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| *In the matter of:* | Clauses 6 and 8 of Schedule 1 – Resource Management Act 1991 – Submissions on publicly notified plan change and variation – Proposed Plan Change 1 and Variation 1 to Waikato Regional Plan – Waikato and Waipa River Catchments |
| *And:* | **Wairakei Pastoral Ltd**<br><br>Submitter |
| *And:* | **Waikato Regional Council**<br><br>Local Authority |

# STATEMENT OF EVIDENCE OF STUART JOHN FORD

## Block 2 Hearing Topics

*Dated*: 3 May 2019

# STATEMENT OF EVIDENCE OF STUART JOHN FORD

## SUMMARY


1 The key points from the Block 1 relevant to my evidence are:

2 The Block 1 evidence of Mr Williamson also showed that the flow path for nitrogen (**N**) in groundwater is much shorter in time than previously considered by WRC, and the Block 1 evidence of Dr Neale showed that the heavy emphasis on the management of N in PC1 (as notified) is not appropriate. All four attributes or contaminants should be addressed together via risk assessment as part of the FEP process.

3 The scenario modelling by Dr Doole (WRC/Dairy NZ) focused (almost exclusively) on whether land use **change** should be constrained and is predicated on there being a "load to come".

4 The first 10-years are critical for the success of PC1 and the long-term 80-year strategy, and the key dates that trigger resource consents and FEPs should be brought forward.

5 The key points from my Block 2 evidence are:

6 I have reviewed the RDST scenarios that were modelled. I have undertaken economic modelling on those scenarios including calculation of the flow-on impacts that will occur. I find that when considering the merits of the range of scenarios presented listing both those proposed under PC1 and the alternatives as suggested by WPL, that the Vulnerable Land FEP and mitigations scenario is the most attractive option from both a financial and an economic perspective.

7 When considering this result in a Section 32 framework it is the most effective and efficient because it achieves a significant level of progress towards meeting the freshwater objectives in Table 3.11-1 while still achieving the highest returns in terms of Gross Revenue and Net Cash Position and in the flow-on metrics for Gross Output, Value Added and Employment of the scenarios modelled. This means that it will have the greatest impact on community wellbeing because it will create the greatest amount of economic growth and employment in the Waikato Region.

8 The OVERSEER model is not appropriate (as the sole) decision support tool for use under PC1. In my view, it is more effective and efficient to allow for the adoption of a suite of more inclusive and complete alternative decision support tools in PC1 than to prescribe

the use of what has been well described as a particularly crude and uncertain modelling tool.

9 The policies, methods, and rules in PC1 as notified do not implement Objective 3 and should be amended to meet this objective by 2026 (because the first 10-years are critical for the success of PC1).

10 The 75$^{th}$ percentile nitrogen leaching value should be deleted because it depends on full knowledge that will not be available during the plan period.

11 Vulnerability (temporal and spatial) should be the driving criteria for land use (farming) controls in PC1.

12 Delete the requirement for the 75$^{th}$ percentile N leaching value mechanism and replace it with appropriate methods in the FEP that achieve the freshwater objectives in the Table 3.11-1 more effectively and more efficiently.

13 FEPs should be used as the primary risk assessment tool for all four attributes (i.e. contaminants) and to derive a consent condition cap for N and P discharges.

14 Consenting at scale:

14.1 Sub-catchment consents and catchment-wide global (industry) consents should be provided for in the PC1 rules together with property and enterprise consents, and any legal person or entity should be able to apply for (managing) them.

15 The land use change constraint is not efficient in RMA s 32 terms and Policy 6 and Rule 3.11.5.7 as notified should be deleted or permit this to occur except on vulnerable land. There would in my view be no reasons for constraining land use change where the freshwater objectives in Table 3.11-1 are able to be met.

## BLOCK 2 HEARING TOPICS

16 My name is **Stuart John Ford**. I have the qualifications and experience recorded in my statement of evidence filed in relation to the Block 1 Hearing Topics.

17 Relevant to my Block 2 evidence, The AgriBusiness Group was instrumental in development of the first Farm Environment Plan (**FEP**) that was developed in Canterbury for the Morven Glenavy Irrigation scheme, and I now supervise five staff who are involved in the development of FEPs for individual properties or enterprises who are all certificated by Environment Canterbury as FEP auditors. As a consultancy team we carry out approximately 400 audits annually across individual properties or enterprises and the majority of the irrigation schemes in Canterbury.

18 I have also attended the training course for APSIM and therefore have a good working knowledge of the way that APSIM is able to model a multitude of contaminants, but I do not claim to have a detailed knowledge of this model. Dr Cresswell will give detailed evidence on this model for Wairakei Pastoral Ltd (**WPL**).

19 My statement of evidence has been prepared in accordance with the Code of Conduct for Expert Witnesses set out in Section 7 of the Environment Court of New Zealand Practice Note 2014.

### PART C – TOPICS

20 Key points from the Wairakei Pastoral Limited (**WPL**) Block 1 evidence that are relevant for my Block 2 evidence include:

21 While there is considerable uncertainty as to the accuracy of the HRWO modelling which puts into contention the accuracy of the recommendations made by the Collaborative Stakeholder Group (**CSG**) and ultimately the decisions made by Waikato Regional Council (**WRC**), the PC1 objectives (as amended by WPL) are suitable for achieving sustainable management.

22 Alternatives which all offer superior economic and employment growth whilst restoring or protecting (improving or maintaining) the environmental performance of the river system were not (in reality) considered or evaluated in a s 32 evaluation framework.

23 The various options available to the CSG were not adequately put through a s 32 evaluation framework that estimated in a quantifiable way the costs and benefits of the effects of each alternative on the environmental, economic, social and cultural considerations.

## TOPIC C1. DIFFUSE DISCHARGE MANAGEMENT

### Overview

24 In my opinion the first 10 years of Plan Change 1 (**PC1**) are critical in terms of shaping our approach towards achieving the short-term and long-term goals.

25 In relation to time, I note that:

25.1 Mr Williamson in his Block 1 evidence considered that the period 2016-2026 (reflected in PC1 Objective 3) is the most critical for meeting freshwater objectives.

