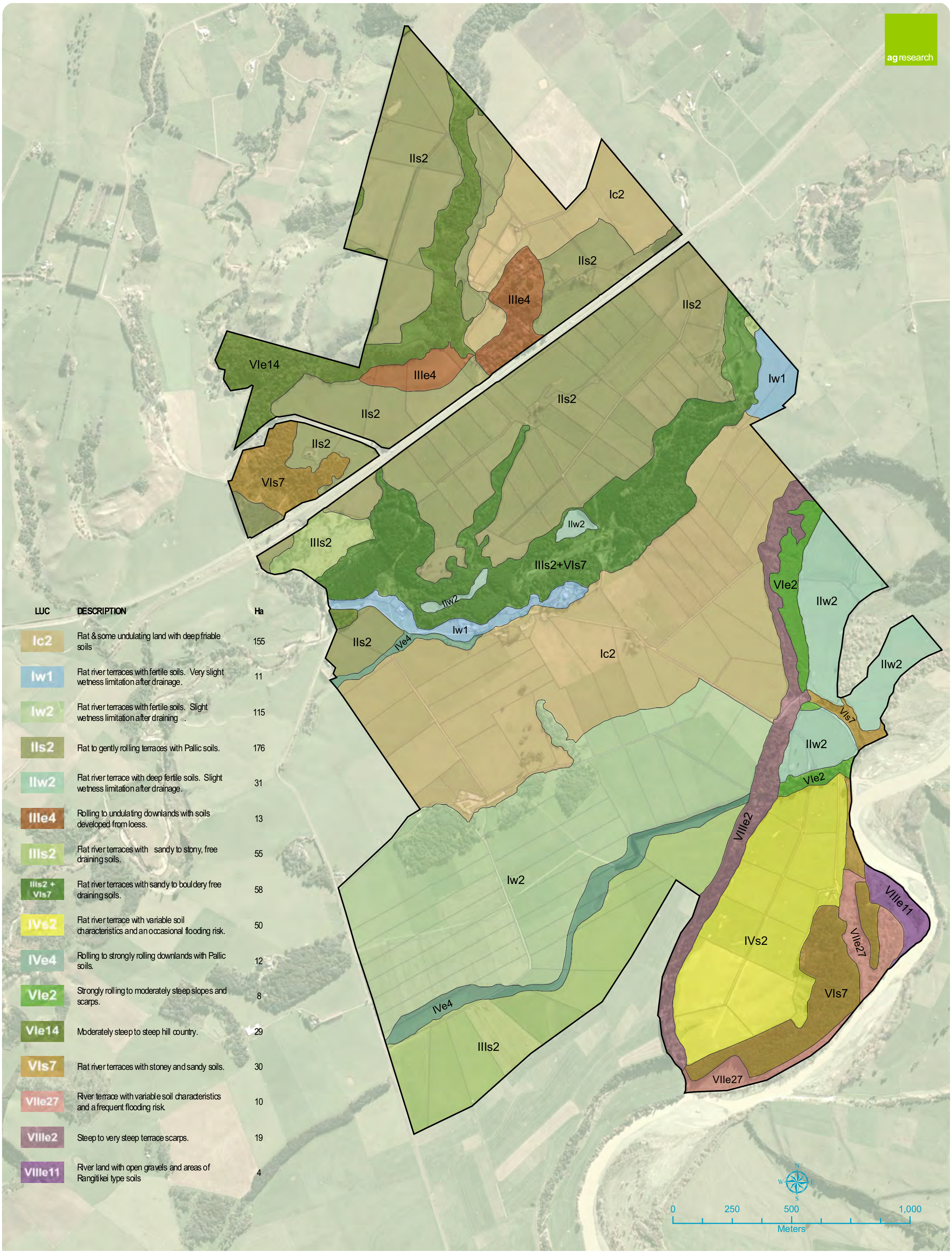
LUC	*N-loss targets (kg N ha^{-1} yr^{-1})*			
	YEAR_01	YEAR_05	YEAR_10	YEAR_20
I	32	27	26	25
II	29	25	22	21
III	22	21	19	18
IV	16	16	14	13
V	13	13	13	12
VI	10	10	10	10
VII	6	6	6	6
VIII	2	2	2	2

4.2 Land resource assessment

The land resource for Tutu Totara has been described and evaluated according to the Land Resource Inventory (LRI) and Land Use Capability (LUC) Classification. Survey was undertaken at a 1:8,000 scale. The LRI system involves mapping landscape units according to five inventory factors (rock type, soil unit, slope class, erosion type & severity, and vegetation).

LRI is then classified as LUC, which further groups similar units according to their capacity for sustainable production under arable, pastoral, forestry or conservation uses. The LUC code (e.g. 6e7) indicates *general capability* (1-8 classes), the *major limitation* (4 subclass limitations of **w**etness, **e**rosion, **s**oil and **c**limate), and the *capability unit* to link with units with similar management requirements and production opportunities. Note that the capability units used in this report are specific to Tutu Totara farm. A correlation with regional equivalents is presented in Table 2 in the *rLUC* column.

Land Use Capability is presented over the page. Description of the land resource by LUC is summarised as Table 2. N-loss targets for Tutu Totara have been calculated and presented on page 16.



FARMS

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LAND USE CAPABILITY

Tutu Totara Farm

Porewa, Marton

Survey and classification by Landvision Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

TABLE 2: Land resource description by LUC unit

	FARM LUC	Ha	DESCRIPTION	rLUC	ROCK	SOIL*	SLOPE	VEGETATION	EROSION	TARGET N-LIMIT**
	1c2	151	Flat to gently undulating terraces with deep friable soils.	Ic2	Deep loess and loess over gravel	Ref #7 & #10	0-7^{0}	Improved pasture	Nil	**32 kg N/ha/yr** (4841 kg N per LUC area)
	1w1	11.3	Flat river terraces with fertile soils which have only a very slight wetness limitation remaining after drainage	Iw1	Alluvium	Ref #11	0-7^{0}	Pasture	Nil	**32 kg N/ha/yr** (360 kg N per LUC area)
	1w2	115	Flat terrace with fertile soils that have just a slight wetness limitation after drainage.	Iw2	Old alluvium and loess over gravels	Ref #7	0-7^{0}	Pasture	Nil	**32 kg N/ha/yr** (3678 kg N per LUC area)
	2s2	180	Flat to gently rolling terraces with yellow-grey earth soils developed on loess.	IIs2	Old alluvium and loess over gravels	Ref #8 & #14	0-7^{0}	Pasture	Nil	**29 kg N/ha/yr** (5208 kg N per LUC area)
	2w2	30.8	Flat river terrace with deep fertile soils. A slight wetness limitation remains even after drainage.	IIw2	Fine alluvium	Ref #4, #6, #12	4-7^{0}	Pasture	Nil	**29 kg N/ha/yr** (911 kg N per LUC area)
	3e4	13.2	Rolling to undulating downlands developed from loess.	IIIe4	Loess and loess over gravel	Ref #14	4-17^{0}	Pasture, forestry or bush	Nil	**22 kg N/ha/yr** (291 kg N per LUC area)
	3s2	54.6	Flat river terraces with sandy to stony free draining soils.	IIIs2	Old alluvium and loess over gravels	Ref #1, #2, #9	0-7^{0}	Pasture	Nil	**22 kg N/ha/yr** (1201 kg N per LUC area)
	3s2 + 6s7	58.3	Flat river terraces with sandy to bouldery free draining soils. Topsoil depth varies considerably	IIIs2 + VIs7	Old alluvium & gravels, grading down to more recent alluvium	Ref #1, #2	0-7^{0}	Bush & pasture	Nil	**22 kg N/ha/yr** (1283 kg N per LUC area)
	4e4	12.4	Rolling to strongly rolling downlands with yellow-grey earth soils developed on loess.	IVe4	Old alluvium and loess over gravels	Ref #7, #9	16-20^{0}	Pasture	Nil	**16 kg N/ha/yr** (199 kg N per LUC area)
	4s2		Flat river terrace formed from alluvial soils with varying degrees of texture/ Prone to occasional flooding.		Alluvium over gravels	Ref #1, #2, #3	0-7^{0}	Pasture	Minor deposition	**16 kg N/ha/yr** (799 kg N per LUC area)
	6e2	8.3	Strongly rolling to moderately steep short slopes and terrace scarps. Unit has yellow grey earth soils and yellow brown earths derived from loess.	VIe2	Variable (loess, sandstone, greywacke)	Ref #9 & #15	16-25^{0}	Pasture, bush, forestry	Parts with minor soil slip and gully erosion	**10 kg N/ha/yr** (83 kg N per LUC area)
	6e14	28.9	Moderately steep to steep hills of moderately consolidated and unconsolidated sandstone mantled with loess	VIe14	Loess over sandstone & gravels	Ref #14	21-25^{0}	Bush, forestry, pasture, scrub	Nil	**10 kg N/ha/yr** (289 kg N per LUC area)
	6s7	80.4	Flat river terraces with alluvial soils varying in texture from course sandy to bouldery.	VIs7	Alluvium over gravels	Ref #1, #2	0-7^{0}	Pasture, forestry, bush	Minor streambank erosion + flood deposition	**10 kg N/ha/yr** (304 kg N per LUC area)
	7e27	10.1	Rapidly accumulating river terrace prone to frequent flooding.	VIIe2 7	Alluvium and gravel	Ref #1, #2	8-15^{0}	Forestry, lupins	Minor deposition	**6 kg N/ha/yr** (61 kg N per LUC area)
	8e2	18.9	Steep to very steep inter-terrace sidlings.	VIIIe2	Sandstone, gravels, greywacke	Ref #15 + bare rock	26-35^{0}	Bush & scrub	Minor soil slip	**2 kg N/ha/yr** (38 kg N per LUC area)
	8e11	4.2	River land	VIIIe1 1	Gravel & alluvium	Bare rock & Rangitikei soils	0-3^{0}	Bare rock, lupins, etc.	Severe streambank & deposition	**2 kg N/ha/yr** (8 kg N per LUC area)

* Soil reference descriptions included in the appendices.

** Permissible N-loss limits proposed in the One Plan for Year 20 (see Table 1). Refers to N-losses from leaching.

4.3 N-TARGETS for Tutu Totara Farm

To remain compliant under the One Plan, Tutu Totara Farm is required to operate within the N-loss limits described below (Table 3). They represent the maximum permissible N-loss from leaching and runoff beginning 1st April 2014. N-targets will not change over the 20 year period unless Land Use Capability changes (unlikely). Calculation uses the same land area used for the Overseer analysis.

Table 3: Permissible N-loss limits for Tutu Totara (N-targets)

	Year	2014	2019	2024	2034
N-target (kg N/ha/yr)	*Dairy Platform*	25	22	20	20
	Sheep & Beef Unit	24	21	19	19
	Cropping Unit	30	26	23	22
	Whole farm	**25**	**22**	**20**	**20**

4.4 Implications

4.4.1 Farm unit N-targets

Current N-loss from the three units are compared against permissible N-loss in Table 4. Note that a uniform N-loss across all years assumes a matched balance between current intensification trends and the development of mitigation technologies. Current N-loss across all units is comfortably within immediately pending N-limits, although the cropping unit will be slightly above when longer timeframes are considered. For the short term, Tutu Totara is not required to implement any new N-mitigation practices specifically to reduce N-loss.