25.2 Emerging Government policy indicates that more urgent short-term and long-term timeframes (5 and 30 years) may be appropriate.

25.3 The National Policy Statement for Freshwater Management (**NPS-FM**) (Appendix 6) arguably sets more ambitious timeframes for achieving swimability than PC1 and encourages WRC to substantially meet this objective by 2040 rather than by 2096.

25.4 It is unlikely that PC1 Objective 3 (short-term freshwater objectives) will be achieved in all sub-catchments by 2026 (see the Section 42A Report, p 125) under the notified provisions.

26 The Block 1 evidence of Mr Williamson also showed that the flow path for nitrogen (**N**) in groundwater is much shorter in time than previously considered by WRC, and the Block 1 evidence of Dr Neale showed that the heavy emphasis on the management of N in PC1 (as notified) is not appropriate and that there should be an equal amount of emphasis on phosphorus (**P**), sediment and E.coli in the planning framework that is ultimately developed.

27 In my following Block 2 evidence I will evaluate some additional options proposed by WPL that will both achieve the PC1 freshwater objectives and maximise the wellbeing of the Waikato River communities.

28 While my evidence has an economic focus my approach to sustainable management and providing for community wellbeing is in line with the Vision and Strategy's approach to these matters that emphasises the connections between restoring and protecting water quality and community wellbeing and the community's ability to accomplish restoration and protection of water quality. In my view, the Vision and Strategy provides for a complete

consideration (in terms of sustainable management) that includes economics and other considerations (environmental, cultural, etc).

**Topic C1.1 OVERSEER**

29 The Section 32 Report Part E.3 **Making reductions**: Catchment wide rules and Nitrogen Reference Point (**NRP**) states that:

> For Plan Change 1, *OVERSEER* is recognized as an appropriate tool to undertake the process of establishing the Nitrogen Reference Point, whilst recognizing that for some types of primary production industries there has been less development and validation of this model to date. Processes will be developed in the implementation of Plan Change 1 to fill some of these gaps. (p156)

30 And that:

> To manage any uncertainty around approval of alternative models, a process of approval by the Chief Executive Officer of Waikato Regional Council for each alternative model has been inserted into … schedule [B] … (p157)

31 In the discussion around the recognition of OVERSEER as an appropriate model, the Section 32 Report fails to investigate the potential alternatives to the use of OVERSEER. But it recognises that OVERSEER is inadequate in the way that it models the loss of phosphorus (**P**) across the soil surface, its estimation of the volume of P and E.coli lost, and the impact of these contaminants on water quality.

32 In my opinion this failure of the Section 32 Report results from its focus being substantially on management of nitrogen (**N**), its failure to recognise the importance of the three other contaminants, and its failure to evaluate alternative models that are able to address the reduction of all four contaminants and meet the freshwater objectives in Table 3.11-1.

33 I would also make the following points as to why I question the choice of OVERSEER and its use in a regulatory context:

33.1 OVERSEER is a “black box” piece of software that means that its operation is not open sourced therefore it cannot be reviewed as to the accuracy of what it is modelling. It has not been externally reviewed in any form.

33.2 OVERSEER uses monthly time steps in the majority of its inputs so it is not able to accurately portray various operations, including a range of available mitigations that are subtler in their timing.

33.3 OVERSEER uses a long-term average climatic record therefore it is only able to report average data, it is not able to report the plumes of contaminant emissions, and it does not accurately report the actual nature of emissions or the timing of them.

33.4 OVERSEER only models to the end of the root zone and does not allow for more detailed reporting of the transport of nutrients through the total soil profile.

33.5 The modelling of P is crude in the way that OVERSEER analyses and reports the transfer of P across the surface of the ground.

34 I note that the Parliamentary Commissioner for the Environment (**PCE**) recently released his report "OVERSEER and regulatory oversight: Models, uncertainty and cleaning up our waterways" (December 2018) where he concludes that:

> … a significant amount of information needed to confirm OVERSEER's use in a regulatory setting is lacking. (p118)

35 He then goes on to make a number of recommendations as to what needs to be done to make OVERSEER suitable for use in a regulatory setting. These recommendations are covered in the evidence of Mr Conland.

36 I also note that the Ministry for Primary Industries, one of the joint owners of OVERSEER, has recently announced that it intends to spend $5 million over the next four years on software development on OVERSEER. While this investment is laudable, the limitations of the OVERSEER model will remain until the issues identified by the PCE and other commentators (including myself) have been fixed. It is therefore critical that PC1 provides for other models to be used either in conjunction with or instead of OVERSEER as recommended by Mr Williamson, Dr Jordan, and Dr Cresswell in their Block 2 evidence.

37 I therefore am encouraged by the Block 2 Section 42A Report and the officers conclusion that:

> … OVERSEER can be used in regulation in a relative sense but not an absolute sense. OVERSEER can be used to give a good indication of whether a change in practice, on a particular farm, is likely to increase or decrease nitrogen leaching from that farm. It cannot be used to definitively identify how much nitrogen is actually leaching from the farm. (Para 19)

38 And that:

> Currently, an OVERSEER derived NRP should not be a point of compliance, but a tool to ensure farm changes described in the FEP do not result in increasing nitrogen leaching. ( Para 21)

39 I cannot however agree with the officers conclusion that:

> OVERSEER is the best tool we have for managing nitrogen leaching from most properties or enterprises. (Para 21)

40 Because of the limitations that I have outlined in paragraph 29 above and my knowledge of the capability of alternative models like APSIM I would question that conclusion.

41 Although WPL initially sought to include the names of alternative models in PC1 it is my understanding that WPL now suggests that this is not necessary and that a description of the appropriate capabilities of a decision support tool or model (based on the PCE's criteria) is a more appropriate manner of dealing with the use of alternative models when preparing FEPs. I agree with this approach.

42 I discuss this approach in my Block 2 evidence (below) in relation to the appropriate features of a FEP.

43 While there will no doubt be a number of properties that could be adequately served by the use of OVERSEER in the estimation of their alternative options for mitigation (reducing diffuse contaminant discharges) there will likely be many other properties and enterprises who would be better served by an alternative decision support tool that is better able to estimate all of the four contaminants and to project their pathway from the farm to the river.

44 In my view, it is more effective and efficient to allow for the adoption of a suite of more inclusive and complete alternative decision support tools in PC1 than to prescribe the use of what has been well described as a particularly crude and uncertain modelling tool.

45 It is also pleasing to note that in the Block 2 Section 42A Report the officers recommend that:

> Table 1 should be deleted [from Schedule B] and included in a WRC guidance document for populating the OVERSEER model, which can be updated as new OVERSEER versions are produced. (Para 152)

46 I support this recommendation. This is the approach that I will articulate in my Block 3 evidence on FEPs.

**RDST and scenario modelling**

47 WPL have created their own decision support tool that is called the Ruahuwai Decision Support Tool (**RDST**) Mr Williamson, Dr Jordan and Dr Cresswell, outlined the creation of the RDST in their Block 1 evidence. The RDST has been used to evaluate a range of possible scenarios to compare their individual performance in terms of losses to the river of N, P and sediment.

48 In this way I have been able to compare the results of the various RDST scenarios in terms of their financial performance and their financial efficiency calculated as the return per unit of leaching to the river. My financial analysis is set out in **Appendix 1** attached.

**Topic C1.2 Policy 1 and rule framework**

49 Part E.3 of the Section 32 Report (pp141-183) evaluates a suite of 19 provisions that are designed to achieve the long-term and short-term goals in Objectives 1 and 3. These provisions include all 6 land use rules that control farming activities and commercial vegetable production together with the related PC1 policies, methods, and schedules. In my view, the most critical aspects of these provisions are the priority dates in the rules, and the FEP requirements. The dates in the rules underpin when resource consent applications must be filed and when FEPs must be put in place for implementation. My general conclusion is that the notified dates will not (unless amended) implement Objective 3.

50 The Block 2 Section 42A Report (p39) also emphasises the combined importance of Policy 1 and the rule framework, and Policy 2 and FEPs.

**The dates to achieve the rules**

51 I understand that a range of dates are provided in PC1 by which landowners may be required to action and implement measures to meet the freshwater objectives in Table 3.11-1. For example, under Rule 3.11.5.4 (as amended by Var1):

51.1 Priority 1 sub-catchments – farming is permitted until 1 September 2021 and resource consent applications including FEPs are required to be lodged by 1 March 2022.

51.2 Priority 2 sub-catchments – farming is permitted until 1 September 2024 and resource consent applications including FEPs are required to be lodged by 1 March 2025.

51.3 Priority 3 sub-catchments – farming is permitted until 1 January 2026 and resource consent applications including FEPs are required to be lodged by 1 July 2026.

52 For properties and enterprises in Priority 3 sub-catchments compliance with the freshwater objectives in Table 3.11-1 is not therefore required until the end of the PC1 plan period.

53 In my opinion this approach is inequitable for a number of reasons. It requires landowners in Priority 1 sub-catchments to take action while landowners in other sub-catchments are apparently required to do nothing to restore or protect (improve or maintain) water quality. More importantly, it prevents landowners in Priority 2 and Priority 3 sub-catchments from obtaining resource consent early and implementing FEPs early, and will likely result in landowners in these sub-catchments being unable to meet the short-term freshwater objectives in Table 3.11-1 by 1 July 2026. At one extreme this approach (potentially) allows some landowners to carry on existing farm practices with no change in profitability until consent is finally required, and at the other extreme denies innovative landowners the commercial certainty of operating under consents designed to comply with best practice methods.

54 In terms of water quality improvement it will (following the grant of resource consent) take landowners approximately two to three years to action and implement their FEPs before we can expect to see a positive change in the water quality of the river. For the properties and enterprises in Priority 2 and 3 sub-catchments any change in water quality will be outside the time frame of PC1. It is unlikely that the critical short-term objective (Objective 3) will be met.

55 This does not sit well with the officers' contention that all properties or enterprises should contribute to the desired gains in water quality from the start of the PC1 plan period. The WPL submissions requested amendments to the rules (e.g. Rule 3.11.5.4) that would overcome these issues by allowing landowners to apply for consent early, and Mr McKay has refined these amendments in his Block 2 evidence.

56 As I understand it the reason for staging the implementation of PC1 was because WRC staff estimated that there could likely be 5,000 consents required across the whole catchment so it was considered necessary to stagger them in this way.

57 However, these assumptions do not take account of the efficiency gains implicit in PC1. For example, by providing for enterprise scale consents it is likely that less consent applications will be lodged because some landowners will combine to submit such applications. PC1 also provides for a sub-catchment scale approach (Method 3.11.4.5) but fails to follow through and provide for sub-catchment scale consents to be obtained. The WPL submissions would however remedy that situation if accepted. Providing for sub-catchment scale consents would also reduce the potential number of consent applications required to be processed.

Making better provision for Certified Industry Schemes (**CIS**) or Sector Schemes would also reduce the number of consents required to be processed. For example, the Block 1 evidence from Miraka suggests that the CIS manager or consent holder would be responsible for preparing a generic FEP that all CIS members within the subject land area covered by the consent would be required to comply with. The same situation could potentially apply to Fonterra globally across the whole catchment, and for other sectors such as Beef + Lamb it is possible that as few as 74 or 75 consents could be required. Overall, consenting at these different scales would significantly reduce both compliance and regulatory costs and reduce the number of consent applications required to be processed in order to implement PC1. Mr McKay illustrates in his Block 2 evidence how the rules should be amended to secure these efficiency gains (including how the problems with CIS as notified can be resolved).

**Topic C1.3 Policy 2 and Farm Environment Plans**

58 As noted above, the requirements for FEPs in Schedule 1 are a critical aspect of making reductions in diffuse discharges. They need to be considered together with Policies 1 and 2 and the rule framework.

**FEPs an overview**

59 The following discussion provides an overview of what I consider to be the necessary elements of a FEP approach to achieving the freshwater objectives in PC1. This approach has been developed as a result of my experience in the development and actions associated with FEPs in Canterbury over the last ten years. I consider that my approach would best be described as enabling rather than a prescriptive approach, based on learnings about the power of FEPs to engender change in the way that landowners carry out their farming activities.