Table 4: N-loss reductions required by farm unit

	Year	2014	2019	2024	2034
Dairy Platform	Current N-loss (kg N/ha/yr)	17	17	17	17
	Permissible N-loss (kg N/ha/yr)	25	22	20	20
	Required reduction (kg N/ha/yr)	***Nil*** *(8 kg in credit)*	***Nil*** *(5 kg in credit)*	***Nil*** *(3 kg in credit)*	***Nil*** *(3 kg in credit)*
Sheep Beef Unit	Current N-loss (kg N/ha/yr)	12	12	12	12
	Permissible N-loss (kg N/ha/yr)	24	21	19	19
	Required reduction (kg N/ha/yr)	***Nil*** *(12 kg in credit)*	***Nil*** *(9 kg in credit)*	***Nil*** *(7 kg in credit)*	***Nil*** *(7 kg in credit)*
Cropping Unit	Current N-loss (kg N/ha/yr)	24	24	24	24
	Permissible N-loss (kg N/ha/yr)	30	26	23	22
	Required reduction (kg N/ha/yr)	***Nil*** *(6 kg in credit)*	***Nil*** *(2 kg in credit)*	***1 kg N/ha*** *reduction required*	***2 kg N/ha*** *reduction required*

4.4.2 Whole farm N-targets

Unit N-loss was aggregated as an estimate of whole farm N-loss (16 kg N/ha/yr) and compared against whole farm N-targets (Table 5). Tutu Totara is consistently within acceptable N-loss tolerances for the full 20 years of interest. This demonstrates the effect of averaging N-loss across a greater area relative to low initial N-losses. Again, provided N-loss does not increase substantially over the next 20 years, then no special N-management actions would be required. From a nutrient perspective the property is fully compliant under the One Plan. However, while N-losses may be within N-targets, this does not necessary mean the uptake of N-mitigation practices should be completely ignored.

Table 5: N-loss reductions required for whole farm

Year	*2014*	*2019*	*2024*	*2034*
Current N-loss (kg N/ha/yr)	16	16	16	16
Permissible N-loss (kg N/ha/yr)	**25**	**22**	**20**	**20**
Required reduction (kg N/ha/yr)	***Nil*** *(9 kg in credit)*	***Nil*** *(6 kg in credit)*	***Nil*** *(4 kg in credit)*	***Nil*** *(4 kg in credit)*

4.4.3 Intensification trends

Substantial buffering between current N-loss and permissible N-loss limits means that whole farm N-loss can legally increase under the One Plan. Conceivably it can also increase further if sufficient mitigation options are available to offset larger N-losses. However, the previous comparisons assume no change in N-loss over the 20 years of interest. This may or may not be a valid assumption (e.g. future technology may offset any additional N-loss increases, or perhaps future political changes or market fluctuations may discourage current N-fertiliser and intensification trends – 20 years is too long to make valid predictions). However, going with current trends, it would not be unlikely or irresponsible to suggest that Tutu Totara could become more intensive over the short to medium term, with a potential increase in N-loss.

Expanding the dairy platform is currently being considered by the farmer as an intensification option. Initially it was proposed to expand the herd from 800 cows to 1100 cows. Production feasibility was evaluated by Chris Lewis at Baker and Associates using the Udder production simulation model. Udder model outputs were provided, and used in Overseer to assess potential nutrient loss implications. Key changes and parameters include:

- *Cow numbers increase from 800 to 1100.*
- *Milksolids increase from 347,301 to 466,639 kg MS.*
- *Dairy unit expanded by 34 ha (Cropping Unit decreases by 34 ha).*
- *25% of replacements grazed off. Assumes no change to heifer numbers grazed on the sheep beef unit (i.e. balance is grazed at another location).*
- *Wintering off (400 grazed on sheep beef unit; 700 remain on farm).*
- *Effluent set up remains unchanged.*
- *Assumed urea use increases proportionally with stock numbers from 220 kg urea/ha up to 286 kg urea/ha (30% increase). Winter N also increased 30% from 50 kg N up to 65 kg N.*
- *Other fertiliser use remains unchanged.*
- *500 tn wheat grain fed on feed pad.*
- *103 ton DM maize grain onto feed pad.*
- *720 tn DM silage harvested on-farm. Assumed 352 tn fed on wintering pad, and 368 tn fed on paddocks.*

N-losses from the Dairy Platform would increase to 25 kg N/ha/yr. Losses on a per hectare basis for the other units remain unchanged. Implications are not particularly dramatic (Table 6), particularly when viewing the farm as a whole. N-limits are consistently balanced or in credit for the first year of implementation, but reductions would be required over the long term for the dairy on a unit-by-unit basis. However, because the property is being assessed on a whole-of-farm basis, results suggest that no mitigations would be required provided that N-loss does not change significantly over the next 20 years. Even if N-loss does increase, this property has a variety of mitigation options available.

Table 6: N-loss reductions required under a 1100 cow scenario

	Year	*2014*	*2019*	*2024*	*2034*
Dairy Platform	Current N-loss (kg N/ha/yr)	25	25	25	25
	Permissible N-loss (kg N/ha/yr)	25	22	20	20
	Required reduction (kg N/ha/yr)	***Nil*** *(balanced)*	***3 kg N/ha*** *reduction required*	***5 kg N/ha*** *reduction required*	***5 kg N/ha*** *reduction required*
Sheep Beef Unit	Current N-loss (kg N/ha/yr)	12	12	12	12
	Permissible N-loss (kg N/ha/yr)	24	21	19	19
	Required reduction (kg N/ha/yr)	***Nil*** *(12 kg in credit)*	***Nil*** *(9 kg in credit)*	***Nil*** *(7 kg in credit)*	***Nil*** *(7 kg in credit)*
Cropping Unit	Current N-loss (kg N/ha/yr)	24	24	24	24
	Permissible N-loss (kg N/ha/yr)	30	26	23	22
	Required reduction (kg N/ha/yr)	***Nil*** *(4 kg in credit)*	***Nil*** *(1 kg in credit)*	***1 kg N/ha*** *reduction required*	***2 kg N/ha*** *reduction required*
Whole farm	Current N-loss (kg N/ha/yr)	20	20	20	20
	Permissible N-loss (kg N/ha/yr)	30	26	23	22
	Required reduction (kg N/ha/yr)	***Nil*** *(10 kg in credit)*	***Nil*** *(6 kg in credit)*	***Nil*** *(3 kg in credit)*	***Nil*** *(2 kg in credit)*

5.0 MANAGEMENT OPTIONS FOR MITIGATING N, P AND BUGS

5.1 Existing practice

Tutu Totara Farm is already implementing a variety of environment-improving practices, some of which include:

- Stock are excluded from all dairy waterways and 70% of sheep and beef waterways.
- Use of the feed pad, and grazing part of the herd off during winter.
- The farm is already well served with bridges and culverts.
- The property has large indigenous forest areas, either fully protected from grazing stock, or partially protected by intermittent grazing.
- Considerably use of high-energy low-N supplementary feeds (maize grain).

Existing practices that mitigate N-loss, P-loss or faecal microbe contamination of water, will need to continue as part of this FARM Strategy (see Section 6.3.1).

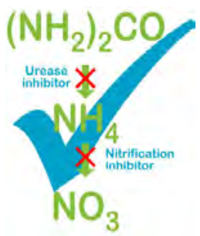
5.2 Additional mitigation options

The previous section compared current N-loss against N-loss targets. The farm is operating well within N-loss limits under the One Plan, and no special N-mitigations or management changes are required. However, this does not negate voluntary adoption of practices that are known to mitigate N, P and bug contamination of waterways. Further, mitigations may be required as the farm intensifies, or they may be a non-negotiable requirement under a different part of the One Plan (see Section 6).

A range of recognised best practices have been listed and rated in terms of relevance to Tutu Totara Farm (Table 8, opposite). Those with the highest relevance are evaluated further according to potential effectiveness and cost. Note that the listed mitigation practices are generally geared towards nitrogen, but with a recognition that many also affect P-loss, faecal microbes, and sediment loss. Recommendations are made on relevance, cost and potential effectiveness.

5.2.1 Urease and nitrification inhibitors

Inhibitors interrupt urea-nitrogen transformation processes. Urease inhibitors work on the first part of the transformation by restricting the conversion of urea to ammonium (thereby restricting the amount of ammonium available for the second key transformation). Nitrification inhibitors operate on the second transformation by interrupting the microbial conversion of ammonium to nitrite then to nitrate. In effect both inhibitors reduce the amount of nitrate-N in soil, which is the main type of N associated with leaching. Recent studies report significant leaching-loss reductions of 30-80%, and improved pasture yields of around 5-20%.



Proposal: To replace the current urea fertiliser product with a urease inhibitor urea-product for all pastoral blocks, and to spray dairy pasture with a nitrification inhibitor according to manufacturer recommended rates and timings.

Effectiveness: While there is a rapidly growing body of research on the effectiveness of inhibitors, it is difficult to predict with any certainty how well they will perform on any given farm at any point in time. For the interim, and for Tutu Totara farm given its location and climate, we suggest a conservative 15% reduction in the leaching/runoff calculated by Overseer as an approximation of inhibitor effectiveness. **Adopting the use of inhibitors is estimated to decrease N-loss by 1.4 kg N ha^{-1} yr^{-1}.**

Implications & cost: Approximately 442 ha of pastoral land currently receives a combined total of 125 tn/urea (average of 282 kg/ha), which at $1.43 per kg of urea applied equates to $178,000 total cost. A shift to urease-treated urea at $1.67/kg applied, would cost an estimated $207,900. The increase is an extra $30,000 per year. Spraying nitrification inhibitors twice per year across 287 ha of the dairy unit at $148/ha (applied) is estimated to cost $42,480. Combined, total on-the-ground cost of adopting both urease and nitrification inhibitors is estimated at $72,250/yr.

Assuming an average $0.26 average value for every extra kg DM grown ($0.08/kg DM for sheep & beef over 155 ha and $0.35/kg DM for dairy over 287ha), then the average response to break even would only need to be 5.42% (i.e. an extra 630 kg DM/ha/yr averaged over 442 ha). Potential returns at different responses are presented as Table 7.

Table 7: Potential returns at increasing inhibitor response rates

Response	Extra kg DM/ha[a]	Kg DM @ 442 ha	Value ($/kg DM)[b]	Gross revenue
5%	580	256360	$0.26	$ 66,654
10%	1160	512720	$0.26	$ 133,307
15%	1740	769080	$0.26	$ 199,961
20%	2320	1025440	$0.26	$ 266,614

a Using 11.6 tn/ha/yr for current pasture production
b Average value at $0.26/kg DM using $0.08/kg DM value for sheep and beef and $0.35/kg DM for dairy (averaged by respective areas)

Recommendation: Consider using inhibitors. Recent research suggests this could result in reduced N-leaching losses and improved pasture responses (amongst other things). Conservatively we estimate an N-loss reduction of at least 1.4 kg N/ha/yr, with the extra cost of inhibitors being offset by pasture yield gains. Further, if pasture response rates achieved at certain research sites are applicable to Tutu Totara, then a switch to inhibitors may result in even more substantial revenue gains.