60 FEPs have made tremendous progress towards the achievement of long-term sustainability and meeting water quality targets. In many cases these achievements have been gained in advance of regulatory time frames.

61 I am of the opinion that the modelling elements of Schedule B should be folded into the requirements for FEPs in Schedule 1 of PC1.

62 The first important step is the risk assessment. This should include an appropriate vulnerability assessment for N, P, sediment and E.coli.

63 I believe that the next important step is a description of the actions that should be undertaken to mitigate the potential risks including a description of the time frames that they are going to be undertaken within.

64 In my opinion it is not appropriate to include a requirement for a 75$^{th}$ percentile N leaching value in a FEP because of the poor connection to meeting the freshwater objectives in Table 3.11-1. Rather the FEP should specify that the risk has been tested through an appropriate decision support tool or model. I also recommend that the role of the NRP be reduced so that it becomes a compliance mechanism to compare changes in land use and mitigation actions within a farming property or enterprise.

65 As noted above, I suggest that it would be appropriate to use criteria, like those developed by the PCE, as the basis for evaluating the appropriateness of a decision support tool or model.

66 The FEP should also inform the conditions of resource consents granted under PC1.

67 On reflection, I do not believe that there is much value in defining things such as Good Farming Practices (**GFP**) or Best Management Practices (**BMP**). In my opinion there is a place for adoption of such practices purely as a means to gain some equity in terms of the scale of mitigations required across similar properties or enterprises that each landowner should start from. However, these do not need to be defined in PC1. I understand that the Vision and Strategy encourages the promotion of "best practice methods" for restoring and protecting the health and wellbeing of the Waikato River. In my view, best practice will be achieved by stock exclusion, avoiding vulnerable land, carrying out an appropriate risk assessment, and implementing FEP mitigations.

68 My recommended changes can be found in the Block 2 evidence of Mr McKay.

**The role of adaptive management**

69 Once a FEP has been implemented there should be a requirement to monitor the performance of the mitigation package adopted and adapt the approach if the monitoring data indicates that the freshwater objectives for the relevant sub-catchment are not being met.

**Topic C1.4 Reductions**

70 The NRP and the 75$^{th}$ percentile N leaching value form part of the suite of PC1 provisions assessed in Part E.3 of the Section 32 Report in relation to making reductions in diffuse discharges. My

general conclusion is that Policy 1 and the rule framework together with Policy 2 and FEPs (as amended by WPL) provide a suite of efficient and effective methods for implementing Objectives 1 and 3. For the reasons given below, the NRP and the 75th percentile N leaching value are not (in my view) required to implement PC1.

**75th percentile**

71 In my Block 1 evidence I maintained that the failure to evaluate the NRP is a s 32 matter in terms of whether it is the most appropriate method for achieving the PC1 objectives, and in terms of the efficiency and effectiveness (in particular) of requiring that everyone above the 75th percentile N leaching value must reduce their N discharges was yet another major inadequacy of PC 1.

72 If the use of the NRP and the 75th percentile N leaching value had been put through an appropriate set of economic tests regarding their effectiveness and efficiency as stand alone alternatives instead of being included in the rather large and unwieldy "Option 6 Mandatory Farm Environment Plans, mandatory mitigations, no increase in nitrogen discharges for any farm, property cap and reduction in nitrogen discharges for high dischargers", I am sure that a more appropriate means of achieving the PC1 freshwater objectives would have been developed which would mean that the long-term 80year freshwater objectives could be met in a much shorter time frame.

73 From an effectiveness point of view, I note that even in the officers' view it is unlikely that PC1 Objective 3 (short-term freshwater objectives) will be achieved in all sub-catchments by 2026 (see the Block 1 Section 42A Report, p125).

74 I also have difficulty with attempting to achieve a certain outcome in the river by managing it with a tool that has no relationship with the amount of N in the river. At best there is a very tenuous link between the amount of N available at the end of the root zone as modelled in OVERSEER and the freshwater objectives detailed in Table 3.11-1. This is particularly so when considered in the light of the Block 2 evidence from Mr Williamson which links the modelled N pathway from the end of the root zone to the river and completely changes our interpretation of the degree of risk at different sites across the catchment.

75 Therefore the use of OVERSEER to calculate a NRP and determine the 75th percentile N leaching value, which is used as a benchmark for everyone who is over the 75th percentile to reduce their diffuse N discharges to the 75th percentile leaching value (by 1 July 2026,) assumes that all properties or enterprises have the same degree of impact on the river. This is not correct and is a particularly ineffective means of achieving the freshwater objectives

because there is no estimation of the true impact on river quality factored into the mechanism.

76 So in all likelihood the adoption of the 75th percentile N leaching value mechanism will achieve an unknown amount of reduction in N getting into the river, poor effectiveness, having potentially large negative impacts on the Regional economy, and poor efficiency.

77 I note that in the Block 2 Section 42A Report the officers (at paragraph 372) equivocate as to their recommendation and say:

> If OVERSEER-based NRP numbers are considered robust enough, clarifying the definition and use of the 75th percentile.

78 It is my opinion that neither the effectiveness nor the efficiency of adopting the 75Th percentile N leaching value provision as modelled through OVERSEER is sufficiently proven to justify its adoption.

79 In the Block 2 Section 42A Report (Appendix C) it recommends a reworded definition of the 75th percentile N leaching value mechanism as:

> **75th percentile nitrogen leaching value:** The 75th percentile value (units of kg N/ha/year) of all of the Nitrogen Reference Point values for dairy farming properties ~~and enterprises~~ within each river (including properties within any lake Freshwater Management Unit within the relevant river Freshwater Management Unit) Freshwater Management Unit^ and which ~~are~~ is determined by the Chief Executive of the Waikato Regional Council and published on the Waikato Regional Council website and can be based on aggregated data supplied to the Waikato Regional Council and individual farm data received by the Waikato Regional Council by ~~30 November 2020~~ YYY. (P80)

80 This definition causes me considerable concern because of the uncertain nature of the definition as to the nature of the data provision. The removal of the enterprise from the definition, and the perverse incentive to delay reduction until the latest possible compliance date, if at all.

81 It is my opinion that much more will be achieved in terms of achieving the PC1 freshwater objectives by adoption of N vulnerable land assessment criteria in the FEP schedule and relevant rules. These criteria will identify which land is vulnerable to loss of N to the river and then allow landowners to assess the amount of risk and develop appropriate mitigation strategies as part of the FEP to reduce the risk. I discuss this approach in my section on the FEPs (above).

82 Therefore my recommendation is to delete both the requirement for the 75th percentile N leaching value mechanism and to reduce the role of the NPR to a compliance mechanism. In the alternative replace them with appropriate methods in the FEP that achieve the freshwater objectives in the Table 3.11-1 more effectively and more efficiently.

**The impact of the NRP on land values**

83 Although PC1 avoids the question of allocation (in terms of assimilative capacity) the reality of the situation is that the calculation of a N leaching number or NRP, will likely be perceived as the creation of a quasi allocation of leaching rights regardless of whether this is actually the legal position under the RMA. The number is one that the property or enterprise is able to farm up to, but it is not allowed to exceed for at least the life of PC1 (2016-2026).

84 This is effectively a form of allocation called “grand parenting”. Under grand parenting of leaching rights landowners are given a nutrient discharge allowance based on their land use and nitrate leaching rates during a benchmarking or baseline period.

85 The advantages which grand parenting achieves are that:

85.1 It recognises existing land use, significant existing capital investment and current N loss.

85.2 This approach is often the least disruptive approach relative to other allocation methods, in terms of net revenue, as it allows landowners to continue without disturbing their current operations and there are no immediate upfront costs (Daigneault, Greenhalgh, & Samarasinghe, 2017).

85.3 Generally, it is the second best approach (out of seven) in terms of economic efficiency (Daigneault, Greenhalgh, & Samarasinghe, 2017).

85.4 It recognises farm variability in N loss rates within and between sectors.

86 The disadvantages that come with grand parenting are that:

86.1 In terms of equity, the grand parenting approach can be considered inequitable, as it may be unfair to reward historic polluters since they may also be best situated to reduce pollution at lower costs.

86.2 The high opportunity costs for landowners who have not yet developed land or have low N discharges, because it may artificially constrain land use change.

86.3 It potentially rewards current inefficiencies by allocating a higher number of discharge allowances to operations on lower class or high leaching land.

87 These perceptions about allocation are already being factored into land valuations within the Waikato Region and are now generally a requirement of any sale and purchase agreement (particularly, from a purchasers or bank lending perspective).

**Topic C1.5 Land use change**

88 Restricting land use change was assessed in Part E.4 of the Section 32 Report (pp184-193). The report notes that this policy area is also intended to achieve Objectives 1 and 3. Policy 6 and Rule 3.11.5.7 are proposed to implement these objectives.

89 My general conclusions are that these provisions (as notified) will not be effective or efficient because:

89.1 PC1 includes a suite of 19 other provisions that (as amended by WPL) will be appropriate to implement Objectives 1 and 3 without constraining land use change.

89.2 The provisions will effectively preclude land use change on non-vulnerable land that could otherwise be carried out in a way that meets the freshwater objectives in Table 3.11-1.

89.3 Meeting the freshwater objectives in Table 3.11-1 for the relevant sub-catchment should be the key resource management criterion for deciding land use change applications.

89.4 For non-vulnerable land the constraints on land use change will reduce economic growth and employment opportunities.

89.5 For non-vulnerable land the constraints on land use change will also impose an unreasonable restriction on use of the subject land and likely render it incapable of reasonable use.

89.6 A less restrictive restricted discretionary activity consent pathway will (based on the Block 2 evidence of Mr McKay) be appropriate for deciding land use change applications.

90 While the Section 42A Report recommends some amendments to these provisions, the recommended amendments do not in my view address the issues raised in my Block 2 evidence below.

91 The s 32 evaluation under the RMA includes a requirement to take into account the proposed polices and rules and in doing so identify and assess their environmental, economic, social and cultural effects, and (in particular) address whether the policies and rules will provide for or reduce the opportunities for economic growth and employment.

92 It is my opinion that the WRC s 32 evaluation is wholly inadequate because it focused almost exclusively on the preferred options, and because it did not consider the opportunity to allow for land use change while still meeting the freshwater objectives in Table 3.11-1. Land use change certainly allows for economic growth and employment, and is (in my view) an appropriate option to select where environmental bottom lines are met.

93 In the Section 32 Report there are only two options evaluated as being reasonably practical. The first was "Existing Waikato Regional Plan policies, rules and methods" the second is "Controls on changes in land use" the description of the second option states that:

> Restrict and manage specified, major changes in land use that are likely to result in additional diffuse discharges of nitrogen, phosphorus, sediment and microbial pathogens. (P 184)

94 It is disappointing to me that they did not also evaluate an option that allows for land use change where the freshwater objectives in Table 3.11-1 can be met.

95 What is proposed is a particularly blunt instrument. It certainly fails the effectiveness evaluation criteria because it is not based on any connection between land use change and the freshwater objectives in Table 3.11-1. The resultant economic growth that would come from appropriate land use intensification would certainly contribute to the efficiency measure in terms of allowing communities to enhance their wellbeing in both economic and environmental terms. For example, in relation to the Wairakei Estate the constraints on land use change will have an impact on the delivery of the significant economic and employment opportunities that contribute to community wellbeing outlined by Mr Green in his Block 1 evidence and detailed in the attached Insight report (**Appendix 2**). The impact on other non-vulnerable land in the upper Waikato River FMU will likely be similar.

96 Rule 3.11.5.7 as notified assumes an incorrect connection between the discharges as a result of land use change in terms of N leaching and a deleterious impact on water quality in the river. As demonstrated in the Block 1 evidence of Mr Williamson that connection is not valid (in all cases) as a result of attenuation and other factors.