TABLE 8: Relevance of common N-loss mitigation options (+ P-loss & faecal microbes)

MITIGATION OPTIONS	Issue & ranking[1]	Relevance or opportunity	NOTES
Mitigation options captured by Overseer			
Avoid winter (May, June or July) N-applications	N	HIGH	Dairy unit receives 50 kg N/ha/yr during winter
Ensure effluent application area is large enough to keep loading <150kg N/ha/yr	N, bugs, P	HIGH	Current effluent area results in loads far greater than 150 kg N/ha/yr
Avoid winter effluent applications	N, bugs, P	LOW	Given the soil characteristics and reasonable low annual recharge rates, deferred irrigation is unlikely to be necessary. However, it is acknowledged that production responses of using effluent would be greater outside of the winter months.
Use supplements with N-concentrations that are lower than pasture (or higher energy content - e.g. maize)	N	LOW	Currently use a high proportion of high-E low-protein supplement in the form of maize silage.
Replace fertiliser N with equivalent supplement-N	N	LOW	Cannot be used strategically to target periods of growth when N is most needed.
Ensure other nutrients are non-limiting (optimal) for max yield per kg N input	N	LOW	Soil tests indicate levels for major nutrients are near optimum or above.
Decrease use of N-fertiliser	N	LOW	While urea rates are high, current N-loss is well within permitted N-limits. Reducing current rates would have implications for current production levels.
Decrease stocking rate	N, bugs	LOW	Stocking rate is not particularly high (2.6 cows/ha).
Change stock type or class	N	LOW	Not suitable. Already have a variety of land uses and stock types.
Reduce imports of supplementary feed	N	LOW	Reductions have major implications for current levels of production, and given that current N-loss is within N-limits, feed reductions are not necessary.
Graze cattle off during winter (May, June, July)	N, bugs, P, sed	LOW	All ready practiced with 50% of herd.
Use a sealed wintering/standing pad with effluent collection and storage system	N, bugs	LOW	All ready practiced with 50% of herd.
Increase supplement exports off farm	N	LOW	Not financially prudent at current time.
Other mitigation activities			
Time N-fertiliser application for periods when N demand is greatest[2]	N	LOW	Already practiced[4].
Avoid high-rate, single dressings of N-fertiliser. Use split dressings (20-50kg N/ha per dressing)	N	LOW	Already practiced[4].
Adjust N-fertiliser rates & timings seasonally to respond to actual or expected production demand (seasonal variations)	N	LOW	Already practiced[4].
Use an N-fertiliser product with an N-uptake efficiency that is better than the current N-product	N	LOW	Urea is a cost effective source of fertiliser-N. However, see note on urease treated urea below.
Avoid N-applications when soils are saturated (leaching/runoff & low plant activity).	N	LOW	Already practiced[4].
Avoid N-applications during excessive dry periods (plant N-uptake low)	N	LOW	Already practiced[4].
Delay N-applications directly after dry periods until pastures have started recovering	N	LOW	Already practiced[4].
Ensure an adequate buffer distance from waterways when applying fertiliser[3]	N, P	LOW	Already practiced[4].
Use urea product treated with urease inhibitor	N	HIGH	Proven potential to reduce N-leaching but degree of effectiveness likely to be lower in the Marton area (relative to colder areas in the region).
Ensure you can actually use the extra grass grown when N-fertiliser is used	N	LOW	Already practiced[4].
Spray nitrification inhibitor according to manufacturer recommended rates and timings, particularly on highly stocked areas (e.g. camps)	N	HIGH	Proven potential to reduce N-leaching but degree of effectiveness likely to be lower in the Marton area (relative to colder areas in the region).
Ensure effluent storage facilities do not overflow (part. winter)	N, bugs, P	HIGH	Current sump capacity is insufficient and overflow occurs, particularly when there is a pump failure
Use adequate buffer distance from waterways when applying effluent (+20m)	Bugs, N, P	LOW	Low relevance with existing system.
Other best management works			
Ensure all paddocks are supplied with adequate troughs or dams	Bugs, N, P, sed	LOW	Farm owner has assured that all paddocks have reticulated stock water
Replace fords with bridges or culverts	Bugs, sed, N, P	HIGH	There are two major stock-fords on the sheep and beef unit, likely to be subject to high stock-crossing densities at certain times of the year
Exclude stock from flowing waterways by fencing	Bugs, sed, N, P	MEDIUM	Only a small proportion of sheep & beef streams are currently unfenced (~30%), most of which fall within intermittently grazed areas
Create wetland attenuation zones where runoff converges	Bugs, sed, N, P	LOW	However, the ungrazed boggy area below the feed pad could be developed into a receiving wetland to offset risks associated with effluent overflow
Create riparian attenuation zones wider than 10-30m	Bugs, sed, P, N	LOW	Most riparian areas are already fenced and well vegetated. Where not fenced, the gains would likely be small, and a more logical option may be to retire bush areas adjacent to streams
Ensure runoff from tracks/lanes is not channelled into streams near crossings	Bugs, sed, N, P	LOW	Generally adequate to good lane & drainage designs
Ensure there are no major leaks in the effluent irrigation system (e.g pipe joins).	N	LOW	The effluent line was examined and there was no evidence of major leaks
Invest in a high efficacy effluent treatment/disposal system (e.g. digesters)	N, bugs, P	LOW	For this farm there are many other lower cost options.
Ensure runoff from yards, feed pads, etc. does not go directly into waterways	Bugs, N, P, sed	HIGH	Dairy: Effluent sump overflow discharges to a 'drain to no where' (i.e. effectively a discharge to land), which is not a recognised concern. Sheep yards: Runoff and (artificial) drainage from the sheep yards both represent discharges to the adjacent Porewa Stream.
Ensure effluent storage facilities are sealed	N, bugs	LOW	Effluent sumps are sealed concrete
Ensure effluent storage facilities are of a sufficient size	N	HIGH	Current sump capacity is insufficient and overflow occurs, particularly when there is a pump failure
Store leakable supplementary feeds (e.g. silage) on a sealed base with an effluent collection/storage/disposal system	N	LOW	Maize silage is stored in a concrete bunker and silage effluent enters the main effluent disposal system

[1] ***N***= *nitrogen loss,* ***P***= *phosphorus loss,* ***bugs*** *= faecal microbes,* ***sed*** *= sediment*

[2] *When pastures are higher than 25mm or 1000kg DM/ha, are actively growing, when soil temp >6degrees*

[3] *See formulas in Spreadmark code of practice*

[4] *Based on farmer assurance. Cannot be assessed conclusively within project limits. Assumed compliant until proven otherwise.*

5.2.2 Control sheep-yard runoff

The manager of Tutu Totara agreed to have compliance requirements evaluated for the entire farm, rather than just the intensive blocks. This implicates the sheep yards, which are located on a downward slope directly adjacent to the Porewa Stream. The yards border along the stream bank, with most runoff converging at a low point just below the dip crush and main drafting area. Some of the yard area is also drained with novaflow pipe, with the outfall exiting directly above (and into) the stream. Yard effluent and excess dip-wash are both likely contaminate water (faecal bug contamination would be a particular concern), particularly during high rainfall events. As an intensive-farming compliance consideration these discharges are not permitted under the One Plan.

There is no easy solution. One option is to reconfigure and seal part of the yards so runoff and drainage can be intercepted, and redirected for storage, treatment or disposal (just like a dairy yard system). Other than that, the yards would probably need to be relocated. While this could be perceived as being overly excessive, it should be remembered that high stock densities pass through the yards on an annually basis, and dung and urine contributions from a large number of animals are being concentrated into a small area.

Proposal: Seal the lower end of the yards with concrete, install an open sealed-drain running the length of the top yard, and install a sump for temporary collection of effluent and runoff to be irrigated or pumped to a storage pond.

Effectiveness: It is difficult to estimate contributions from yard runoff without knowing when and how many stock pass through the yards in question. However, consider a once-off situation where 800 ewes are penned for half a day. If each ewe urinated once, then there would be around 1 kg N deposited on what is essentially an impervious surface (at 1.2g N/urine patch or an equivalent rate of 500 kg N/ha. N contribution from dung not included). If this occurred over a runoff event, then it is not unreasonable to propose that the full 1 kg of N would enter the adjacent waterway. Even if runoff events were infrequent and atmospheric losses were high (say 70%), then there would still be the potential loss of around 0.3 kg N for every 800 stock units that are in the yards long enough to urinate. Depending annual stock flow volumes, this could easily amount to several kilograms of N-loss from the yards each year. Also of concern is the risk of faecal microbes, phosphorus and sediment – both the source potential and transport mechanism associated with the yards would likely facilitate high contaminant loads entering the receiving creek.

Implications & cost: A sheep-yard effluent treatment system is difficult to cost because they are not particularly common. A specialist would need to examine the site in question. As a preliminary ball-park estimate, a system to treat sheep-yard effluent may cost around $5,000 to $10,000 to establish. Note that storm-water from the woolshed and the race shading structure will need to be collected separately and discharged to land (i.e. guttering and downpipes are required).

Recommendation: To seek clarification from Horizons Regional Council, firstly to affirm yard that runoff does actually need to be controlled for compliance, and secondly to find out if any other mitigation options might be possible. Failing that, look to engage the services of a specialist to design and construct a sheep-yard effluent treatment system. Also note that managing yard effluent could be required under Rule 13-27 (discharges to land or water not covered by other rules) irrespective of Rule 13-1.

The yards slope downwards, and runoff converges at a natural low point in the background, where it can flow directly into the stream.

In-race dip sprayer, where excess wash is not managed. Porewa Stream is just over the left fence (downslope <10m from the sprayer).

Nova Flow pipe running beneath the yards, and exiting directly over Porewa Stream.

5.2.3 Fence waterways

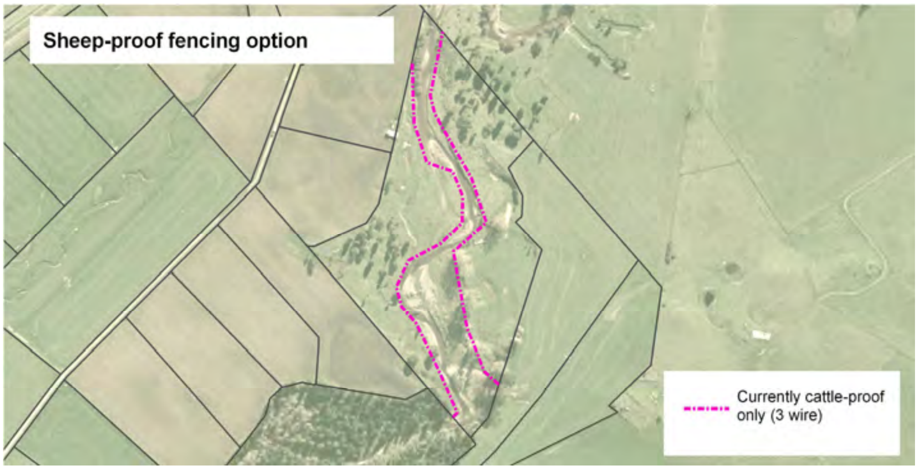
Direct access of stock to waterways amplifies the risk of contamination by faecal microbes, and to a lesser extent, the contribution of nutrient to water. Both the dairy industry and Horizons Regional Council are aiming to have appreciable streams on all dairy farms excluded from the grazing rotation. Currently all streams on Tutu Totara's dairy unit are fenced. Three proposals are put forward for unprotected waterways on the sheep and beef unit.

Proposal 1: Upgrade fencing in the paddock where the Porewa Stream enters the farm to make it sheep-proof (map below). The stream is currently fenced but with only three wires.

Effectiveness: Likely to be minor because the area is not intensively grazed, and sheep do not exhibit the same level of water-contamination risk relative to cattle.

Implications & cost: An extra two wires on each side of the stream (600m x2 wires x2 sides) equates to an estimated $300 for materials and labour (2.4 km of 12.5 gauge wire at $100/coil and 650m/coil = $200 plus half a day labour). Revenue losses associated with reduced area of production are likely to be negligible.

Recommendation: Fully exclude stock from the paddock where Porewa Stream enters the farm by upgrading the stream fencing.