97 Therefore it is my opinion that it would be more efficient and effective to provide for land use change as long as it could be shown that the freshwater objectives in Table 3.11-1 could be met. This could be achieved by allowing for land use change in a more enabling consenting process as a restricted discretionary activity as suggested in the Block 2 evidence of Mr McKay.

98 Generally, there would in my view be no reasons for constraining land use change where the freshwater objectives in Table 3.11-1 are met.

**Topic C1.6 Other relevant policies and schedules**

99 This topic appears to address two different sets of provisions.

100 First, it addresses in part the suite of PC1 provisions designed to make reductions in diffuse discharges. These provisions were addressed in Part E.3 of the Section 32 Report (pp141-183). The key provisions have already been discussed under Topic C1.1 above. Policy 4 as notified enables existing and new low discharging activities to continue provided that they meet short-term freshwater objectives in Table 3.11-1. The WPL submissions generally support this policy subject to appropriate provision being made in PC1 for sub-catchment scale consents. Policy 4 is in my view appropriate but will not be implemented unless the PC1 rules and schedules are amended as discussed above in my Block 2 evidence. Policy 8 is more problematic because it puts in place the priority dates used in Rule 3.11.5.4 that trigger when resource consents and FEPs are required. For the reasons discussed above in my Block 2 evidence the notified dates are not practical and will (unless amended) impede rather than implement Objective 3. Schedule A in terms of property registration will in my view be important as a condition of permitted activities and as an information requirement when applying for land use consent.

101 Second, this topic addresses the PC1 provisions relating to staging the transition to the 80-year goal in Objective 1. From Part E.2 of the Section 32 Report (pp131-140) Objectives 2, 3, and 4 also appear to be relevant in terms of meeting this long-term goal. WPL generally supports this policy and related objectives. Policy 5 is appropriate in my view for implementing these objectives but it is unlikely to be implemented unless the suite of provisions designed to implement the short-term goal in Objective 3 are amended as discussed above in relation to Topic C1.1 in my Block 2 evidence.

102 I also note that a number of provisions that appear (from Part E.2 of the Section 32 Report) to be relevant for implementing Policy 5 have been left for consideration in Block 3. These provisions include: Policy 7, Policy 17, Method 3.11.4.7, Method 3.11.4.8, Method 3.11.4.10, Method 3.11.4.11, Method 3.11.4.12. If these

provisions are relevant they should, in my view, be considered together in the same Block.

103 Mr McKay will address the various definitions that are recommended to be amended by the Block 2 Section 42A Report in his Block 2 evidence.

**TOPIC C3. CERTIFIED INDUSTRY SCHEMES**

104 As noted above, making some provision for Certified Industry or Sector Schemes (**CIS**) in PC1 is (in my view) sensible in terms of efficiency and effectiveness and reducing the number of resource consents required under PC1. While arriving at this general conclusion I am aware of the legal issues regarding CIS addressed in the WPL submissions, and note from the Block 2 evidence of Mr McKay that some amendments will need to be made to the PC1 rules and schedules to provide an appropriate consenting pathway for CIS.

105 Generally, CIS provide the potential for global consents to be held and managed (across the whole or part of the river catchment) by an appropriate legal entity, and for individual properties and enterprises that are CIS members to be operated in accordance with the FEP for the CIS.

106 In my view, devising the appropriate consenting pathway for CIS should be considered in the context of making reductions and the catchment wide rules under Topic C1 above because they were assessed in this way in Part E.3 of the Section 32 Report (pp141-183).

107 Similarly, it does not make sense to leave Method 3.11.4.2 for consideration in Block 3 because (again) this method formed part of the assessment in Part E.3 of the Section 32 Report. If this method remains relevant it would be sensible in terms of efficiency and effectiveness for it to be considered now as part of the package of provisions that are focused on making reductions and the catchment wide rules.

**TOPIC C4. STOCK EXCLUSION**

108 In my view, stock exclusion is a critical element of avoiding N vulnerable land. It is part of the package of provisions relevant to making reductions and the catchment wide rules considered in Part E.3 of the Section 32 Report.

109 The main issue with Schedule C as notified is the question of timing because it is broadly aligned with the compliance dates for land in Priority 1, Priority 2, and Priority 3 sub-catchments. These compliance dates will need to be amended to reflect the need for

FEP mitigations (including stock exclusion) to be implemented in advance of 1 July 2026 so that the short-term freshwater objectives in Table 3.11-1 are met by this date. I understand that this is essential to meet PC1 Objective 3. Mr McKay addresses this point in his Block 2 evidence.

**TOPIC C5. MAORI TREATY SETTLEMENT LAND**

110 I understand that Objective 5 and Policy 16 address the equity issues regarding the flexibility of the use to Te Ture Whenua ancestral land and Treaty settlement land. Policy 6 as notified also includes a cross-reference to Policy 16 but I note that the Block 2 Section 42A Report now recommends that Policy 6 should be deleted.

111 Providing for the development of Te Ture Whenua ancestral land and Treaty settlement land in the context of meeting the freshwater objectives in Table 3.11-1 could be challenging in some (if not all) sub-catchments.

112 The possibility of N discharge allowance transfers as provided for in Rule 3.10.5.7 and Rule 3.10.5.8 in the operative Waikato Regional Plan (**WRP**) could provide a mechanism that would assist in the development of Te Ture Whenua ancestral land and Treaty settlement land but would require the allocation of N discharge allowances via NRP and 75$^{th}$ percentile N leaching value type provisions. For the reasons given above I do not consider that these types of provisions would be efficient or effective.

113 While I recommended the inclusion of transfer provisions in PC1 in my Block 1 evidence, the focus on land use rules (rather than hybrid rules as notified) means that such provisions are unlikely to be workable because land use consents normally run with the land.

114 The other possible (and in my view, preferable) mechanism to enable the development of Te Ture Whenua ancestral land and Treaty settlement land would be via sub-catchment scale resource consents as requested in the WPL submissions. This mechanism would enable such to be developed while meeting the freshwater objectives in Table 3.11-1. The FEP for the sub-catchment consent would address the mitigations required to enable this. Mr Conland illustrates how this could work in the context of Sub-catchment 66B in his Block 2 evidence, and Mr McKay explains the amendments required to the PC1 rules to provide for sub-catchment scale resource consents in his Block 2 evidence.