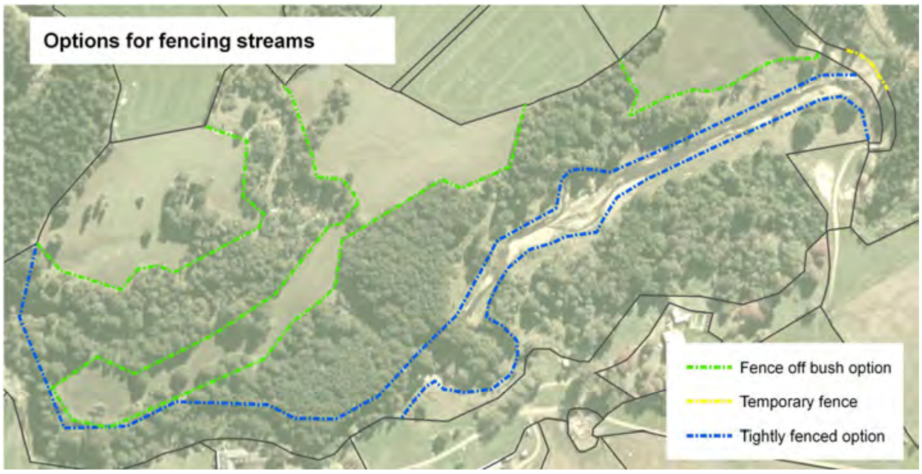
Proposal 2: Exclude stock from the intermittently grazed area that is located down from the Porewa Stream farm bridge (map below). Two options are considered, including fencing off the bush areas (~12 ha, 1.6 km of sheep-proof fence), and cattle-only grazing with semi-permanent 2 wire electrics that tightly parallel the stream (1.8 km of cattle-proof fencing).

Effectiveness: Likely to be minor because the area is not intensively grazed.

Implications & cost: Fencing off bush areas is estimated at $11,900 (1.6 km of 7-wire fencing system at 7.60/m), while tightly fencing the stream with a two-wire waratah system is estimated to cost $7,920 (1.8 km 2-wire electric at $4.40/m). The tightly fencing option would likely need to be replaced every five years because of flooding.

Implications for production are difficult to gauge. While a degree of grazeable pasture would be lost, low fertility and shading means the actual production loss from the area would be small. However, there is an important strategic value of grazing beneath trees which is difficult to calculate (e.g. emergency feed, or as an area to temporally hold sheep after shearing if bad weather is experienced).

Recommendation: Fence off the bush areas. This will achieve compliance while retaining open pasture, and protect the bush areas from further grazing damage. A degree of stock protection will still be available from the trees, and the cost of investment ($12,000) would be recovered after three years (6 ef ha @ ~8 t DM/ha/yr and $0.08/kg DM = ~$3,850/yr gross).



Proposal 3: Consider extending the stream-fencing further up the non-perennial 'suspect' stream near the main road (map below). This is an unusual stream in that it exhibits features that suggest a considerably greater volume of water should be flowing. It effectively represents a series of deep ponds interconnected with the smallest of trickles (at the time of examination), and does not therefore qualify as a targeted stream under the One Plan. However, it does represent a 'water body' subject to contamination by stock, particularly around the stock camp area (the trees near the bridge).

Effectiveness: Impact on improving water quality is likely to be small over-all, due to the predominant stock type (sheep), and because tile outfalls discharge drainage from the surrounding terraces (fencing will not reduce nutrient and faecal bug loads associated with artificial drainage).

Implications & cost: A suggested design is 4-wire electrics (sheep proof) that tightly parallel the stream, thereby leaving a large proportion of land between the stream and the existing fence available for grazing (access across the existing culvert/bridge). Approximately 0.9 km of fencing is required, which equates to an estimated cost of $4,680 at $5.20/m.

Area of land retired would be around 0.4 ha (i.e. fenced area less the area of a uniform stream width of 2m). Assuming pasture yields of 11.6 t DM/ha and a $0.08/kg DM value, then gross revenue could decrease by approximately $370.

Recommendation: Consider fencing what appears to be a non-perennial stream. Please also note that this stream extends further across the property, and it is possible that the entire length of stream could be more perennial than evidenced on the day of examination.

5.2.4 Decommission stock fords

Fords and crossings can result in water contamination through direct defecation of stock to water, and turbidity exacerbation as stock shift sediment into the stream, and stir up sediment already in the bed. Two fords are evident on the farm, one of which has recently been levelled to improve access (see photos). Both are adjacent to bridges. It is assumed that the fords are used for heavy machinery and stock.

Proposal: To decommission the use of fords for stock crossings (but keep for heavy machinery).

Effectiveness: Under the current system losses of N & P from direct defecation would be minor. Reduction in faecal contaminants would be higher, but still small on a whole-farm basis.

Implications & cost: Any fencing costs are built into the estimates given in previous section 5.2.3. No other financial costs would be likely. However, it is acknowledged that directing all stock across the bridges carries a risk, particularly with young stock baulking and smothering (i.e. lambs).

Recommendation: That the fords be decommissioned from stock use. Environmental enhancements would be minor, but this is a non-negotiable requirement under the One Plan (see section 6).

Ford across the Porewa Stream.

Ford across the 'suspect' stream

Bridge adjacent to the ford that crosses the non-perennial stream

5.2.5 Improve Farm Dairy Effluent (FDE) management

Currently all Farm Dairy Effluent (FDE) is collected in a sump system and is sprayed to land daily via a travelling irrigator. Total effluent area is 13.8 ha, sump capacity is estimated at 60 m^3, and the combined catchment area of the yards, silage bunker, sumps, milking parlour roof (no guttering) and feed pad was measured at 4758 m^2 from high resolution ortho-photography. Problems were evident (e.g. sump overflow), and greater inefficiencies were suspected. An effluent systems specialist (Dave Horne from Massey University) was contracted for independent assessment of FDE production, and the application of FDE to land.

FDE production was modelled yearly for ten years using climate data from a local weather station. Average FDE production was estimated at 28,493 m^3/yr (78 m^3/day). This is a disproportionately large volume, most of which is attributable to catchment area size (particularly with the inclusion of both the feed pad and silage bunker runoff), and high shed water usage (100 l/cow/day which is double the recommended 50 l/cow/day used for design purposes). Daily volume (78 m3/day over 365 days) is likely to be far greater during the milking season (i.e. 105 m^3/day over 271 days), both of which far exceed sump storage capacity (60 m^3) should the pump fail. Improvements are possible by managing shed storm-water (see Section 6.3.2), improved wash-down efficiencies (e.g. scraping), and expanding effluent storage capacity.

Successive soil-water balances over 10 years indicated that the volume of FDE applied to the effluent application area (13.8 ha) is excessive. Deep drainage is likely to increase from a background 390 mm/yr to 549 mm/yr (an extra 159 mm), thereby increasing the risk of N-leaching losses. Preferential flow through the soil is unlikely to be a problem, so deferred irrigation of effluent may not be necessary with these particular soils. However, a degree of effluent storage could be useful to delay irrigation of FDE during periods of heavy rainfall (3-4 days storage capacity), and a larger effluent application area would decrease the risk of deep drainage. Increasing the area to 60 hectares would allow the FDE application rate to decrease down to 47 mm/yr, and the risk of FDE being lost via deep drainage would be reduced to 13 mm/yr.

Proposal: The proposal has three parts: 1) Construct an effluent pond with sufficient capacity to hold 4 days of effluent during peak milking, 2) Enlarge the effluent application area to 60 ha, and 3) Reduce water consumption by adopting improved wash-down practices.

Effectiveness: Enlarging the effluent application area and reducing drainage in Overseer suggests N-leaching can be reduced by 37 kg N/ha for the Effluent Block (57 kg N/ha down to 20 kg N/ha). However, despite being a sizeable improvement on a block basis, the reduction averages down to 1 kg N/ha/yr across the Dairy Platform, and the whole-of-farm N-loss remains unchanged (i.e. stays at 16 kg N/ha/yr). Scraping prior to wash-down could potentially reduce this further. If manufacturer claims are to be believed, scraping can reduce water usage by up to 60%. At the current 100 l/cow/day, this would potentially reduce total FDE production by 54% (15,485 m^3/yr). Total N applied would probably not change significantly, but the risk of deep drainage would be reduced.

Implications & cost: Scraping is claimed to reduce wash-down times by half. Constructing a storage pond with the capacity to hold 4 days of effluent at peak milking (4 days x 105 m^3 = 420 m^3 which is equivalent to a 10m x 15m x 2.8m deep pond) is estimated at $5,460 (digger costs @ $12/$m^3$ and clay lining to 150mm thickness @ $20/$m^3$ of clay). Enlarging the effluent area to 60 ha will incur few costs if the existing pump has the capacity to service a larger area, and there is land available adjacent to the existing effluent area. One potential configuration is presented on page 26, which would only require an estimated 1,320 m of new pipe (75 mm 8 bar MDPE). At $8.50/m of pipe, total cost of a 60 ha effluent area is estimated at $11,220.

Total cost of the proposal is estimated at $16,680. Potential improvements in workplace productivity associated with reduced wash-down times are not estimated. Nutrient use efficiencies would also be improved. Using 2005 fertiliser prices, Overseer suggests that enlarging the effluent area to 60 ha will save over $12,000 per year in fertiliser costs. Potentially the saving could be higher at increasing fertiliser prices. Further, 60 ha was proposed from a hydrological loading perspective – this area is still too small to achieve optimal nutrient application for N and K (e.g. to achieve 100 kg K/ha from effluent would require 152 ha), so further cost savings are possible with an effluent application area >60 ha.

Recommendation: That the proposal be adopted. While N-loss reductions are minor on a whole-of-farm basis, many of the improvements could be considered as requirements under both the Clean Streams Accord and the One Plan. Costs are likely to be substantial (~$16,680), and would be readily offset by improved nutrient use efficiencies (+$12,000/yr), potentially less time in the milking shed, and greater flexibility for the seasonal management of effluent and pump breakdowns.

5.2.6 No winter N-fertiliser

Pasture N-uptake slows towards winter due to low plant activity, colder temperatures, and wetter soils. Likewise, the risk of leaching tends to increase during winter. Currently 50 kg urea-N/ha is applied in winter on the Dairy Platform to increase late season production.

Proposal: To adjust the timing of urea application so no urea is applied during the winter months (but current 220 kg N-urea/ha/yr rate is maintained).

Effectiveness: Stopping the use of urea in winter is predicted to reduce N-leaching losses from the Dairy Platform by 1 kg N/ha/yr. This is a modest reduction that does not affect the whole-farm N-loss (i.e. remains at 16 kg N/ha/yr).

Implications & cost: Assuming an early winter pasture N-response of 5 kg DM per kg N, then 50 kg N/ha proves an extra 250 kg DM/ha or 71.8 tn DM/yr over the 287 hectares currently receiving urea. If every kg of late-season DM resulted in a140g MS/kg production gain, then winter urea use could be worth 10,050 kg MS or $69,300 at a payout of $6.90.

Recommendation: To continue the use of winter urea. While the cost analysis is simple, it suggests that stopping winter urea would have a sizeable impact on gross revenue (-$69,300) relative to a modest N-leaching reduction (1 kg N/ha/yr).

5.3 Achieving N-targets (summary)

Nitrogen leaching losses calculated by Overseer are generally low for Tutu Totara. A large part of the reason can be explained by low stocking rates (2.6 cows/ha on the dairy platform and ~6.8 su/ha for the sheep and beef unit), the inclusion of the entire farm in the modelling exercise, and that many N-mitigation are already practiced. Non-pastoral areas and the low intensity areas effectively diluted N-losses reported for the more intensive areas, thereby giving the farm an over-all low N-loss.

The farm also has a comfortable N-loss limit readily attributable to the predominance of better class land, with over 87% of the farm represented by LUC classes 1-4 (versatile soils generally suitable for arable and other intensive land uses).