**TOPIC C6. URBAN/POINT SOURCE DISCHARGES**

115 I understand that PC1 includes a number of provisions (Policy 10, Policy 11, Policy 12, Policy 13, and Policy 17) that provide the basis

for consequential amendments to the point source discharge rules in the operative WRP. The Section 32 Report (pp193-200) explains that these provisions are designed, in particular, to implement the short-term (2016-2026) Objective 3.

116 The WPL submissions requested amendments to Policy 13 in particular to provide guidance in relation to the consent duration of both point source and diffuse contaminant discharges. Policy 13 as notified provides for a 25year consent duration. I also note that WRC has granted consents for land use change under Rule 3.11.5.7 expiring in 2030. In my view, either of these consent durations would be appropriate. The critical point in terms of efficiency and effectiveness is that policy guidance is provided by PC1 regarding consent duration to provide commercial certainty for landowners and environmental certainty for the community in terms of monitoring and consent renewals.

117 I note that Policy 17 has been left for consideration in Block 3. If this policy forms an integral component of the package of provisions assesses in Part E.5 of the Section 32 Report, then (in my view) it should be considered now in a holistic way along with the other relevant policies. Splitting the assessment of provisions designed to work together does not appear to me to be sensible, or an efficient or effective way of examining the PC1 provisions.

**CONCLUSIONS**

118 I have reviewed the RDST scenarios that were modelled. I have undertaken economic modelling on those scenarios including calculation of the flow-on impacts that will occur. I find that when considering the merits of the range of scenarios presented listing both those proposed under PC1 and the alternatives as suggested by WPL that the Vulnerable Land FEP and mitigations scenario is the most attractive option from both a financial and an economic perspective.

119 When considering this result in a Section 32 framework it is the most effective and efficient because it achieves a significant level of progress towards meeting the freshwater objectives in Table 3.11-1 while still achieving the highest returns in terms of Gross Revenue and Net Cash Position and in the flow on metrics for Gross Output, Value Added and Employment of the scenarios modelled. This means that it will have the greatest impact on community wellbeing because it will create the greatest amount of economic growth and employment in the Waikato Region.

120 The Block 1 evidence of Mr Williamson showed that the flow path for nitrogen (**N**) in groundwater is much shorter in time than previously considered by WRC, and the Block 1 evidence of Dr Neale showed that the heavy emphasis on the management of N in PC1 (as notified) is not appropriate and that there should be an

equal amount of emphasis on phosphorus (**P**), sediment and E.coli in the planning framework that is ultimately developed.

121 In my view, it is more effective and efficient to allow for the adoption of a suite of more inclusive and complete alternative decision support tools in PC1 than to prescribe the use of what has been well described as a particularly crude and uncertain modelling tool.

122 The range of dates that are provided in PC1 by which landowners may be required to action and implement measures to meet the freshwater objectives in Table 3.11-1 will mean that the action of farmers will be variable and that it denies innovative landowners the commercial certainty of operating under consents designed to comply with best practice methods. By providing for enterprise scale consents it is likely that less consent applications will be lodged because some landowners will combine to submit such applications and therefore the staggering of the dates is not necessary.

123 I am of the opinion that the modelling elements of Schedule B should be folded into the requirements for FEPs in Schedule 1 of PC1.

124 In my opinion it is not appropriate to include a requirement for a 75$^{th}$ percentile N leaching value in a FEP because of the poor connection to meeting the freshwater objectives in Table 3.11-1. Rather the FEP should specify that the risk has been tested through an appropriate decision support tool or model. I also recommend that the emphasis on the NRP be reduced so that it becomes a compliance mechanism to compare changes in land use and mitigation actions within a farming property or enterprise.

125 I do not believe that there is much value in defining things such as Good Farming Practices (**GFP**) or Best Management Practices (**BMP**).

126 It is my opinion that it would be more efficient and effective to provide for land use change as long as it could be proven that the freshwater objectives in Table 3.11-1 could be met. This could be achieved by allowing for land use change in a more enabling consenting process as a restricted discretionary activity as suggested in the Block 2 evidence of Mr McKay.

**Stuart John Ford**

The AgriBusiness Group

3 May 2019

**APPENDIX 1**

**Financial Analysis**

# Methodology and Results of the RDST Scenario Financial and Economic Modelling

## 1 Summary

I have developed an economic model that has allowed me to express the performance of the scenarios modelled in the RDST model, as covered in the evidence of Mr Williamson and Mr Conland.

The information provided on the financial and economic evidence should be regarded as indicative rather than actual. A number of assumptions have had to be made during the development of my model. When I am able to replace these assumptions with actual data the quality of the information will improve but I am of the opinion that this will not alter the conclusions that can be gained from my work.

It is my opinion that the financial and economic analysis should form an important part of the decision making. Under the RMA decision making is a balancing act between the environmental, social and the economic elements of the decision. Dr Neale in his evidence has been able to comment on the relative performance of the various scenarios as to their environmental impact in terms of meeting the freshwater objectives in Table 3.11.1. In my evidence I am able to report the relative financial performance of the various scenarios and indicate several flow on impacts that should be considered as part of the social assessment in terms of whether the community in the Waikato Region is able to contribute to their wellbeing.

The financial models as presented report:

- Gross Revenue, which is the total revenue from all sources;
- Farm Working Expenses which report all of the working expenses of the farm;
- Cash Farm Surplus which reports Gross Revenue minus Farm Working Expenses; and
- The Net Cash Position which reports the Cash Farm Surplus minus Interest, Taxation, Drawings, Capital Purchases, Development Expenditure and Principal repayments. Essentially it reports the true profit from the business.

The Gross Revenue figure deteriorates depending on which scenario is considered. For example: with a Farm Environment Plan (FEP) and GFP ($ 451 m); or with a FEP and BFP ($437 m); or with a FEP and 75th Percentile ($444m). Then there is a considerable downward change with a FEP and LUC ($306m); a considerable rise with the Vulnerable Land FEP and mitigations ($490m); and a corresponding drop down with a Vulnerable Land FEP and land use change and mitigations ($371m).