Given low N-losses relative to high permissible N-limits, then it is of little surprise that Tutu Totara does not need to adopt special N-reduction or N-mitigation practices to be compliant with the One Plan. Further, the margins are appreciable, which means there is considerable buffering for future development. Provided current N-loss does not change appreciably over the 20 years, then Tutu Totara can continue to operate comfortably within the One Plan's N-loss limits out to at least 2034. Further, even if the farming operation does become more intensive, then it is still likely that N-limits will be comfortably achieved (as demonstrated with the 1100 cow scenario), and there are many mitigation options available should the margin become tight.

However, being in a strong position does not necessary negate the voluntary uptake of N-mitigations, and some of the mitigation options examined here are required under a different part of the One Plan (Section 6). Those recommended for further consideration include improving the dairy effluent system, fencing all waterways, decommissioning the two stock fords, managing sheepyard effluent (pending clarification), and considering the adoption of N-inhibitors.

6.0 ONE PLAN REQUIREMENTS

Controlled and permitted activities relevant to Tutu Totara have been assessed to identify current levels of compliance under the One Plan (Table 10, opposite). Note that the list and terminology is a summary and only applies to the Tutu Totara property. Refer to the One Plan for a full list of controlled and permitted activities. Non-compliant activities are further evaluated to identify actions or options required to become compliant (Section 6.3). There is an unavoidable degree of overlap with recommended N-loss mitigations (previous section) and recommendations to become fully compliant under One Plan rules.

6.1 Existing consents

Currently there are three active consents for discharge to land and water takes (Table 9). Note that existing consents will be replaced by a Whole Farm Consent associated with this FARM Strategy, except for consents concerning large ground water takes, construction of bores, and any other type of consent not covered in the FARM Strategy workbook. Also note that new One Plan allocation limits have implications for Tutu Totara's surface-water takes.

Table 9: Active resource consents for the Tutu Totara, 2007

Consent reference	*Consent Type*	*Max Daily (m^3/d)*	*Max Rate (l/s)*	*Started*	*Expires*	*Water Body*
101504	Water permit	9110	116	9/7/01	18/06/11	Rangitikei River
3915	Discharge to land	35	-	9/11/93	31/10/08	-
MWC913 019	Water permit (ground)	1308	-	27/10/92	31/10/12	Rangitikei River

6.2 Planning period

This FARM Strategy is designed for a 5-year planning period. However, it is recognised that the viability of some mitigation practices are strongly dependent on seasonal factors (cost, payout, climate, etc), and it is conceivable that the most suitable options for mitigating environmental impact will fluctuate annually. It is therefore recommended that the nutrient budget be reassessed each year, and mitigation practice adjusted accordingly.

TABLE 10: Summary of controlled and permitted activities under the One Plan (2008)

CONSENTABLE ACTIVITY	REQUIREMENTS	STATUS 08	NOTES
Farming within N-loss target?	1. Farm N-loss must be within N-loss targets	Compliant	Comfortably within N-loss limits
Produce animal effluent?	1. No direct discharge of effluent to water from yards or pads	Requires attention	Runoff and artificial drainage from the sheep yards discharges directly into Porewa Stream
Store animal effluent?	1. No direct discharge of effluent to water from ponds & sumps	Compliant	Overflow discharges to land
	2. Ancillary storm water must not discharge into pond or sump	Requires attention	A proportion of storm-water from milking parlour roof is deposited on the yards and then into the sump
	3. Effluent storage must be sealed and not leaking	Compliant	Sumps are sealed concrete
	4. Effluent pond or sump must have capacity to hold 2-days of effluent between applications (if applied to land)	Requires attention	The main effluent sump has insufficient capacity to store even 1 day of effluent
Apply effluent to land? **	1. No substantial leaks in irrigation pipes or equipment	Compliant	
	2. Discharge application must be > 20m from surface water bodies, bores, or the CMA	Compliant	
	3. Discharge application must be > 20m from public areas & roads, or residences	Compliant	
	4. Discharge application must be > 50m from protected archaeological or biodiversity areas	Compliant	
	5. Must have a nutrient budget (emphasis on N)	Compliant	
	6. Must not apply on days when drift will cause problems for neighbours	Compliant (assumed) *	
	7. No surface ponding for more than 5hrs after application	Compliant (assumed) *	
Surface water take?	1. Total farm water take must be below local Allocation Limits	**UNCERTAIN**	New allocation limits are yet to be calculated by the Council.
	2. Take must not affect wetland water levels	Compliant	
	3. Take must not be from protected wetland	Compliant	
	4. Water intake must have a screen	Compliant	
	5. Intake velocity must be low enough to avoid harming small fish	Compliant (assumed) *	
	6. Water take must not adversely affect legal water takes of existing users	Compliant (assumed) *	
	7. Extracted water must be used efficiently	Compliant (assumed) *	
	8. Must report take particulars to Horizons RC	Compliant (assumed) *	
Ground-water take?	Takes >50m³/d are a discretionary activity not covered by FARMS. There is no clear suggestion that the existing consent would need to be reviewed as a result of the proposed One Plan	Compliant	Note that with the high use of bore water in the milking shed, this could be considered as an inefficient use of water, and may therefore be in breach of consent conditions
Active farm dump or offal hole?	1. Only organic waste & dead animal matter. No dumping of chemicals, metal, plastic, household rubbish, animal remedies, sprays, fuel, poisons, sewage, plastic twine, silage wrap.	Compliant	Current dumping appears to be restricted to organic material only, although some legacy non-organic material was present
	2. Top of seasonally highest water-table not within 1m of the dump base	Requires attention	The seasonal water-table is within 1m of the dump base
	3. No discharge to water	Compliant	
	4. Must not be sited within 150m from residences or public areas	Compliant	
	5. Must not be sited within 10m of the farm boundary or river floodplain	Compliant	Offal holes approximately 15-20m from floodplain
	6. Not be sited within 50m from protected archaeological or biodiversity areas	Compliant	
	7. Must not be sited within 100m from bores, surface water bodies, or CMA	Requires attention	Offal holes are located within 100m of the Porewa Stream
	8. Must manage pests	Compliant (assumed) *	
	9. There will be no objectionable smell	Compliant	No objectionable smell noted when evaluated
Stock have direct access to waterways?	1. Stock must have adequate (reticulated) trough water available in each paddock (ideally to meet peak demand)	Compliant	
	2. Stock excluded from targeted waterways	Requires attention	30% of sheep/beef unit streams require stock exclusion
	3. Stock crossings must have a bridge or culvert	Requires attention	Two stock fords on the sheep and beef unit
	4. Runoff from bridges and culverts must be directed to land rather than water	Compliant	Runoff is redirected to land where practicable
Apply fertiliser?	1. No application of fertiliser directly to water bodies	Compliant (assumed) *	
	2. No application into protected biodiversity areas	Compliant	
	3. Must be applied in accordance with industry Code of Practice	Compliant (assumed) *	
	4. N-fertiliser use requires a nutrient budget	Compliant	
	5. Must not apply on days when drift or odour will cause problems beyond the farm boundary	Compliant (assumed) *	
Store and feed supplements?	1. Feed storage areas must be sealed to restrict effluent seepage (downwards percolation). Excludes silage pits <500m² and presumably hay sheds	Compliant	
	2. Feed storage areas must be protected from water runoff entry	Compliant	
	3. Runoff from feed storage areas must not enter surface water bodies	Compliant	
	4. Feed storage areas must not be sited within 50m of protected areas, or within 20m of bores, water bodies or the CMS	Compliant	
	5. Feeding out must not take place within 50m of protected areas, or within 20m of bores, water bodies or the CMS	Compliant (assumed) *	
	6. Feed storage and feeding out shall not result in objectionable odour, dust or drift beyond the farm boundary.	Compliant (assumed) *	

* Level of compliance cannot be assessed conclusively within project limits. Full compliance is assumed until proven otherwise.

EFFLUENT APPLICATION AREAS

ONE PLAN separation distances

No discharges of dairy effluent permitted within 20 m of a public road.

No discharges of dairy effluent permitted within 20 m of residences, marae, schools, public buildings and public recreation areas.

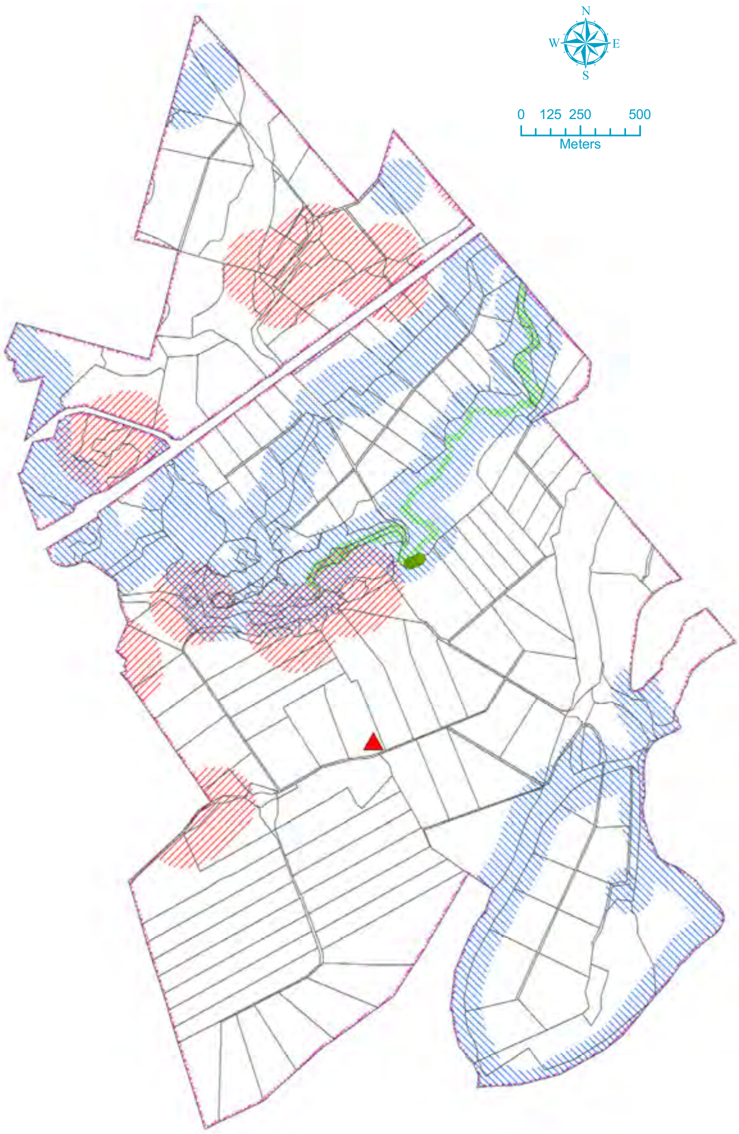
No discharges of dairy effluent permitted within 20 m of bores or surface water bodies.

No discharges of dairy effluent permitted within 50 m of an archaeological site.

Effluent application areas

Existing effluent application block (14.4ha or 13.8 ef ha).

Option for enlarged effluent area (62 ha) (excludes paddock overlap into restricted areas)



FARM DUMPS & OFFAL HOLES

ONE PLAN separation distances

No farm dump or offal hole is permitted within 10 m of the property boundary.

No farm dump or offal hole is permitted within 150 m of residences, marae, schools, public buildings and public recreation areas.

No farm dump or offal hole is permitted within 10 m of the first floodplain terrace of rivers*.

No farm dump or offal hole is permitted within 100 m of bores or surface water bodies.

** The Porewa 'Stream' is interpreted as being a river because of the flood plain size.*

Active farm disposal sites

Offal holes

Farm dump

The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

AREAS WITH RESTRICTIONS

Tutu Totara Farm

Porewa, Marton

Separation distances taken from Rule 13x of the One Plan. Note that specifications have been reworded for clarity, and as such, only apply to the Barrow farm. Does not include all specifications for effluent recycling/disposal, farm dumps, or offal holes. Please refer to the One Plan for full specifications. Location of relevant features are shown on the Property Map (page 5).

6.3 FIVE-YEAR STRATEGY to achieve One Plan compliance

6.3.1 Maintaining existing mitigations

Existing mitigations have been reported in Section 5.1. Change with any of the listed activities may affect N-loss, and would therefore necessitate a nutrient budget reassessment. Accordingly, existing best-practice activities should be maintained for the first year, and reassessed with a new nutrient budget in the second year.

Objective 1: Maintain existing policies for stock, grazing and fertiliser. A significant deviation in these policies requires re-evaluation of the nutrient budget and N-targets.

6.3.2 Storm water runoff

Rainwater from approximately half of the milking shed's roof (~358 m^2) flows into the yard and then into the effluent sump, thereby contributing to the liquid volume of effluent generated. At an annual rainfall of 1100 mm this small area would be collecting around 394 m^3 of water every year (1.1m rainfall x 358 m^2 area = 394 m^3). Roof storm-water discharge to effluent ponds or sumps is not permitted under the One Plan. Storm-water should either be collected in a tank or discharged to land. Cost of additional guttering and pipe to achieve the latter option is estimated at $500.

Objective 2: Install new guttering and pipe to direct storm-water runoff from the milking shed roof onto land.

6.3.3 Exclude stock from targeted waterways

All targeted waterways on the dairy unit are fenced. For the remainder, approximately 3.5 km are fenced, 0.6 km are protected from cattle only, and 1.6 km are unprotected. Further, there is an additional 2.5 km of suspect waterway (stream bed suggests high flows but conditions at time of examination means it did not qualify as perennial), 1.9 km of which is not protected from stock grazing. Excluding stock from this particular stream is therefore not a compliance requirement, but it is strongly recommended (see Section 5.2.3). Estimated cost varies between $12,200 and $14,600 depending on whether the suspect stream is fenced.

Objective 3: Exclude all stock from targeted waterways by 2011.

- **3a**: Sheep-proof the existing riparian fence in the paddock where the Porewa Stream enters the farm during 2009.
- **3b**: Erect 1.6 km of 7-wire to fence off bush and riparian areas in the intermittently grazed paddock during 2010.
- **3c**: Consider erecting 0.9 km of 4-wire electric fencing around the lower reaches of the 'suspect' waterway.

6.3.4 Stock crossings (fords)

Two fords are currently used as stock crossings. All stock crossings must be culverted or bridged. It is recommended that the fords be decommissioned for stock use (but retained for heavy machinery), and that the adjacent bridges be used (see Section 5.2.4).

Objective 4: Cease using the two fords as stock crossings over the next two years (as part of riparian fencing – see above).

6.3.5 Decommission existing offal holes

Current location of the offal holes is non-compliant under the One Plan because of its proximity to Porewa Stream (<100m, see map opposite). The holes should be decommissioned and sealed, and a new offal hole established further from the stream. Cost is estimated at $1,700 (at $571/m for a 3m deep hole).

Objective 5: Decommission and seal the existing offal holes, and establish new holes further away from the Porewa Stream.

6.3.6 Stock effluent discharge from sheep yards

Discharge of stock effluent from yards to waterways is not permitted according to the FARM Strategy workbook. Effluent exiting from the farm's sheep yards represents a discharge to water. One option for managing yard effluent is to design a collection and storage system (see Section 5.2.2). This is estimated to cost between $5,000 and $10,000. However, it is not fully clear if the specification was intended to include sheep yards, and clarification is required from the regional council.

Objective 6: Control effluent discharges from the sheep-yards by constructing an effluent catchment and storage system, pending clarification from the council.

- **6a**: Seek clarification as soon as possible from the regional council to affirm or discount whether sheep-yard effluent needs to be managed.
- **6b**: Engage the services of a specialist to design an effluent catchment and storage system for the sheep yards in 2009.
- **6c**: Look to construct and commission the effluent control system between 2010 and 2014 (if needed).

6.3.7 Decommission existing farm dump

The farm dump is not located within any restricted area as defined by One Plan separation distances (see map page 26). Further, the material being added appeared to be mostly organic and therefore compliant (although there where legacy non-compliant materials such as fencing wire, but these had not been added recently). However, the dump is situated in a wet depression, where the seasonal water-table is near the surface for several months (as evidenced by the gleyic and mottled features of the soil profile). Under the One Plan, 'the lowest point of the … dump shall be at least 1m above the seasonally highest water table'. The dump is therefore non-compliant.

Objective 7: Decommission the existing farm dump effective immediately.

6.3.8 Upgrade the dairy effluent system

The current system transgresses several compliance requirements, including current consent conditions (e.g. currently 78 m^3 of effluent is applied to land, well above the permitted 35 m^3) and One Plan requirements (e.g. require a minimum of 2 days effluent storage capacity – the current sump system does not even have the capacity for 1 day of effluent storage). Further, the amount of water used in the shed (as suggested by the high 100 l/cow/day effluent production) could be considered an inefficient use of bore-supplied water, and may therefore be non-compliant with existing consent conditions. Several recommendations are made to improve the dairy effluent system (Section 5.2.5), which would achieve all compliance requirements. Because the existing system is non-compliant with the existing consent, it is recommended that the improvements be implemented as soon as practicable.

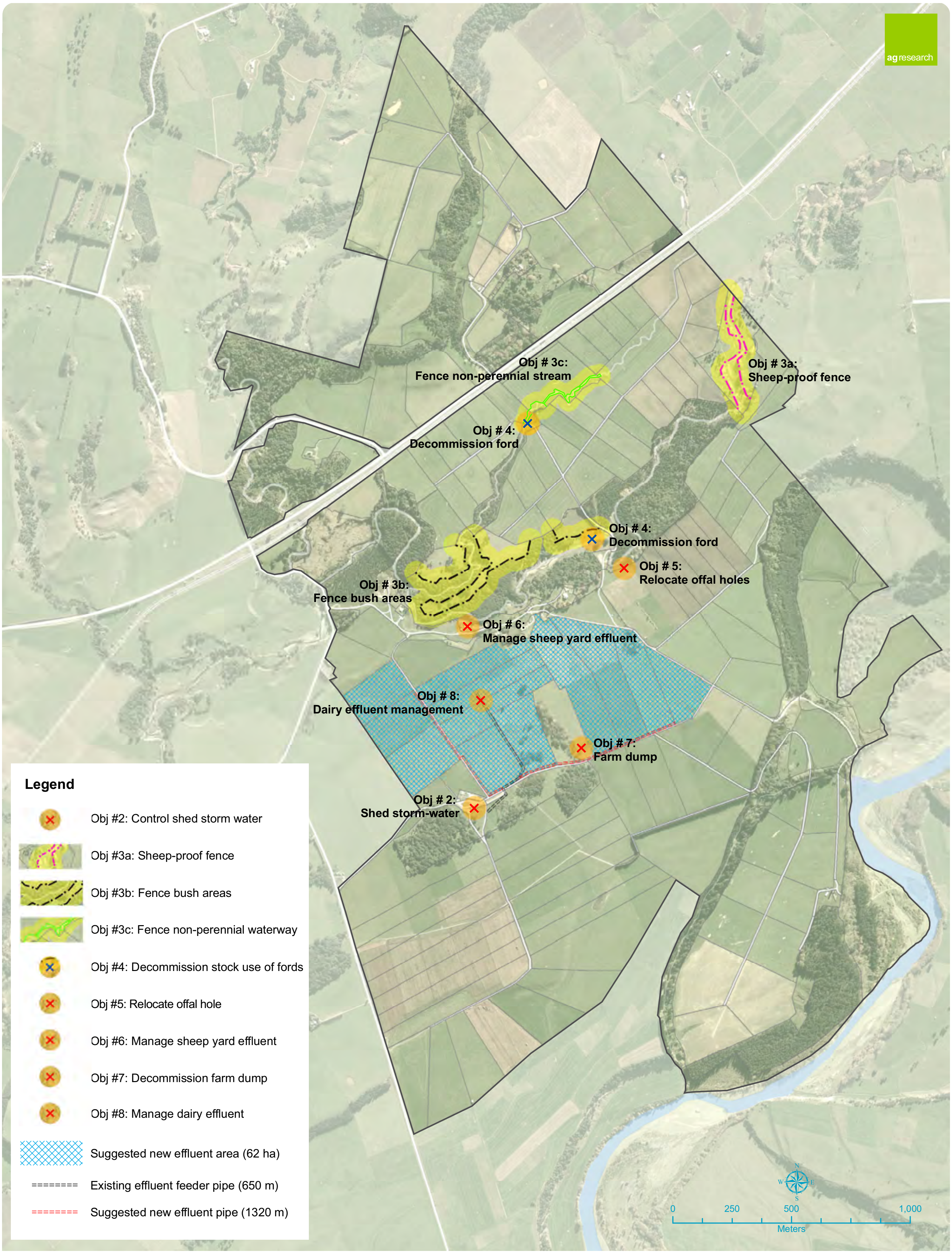
Objective 8: Upgrade the dairy effluent system by constructing a holding pond, enlarging the effluent disposal area, and reduce shed water-consumption by adopting improved wash-down practices.

- **8a**: Construct an effluent pond with sufficient capacity to hold 4 days of effluent during peak milking before the end of 2009.
- **8b**: Initiate expansion of the effluent block to 60 ha before the end of 2009 (see the Works Map opposite for a suggested design).
- **8c**: Adopt the practice of scraping prior to wash-down immediately.

TABLE 11: Five-year strategy for compliance with One Plan requirements

OBJECTIVES	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Operate within N-loss targets					
No special management actions are required at the current time	-	-	-	-	-
Maintain existing mitigations[1]					
1. Maintain current policies for stock, feeding & fertiliser. Particularly important to retain current purpose of the support unit, including the wintering of dairy cows	→	→	→	→	→
Control storm-water runoff					
2. Install new guttering and pipe to direct storm-water from the milking shed roof onto land	Initiate as soon as possible	-	-	-	-
Fence targeted waterways					
3. Exclude all stock from targeted waterways by 2011	Sheep-proof existing riparian fence	Fence intermittently grazed area (	Consider fencing the 'suspect' stream (0.9 km of 4-wire electric)		
Stock crossings					
4. Cease using the two fords as stock crossings	-	Start using the bridges for stock crossings	→	→	→
Offal holes					
5. Decommission and seal the existing offal holes, and establish a new hole further away from the Porewa Stream	Initiate as soon as possible	-	-	-	-
Sheep yard effluent					
6. Control effluent discharges from the sheep-yards by constructing an effluent catchment and storage system, pending clarification from the council.	Seek clarification from the council as soon as possible	Design an effluent system for the sheep yards	Construct and commission effluent management system	Maintain system & spread effluent to land when necessary	→
Farm dump					
7. Decommission the existing farm dump	Initiate as soon as possible	-	-	-	-
Effluent area					
8. Upgrade dairy effluent management system.	Look to upgrade the dairy effluent system as soon as practicable, including the construction of a holding pond (min 420m^3 capacity), enlarging effluent area to +60ha, and adopting water-conserving wash down practices.				

[1] Any substantial change in stock policy, feeding policy, irrigation, inhibitor application, or N-use will require a reassessment of farm N-loss against N-targets (i.e. a new nutrient budget).



The Famer Applied Resource Management Strategy (**FARMS**) is part of an initiative aiming to improve freshwater quality. A **FARM Strategy** is a document to help farmers work out a nutrient management plan for their farm and apply for all the resource consents they need in one go.

WORKS MAP

Tutu Totara Farm

Porewa, Marton

Survey and classification by Landvision Ltd, 2007. Map by AgResearch. Aerial photography supplied by Horizons Regional Council (75cm orthophoto corrected to account for camera distortion & terrain displacement).

6.4 Summary of compliance cost estimates

6.4.1 Direct costs

Cost estimates are generated from local prices at time of writing and are therefore subject to change. Full cost could not be established in all cases (particularly secondary costs), and it is likely that a canny farmer could make substantial savings (cost of services is based on contract rates). Cost of implementing the compliance recommendations of this FARM Strategy are estimated at $36,000 – $45,900 (Table 12). This decreases to $19,500 - $29,200 when Clean Streams Accord costs are taken out ($16,680 for the effluent upgrade under existing consent conditions).

Table 12: Direct costs	
Redirect milking shed storm-water to land (Obj 2)	$500
Exclude stock from targeted waterways (Obj 3)	$12,300 - $17,000[a]
Decommission fords as stock crossings (Obj 4)	$0[b]
Decommission offal holes; establish new offal holes (Obj 5)	$1,700
Manage effluent discharge from sheep yards (Obj 6)	$5,000 - $10,000
Decommission farm dump (Obj 7)	$0
Upgrade dairy effluent system (Obj 8)	$16,680[c]
TOTAL	**$36,000 – $45,900**

[a] *Depends on whether the optional 'suspect' stream is fenced*
[b] *Any associated fencing costs are assumed to be including with the riparian fencing programme*
[c] *Likely to be offset by efficiency gains in shed wash down time and reduced fertiliser costs*

6.4.2 Implications for farm returns

Fencing waterways are unlikely to have any substantial impact on farm returns. For the options examined, most of the required fencing would retire land with a low production value (unfertilised river flats and shaded bush areas). If the 'suspect' stream was fenced, then the estimated revenue impact would likely be negligible (~$370 gross revenue reduction).

Upgrading the dairy effluent system promises efficiency gains that would impact positively on farm returns. However, cost savings for reduced water usage in the dairy shed, plus reduced wash-down times, were not estimated. The major gain would be through improved use of effluent nutrients, estimated to be worth a minimum $12,000/yr (potentially more for a larger effluent area).

6.4.3 Total cost to become One Plan compliant

Direct costs ($36,000 – $45,900) less Clean Streams Accord costs ($16,680) equates to $19,500 - $29,200. If this is offset by savings arising from improved use of effluent nutrient ($12,000 each year), then it could be argued that total cost to become compliant would reduce to $7,500 - $17,200. This may reduce even further pending clarification of sheep-yard effluent management requirements. Further, if an economic analysis was undertaken over a longer timeframe (i.e. capital costs being spread over the life of the capital item, with most of the direct costs being capital costs), then efficiency gains could actually result in net financial gains.

6.5 Other considerations

6.5.1 Council assistance

Fencing and planting waterways will be eligible for consideration of an environmental grant from Horizons Regional Council. Grants are available for enhancing 'water quality by retiring and planting stream banks'. Costs for fencing, plants and labour are all eligible under the grant scheme. Further, Tutu Totara would likely attract a higher grant rate (30% to 40% of costs) because this FARM Strategy is, for all intensive purposes, an 'environmental farm plan'. Contact for a local HRC representative is provided at the end of this section.

6.5.2 Follow up

Please contact your local regional council representative for information or help about implementing this FARM Strategy.

Grant McLaren
Horizons Regional Council
Corner Vogel & Tay Streets
Woodville
Phone 06 9522 800
Mobile 021 227 7107
Email: grant.mclaren@horizons.govt.nz

horizons regional council

ACKNOWLEDGEMENTS

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Andrew Manderson
AgResearch

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Institute of Natural Resources
Massey University

APPENDIX 1: INFORMATION CHECK

Assessment of current N-loss through Overseer Nutrient Budgets can only be as robust as the information used in the model. This appendix is provided as an assurance that the best information available was used for Tutu Totara Farm at the time of assessment.

Resource information

- Annual rainfall is 1141 mm.
- Farm located 29 km from coast

Block	Ha	RY (%)	Topo	Dom soil	Drainage	Sheep: cattle	Soil test results[2]							
							Olsen P	Qt K	SO4-S	TBK	Qt Ca	Qt Mg	Qt Na	PR
Dairy														
Top irrigation	59	135	Flat	Tokorangi sandy loam	Mod.	0:100	46	6	2	3.2	9	21	5	-
Top irrigation suppt	55	135	Flat	Tokorangi sandy loam	Mod.	0:100	46	6	2	3.2	9	21	5	-
River block	48	135	Flat	Rangitkei sandy loam	Well	0:100	72	9	2	4.1	10	23	5	-
Tokorangi dairy	119	100	Flat	Tokorangi sandy loam	Mod.	0:100	46	6	2	3.2	9	21	5	-
Effluent block	14	100	Flat	Tokorangi sandy loam	Mod.	0:100	43	18	21	2.2	9	44	15	-
Mid terrace	6	100	Flat	Ohakea silt loam	Impfct	0:100	46	6	2	3.2	9	21	5	-
Intermittent grazed	4	100[1]	Flat	Rangitkei sandy loam	Well	0:100	6	3	0.5	-	2	2	2	-
Not grazed	68	0	Flat	-	-	-	-	-	-	-	-	-	-	-
Sheep Beef														
A Block	9		Flat	Kiwitea silt loam	Well	60:40	25	10	10	-	7	23	8	-
B Block	52		Flat	Marton silty clay loam	Impfct	60:40	25	10	10	-	7	23	8	-
Maize block	27		Flat	Kiwitea silt loam	Well	-	25	10	10	-	7	23	8	
Ridges block	68		Flat	Marton silty clay loam	Impfct	60:40	25	10	10	-	7	23	8	-
Intermittent grazed	27		Hill	Ashhurst silt loam	Well	60:40	10	10	5	-	7	23	8	-
Not grazed	114		-	-	-	-	-	-	-	-	-	-	-	-
Cropping														-
Cropping block	108	-	Flat	Sedimentary	Well	-	35	10	-	-	10	-	5	-

[1] Effective area estimate already incorporates relative yield

[2] Limited soil test information available. Tokorangi soils & Mid terrace block assumed from RF Ex Potato soil test results. Cropping & Sheep Beef blocks estimated.

Dairy Platform

- Peak milking 800 Friesian cows producing 347,301 kg MS/yr @ 534 kg average live weight. 271 day milking season.
- 25% of herd total as replacements grazed off after weaning (half grazed at another location; half grazed on Sheep & Beef Unit).
- Wintering – 50% herd off in June & July, 15% off in August (grazed on Sheep & Beef Unit). Remainder grazed on-farm plus 8hrs/day on wintering pad during June & July.
- Supplements: Silage @ 191 tn DM harvested from Top Irrigation, Top Irrigation Support, and Tokorangi Dairy blocks, plus 210 tn DM imported from the sheep/beef unit, with ~97 tn DM fed on paddocks and the remainder on the feed/wintering pad. 374 tn DM of maize grain harvested off the cropping blocks and fed in the dairy shed over the milking shed (set up as a feed pad; 100% of milking season; 2 hrs/day).
- No fertiliser for Effluent or Intermittently Grazed Blocks. All other dairy blocks receive 600 kg/ha 15% potash super, 220 kg/ha urea (50 kg/ha urea-N goes on in winter months for these blocks), and 1 tn/ha of good quality lime.
- Effluent sprayed daily during milking season from 500 litre sump to the Effluent Block (13.8 ha).
- Effluent from the wintering pad and feeding pad assumed to have solids separated (solids applied to Tokorangi Dairy Block). Overseer treats the liquid fraction the same as effluent produced at the shed.
- Development status for all pasture blocks set at DEVELOPED.
- Clover levels set at MEDIUM for all pasture blocks.

Sheep & beef unit

- **Cattle**: 100 R1 heifers in November @ 100kg LW and out 30 June @ 253 kg. 100 R2 heifers in July 1 @ 253 kg LW and out May @ 473 kg. 400 cows in June @ 550 kg LW and out July @ 550 kg. 200 cows in August @ 550 kg LW and out August @ 550 kg.
- **Sheep**: 750 lambs in December @ 32 kg LW and out in May @ 50 kg. 500 lambs in January @ 55 kg LW and out November @ 92 kg. 800 lambs in June @ 47 kg LW and out in September @ 62 kg LW. 600 lambs in October @ 62 kg LW and out in November @ 80 kg. 950 lambs in January @ 32 kg LW and out at 30 June @ 80 kg. 20 non-breeding ewes in July 01 @ 80 kg LW and out June 30 @ 80 kg.
- Equates to 8.1 su/ha for sheep and 5.5 su/ha for cattle.
- 210 tn of good quality silage harvested from Ridges and B-Block and exported to the dairy farm.
- Development status for all pasture blocks set at DEVELOPED.
- Clover levels set at MEDIUM for all pasture blocks.
- **Cropping**: 18 tn DM/ha of maize sown in October (conventional cultivation) and harvested then resown to pasture in March. Maize exported off farm.
- No fertiliser on Intermittently grazed block. The 3 main pasture blocks (Ridges, A & B blocks) receive 359 kg/ha 15% potash super and 450 kg/ha urea. Maize Block receives 250 kg/ha 15% potash super, 300 kg/ha 30% potash super, and two dressings of urea at 250 kg/ha and 200 kg/ha.

Cropping unit

- Cropped for maize grain, yielding 17 tn DM/ha. Sown in October and harvested in August. Fertiliser equivalents of 115 kg N/ha, 41 kg/ha P, 58 kg/ha K, 87 kg/ha Ca, and 47 kg/ha S, all applied in October.
- Currently 2 years out of pasture. Previously in ryegrass producing 7.4 tn DM/ha. Sown in March conventional cultivation and harvested in September.

Grazed post harvest. Fertiliser equivalents of 101 kg N/ha, 17 kg/ha P, 10 kg/ha K, 87 kg/ha 36, and 19 kg/ha S, all applied in May.

Assurance statement:

To the best of our knowledge, the information provided above is true and correct at the time the Overseer analysis was undertaken (February 2008).

Farm owner, operator or manager

Name:

Date:

Signed:

Nutrient management consultant

Name: Alec Mackay

Date:

Signed:

APPENDIX 2: SOIL EXTENDED LEGEND

Name: Soil 1 (Rangitikei sandy loam)

LUC map symbol: 1

Drainage status: Well drained

Soil consistence: Friable to firm when moist, loose when wet

Degree of topsoil development: Weakly developed

Parent material: Alluvium and gravels

Profile description: Weakly developed fine granular crumby structure (WO2d) greyish weak orange sandy slit loam. On weakly developed (WO3c) dusky yellow brown sandy loam. On gravels.

Comments: Recent lowest terrace on farm. Evidence of heavy compaction in the top 15 cm of this soil. Still prone to pugging and treading damage despite drainage characteristics. Soil is easily leached.

Management considerations: Care with heavy cattle during wet periods. Requires amelation of compaction damage present. Strategy of nutrient application to reduce nutrient leaching losses.

Name: Soil 2 (Rangitikei stony-bouldery series)

LUC map symbol: 2

Drainage status: excessively well drained

Soil consistence:

Degree of topsoil development: weakly developed

Parent material: Alluvium and gravels

Profile description: thin topsoil over gravels

Comments: Found on the low river terrace. Winter safe with heavy cattle but close to waterway. Prone to frequent flooding

Management considerations: Nutrients easily leached. Requires care with surface runoff into adjacent river system. High fertile pasture species will not persist.

Name: Soil 3 (Rangitikei sandy loam)

LUC map symbol: 3

Drainage status: Well drained

Soil consistence: Very friable when moist, plastic when wet.

Degree of topsoil development: Weakly developed

Parent material: Alluvium and gravels

Profile description: 12cm weakly developed fine granular, with few crumbs, structure (WO4c) dark yellow brown sandy loam with few small rounded pebbles. On raw (O5b) dark yellow brown sand with few to many rounded pebbles over sand or gravels.

Comments: Weak development means this soil is prone to pugging and treading damage when wet. Evidence of heavy compaction throughout this terrace the soil is found on.

Management considerations: Care with heavy cattle during wet periods. Requires amelation of compaction damage present. Strategy of nutrient application to reduce nutrient leaching losses.

Name: Soil 4 (Ohakea series)

LUC map symbol: 4

Drainage status: imperfectly drained

Soil consistence: Firm when moist (due to compacted topsoil), plastic when wet.

Degree of topsoil development: Weakly to moderately developed

Parent material: Alluvium, Loess over gravels

Profile description: 15cm weakly to moderately developed fine nutty structure (WO4b) dark yellow brown sandy silt loam. On weakly developed fine crumb granular (WO3c) dusky yellow brown sandy silt loam.

Comments: Topsoil badly compacted. Small area.

Management considerations: Care with heavy cattle during wet periods.

Name: Soil 5 (Ohakea series)

LUC map symbol: 5

Drainage status: Imperfectly drained

Soil consistence: Firm when moist, firm to slightly plastic when wet

Degree of topsoil development: Moderately to weakly developed

Parent material: Alluvium

Profile description: 12cm moderately to weakly developed fine crumb nut with granular structure (WO4b) dark yellow brown silt loam. On weakly developed fine granular crumb (WO5b) dark yellow brown silt loam with few rounded waterlaid pebbles.

Comments: Small area

Management considerations: Care with heavy cattle during wet periods.

Name: Soil 6 (Ashhurst series)

LUC map symbol: 6

Drainage status: imperfectly drained

Soil consistence: Friable when moist

Degree of topsoil development: Moderately developed

Parent material: Alluvium

Profile description: 8cm moderately developed fine nutty crumb with few large blocks, from compaction, (WO3c) dusky yellow brown sandy silt loam. On 12cm moderately developed fine nutty crumb (WO3c) dusky yellow brown sandy silt loam. On moderately developed fine to very fine nutty crumb (WO5b) dark yellow brown sandy loam.

Comments: Small area. Evidence of heavy compaction.

Management considerations: Care with heavy cattle and machinery during wet periods.

Name: Soil 7 (Tokorangi fine sandy loam)

LUC map symbol: 7

Drainage status: Imperfectly to moderately well drained

Soil consistence: Friable to firm when moist, plastic when wet.

Degree of topsoil development: Moderately developed

Parent material: Loess over gravels

Profile description: 22cm moderately developed fine to medium nutty crumb with few medium to large blocks, from treading, (WO5a) yellow black brown very fine sandy silt loam. On weakly to moderately developed fine to very fine nutty crumb silt loam with few mottles and iron concretions.

Comments: this soil does have the tendency to dry out during the summer months and is often too wet during winter for heavy cattle.

Management considerations: Care with heavy cattle during wet periods. This soil has maximum production during mid spring to early summer whilst there is adequate soil moisture. If drainage is impeded this soil will be slow to warm up in the spring.

Name: Soil 8 (Marton silty clay loam)

LUC map symbol: 8

Drainage status: Imperfectly to poorly drained

Soil consistence: Friable to firm when moist, plastic when wet.

Degree of topsoil development: Moderately developed

Parent material: Loess

Profile description: 7-8cm moderately developed fine nutty blocky structure (WO3b) dusky dark yellow brown silty clay loam with few fine to very fine iron and manganese concretions. On weakly developed medium blocky (WO2d) greyish weak orange silty clay with many (WO4d) weak orange mottles.

Comments: Will hold a mole drain. Winter wet, summer dry.

Management considerations: Care with heavy cattle when wet. This soil is often too wet in winter and dries out in summer.

Name: Soil 9 (Ohakean series)

LUC map symbol: 9

Drainage status: imperfectly to poorly drained

Soil consistence: Firm when moist, plastic when wet.

Degree of topsoil development: Weakly developed

Parent material: Loess over gravels

Profile description: 12cm weakly developed with fine to medium block (WO2d) greyish weak orange clay loam with few to many low chroma mottles and some stones. On 13cm weakly developed fine nutty crumb, very plastic when wet, clay loam with few low chroma mottles. On large bouldery gravels.

Comments: Prone to pugging and treading damage when wet with heavy cattle. Often slow to warm up in the spring.

Management considerations: Utilise for mid spring to early/mid summer strengths.

Name: Soil 10

LUC map symbol: 10

Drainage status: Moderately well drained

Soil consistence: Friable when moist, plastic when wet

Degree of topsoil development: Weakly to moderately developed

Parent material: Loess

Profile description: 12 cm weakly to moderately developed, friable when moist, plastic when wet, fine nutty crumb (WO4a) dark yellow-brown black very friable sandy silt loam. On 8cm weakly to moderately developed fine nut/crumb, friable when moist, (WO4c) yellowish brown sandy silt loam with few low chroma mottles. On weakly developed fine to very fine nutty crumb (WO4d) weak orange sandy silt loam. On loess.

Name: Soil 11

LUC map symbol: 11

Drainage status: Moderately well drained

Soil consistence: Friable when moist, plastic when wet

Degree of topsoil development: Weakly to moderately developed

Parent material: Loess

Profile description: 8cm weakly to moderately developed, friable when moist, plastic when wet, fine nutty crumb (WO3c) dusky yellow brown very friable sandy silt loam. On 10cm weakly to moderately developed fine nutty crumb (WO4c) yellowish brown friable when moist, plastic when wet sandy silt loam. On moderately developed very fine crumb (WO4d) weak orange sandy silt loam.

Comments: Very similar to Soil 10 but with a lighter topsoil and on a lower terrace.

Name: Soil 12

LUC map symbol: 12

Drainage status: Imperfectly drained

Soil consistence: Friable when moist

Degree of topsoil development: Moderately to weakly developed

Parent material: Alluvium

Profile description: 14cm moderately to weakly developed, friable when moist, fine nutty crumb (WO4b) dark yellow-brown silt loam. On 7cm weakly to moderately developed fine nutty crumb (WO3c) dusky yellow brown sandy silt loam with few low chroma mottles and orange and grey mottles. On weakly developed fine to very fine crumby nut structure (WO2c) greyish light-weak orange sandy silt loam with few to many mottles. Formed from alluvium.

Name: Soil 14

LUC map symbol: 4

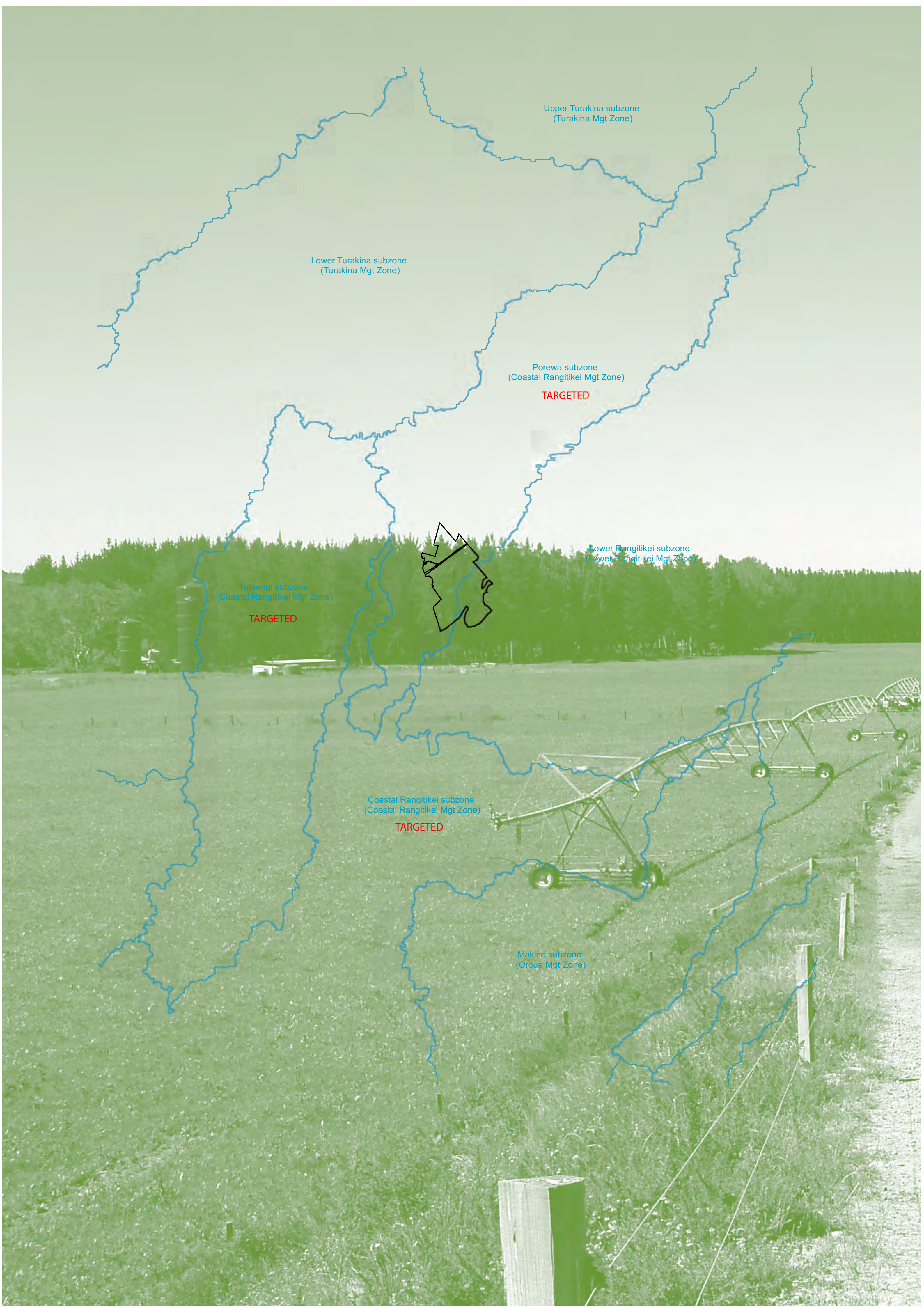
Drainage status: Poorly drained

Soil consistence: Friable to firm when moist, very plastic when wet

Degree of topsoil development: Weakly to moderately developed

Parent material: Loess

Profile description: 15cm weakly to moderately developed nutty crumb, friable to firm when moist, very plastic when wet, (WO4a) dark yellow-brown black silty clay loam. On moderately developed, firm when moist, fine nutty crumb with few fine to medium blocks, (WO4c) yellowish brown silty clay loam with many orange mottles and iron concretions and some grey mottling. Formed from loess.



Upper Turakina subzone
(Turakina Mgt Zone)
Lower Turakina subzone
(Turakina Mgt Zone)
Porewa subzone
(Coastal Rangitikei Mgt Zone)
TARGETED
Lower Rangitikei subzone
(Lower Rangitikei Mgt Zone)
Tutaenui subzone
(Coastal Rangitikei Mgt Zone)
TARGETED
Coastal Rangitikei subzone
(Coastal Rangitikei Mgt Zone)
TARGETED
Makino subzone
(Oroua Mgt Zone)