The Net Cash Position figure shows a more extreme difference than the Gross Revenue analysis although it shows a similar pattern. It also deteriorates depending on which scenario is considered. For example: with a FEP and GFP ($ 127 m); with a FEP and BFP ($91 m); with a FEP and the 75$^{th}$ Percentile ($91m); a considerable downward change \ with a FEP and LUC ($53m); a considerable rise with the Vulnerable Land FEP and mitigations ($172m); and a lesser drop down with the Vulnerable Land FEP and land use change and mitigations ($115m).

What can be concluded from the financial analysis from an overall perspective (and from an individual business owners perspective) is that the FEP and GFP scenario is the most preferred of the three options that are relevant to PC 1 as notified.

Of the alternatives offered the Vulnerable Land FEP and mitigations scenario would be the most preferred scenario over the FEP and LUC, or the Vulnerable Land FEP and land use change and mitigations scenarios.

The financial modelling reports the results at the “farm” or property or enterprise gate. Past the farm gate there is a considerable amount of activity which results in a lot of additional economic activity referred to as the flow on impacts. The farm gate results, are referred to as the direct effects, the flow on effects are referred to as the indirect effects and when they are added together they report the total economic effects of the activity.

For this exercise I report three different factors that can be derived with the use of multipliers:

- Gross Output which reports the total gross income generated by the activity.
- Value Added which reports the gross revenue minus all the costs of production.
- Employment which reports the total number of jobs expressed as full time equivalents (FTE).

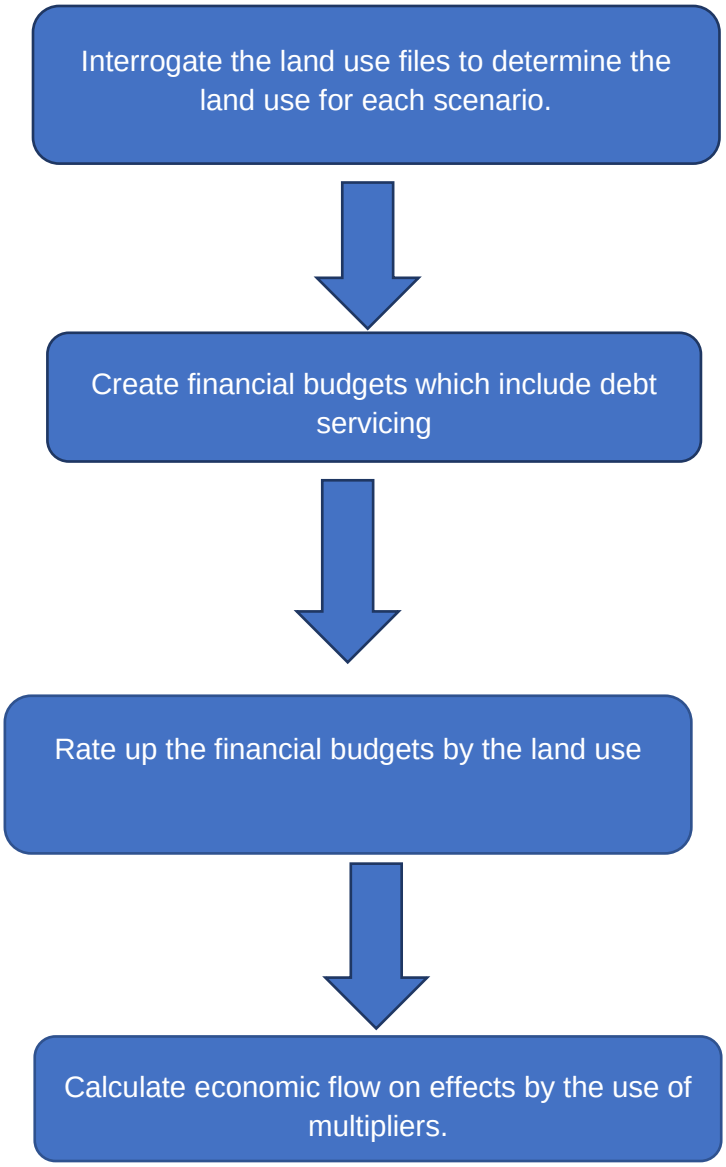
The conclusions that can be drawn from the flow on impact assessment of the scenarios run in the RDST model are:

- The three scenarios which represent PC 1 as notified are all very similar in terms of their flow on impacts. Therefore they would all be considered to contribute equally to the wellbeing of the community.
- The Vulnerable Land FEP and mitigations scenario is the most superior option in terms of the three alternatives of the flow on impacts reported and would be considered to be the preferred option in an economic sense.
- The FEP and LUC is the most inferior option of those tested.

Overall I find that when considering the merits of the range of scenarios presented listing both those proposed under PC1 and the alternatives as suggested by WPL that the Vulnerable Land FEP and mitigations scenario is the most attractive option from both a financial and an economic perspective.

# 2 Methodology

I have developed an economic model that has allowed me to express the performance of the scenarios modelled in the RDST model, as covered in the evidence of Mr Williamson and Mr Conland. This has entailed the following process:




The information provided in the financial and economic evidence should be regarded as indicative rather than actual. A number of assumptions have been made during the development of my model. When I am able to replace these assumptions with actual data the quality of the information will improve but I am of the opinion that this will not alter the conclusions that can be gained from my work.

It is my opinion that the financial and economic analysis should form an important part of the decision making. Under the RMA decision making is a balancing act between the environmental, social and the economic elements of the decision. Dr Neale in his evidence has been able to comment on the

relative performance of the various RDST scenarios as to their environmental impact in terms of meeting the water quality targets in Table 3.11.1. In my evidence I am able to report the relative financial performance of the various scenarios and indicate several flow on impacts which are able to be considered as part of the social assessment regarding whether the community in the Waikato Region is able to contribute to their wellbeing.

The scenarios that were tested are those described by Mr Conland in his evidence as follows:

**Scenario 1 – Do Nothing**

This represents a 'future' where the land use as existing at the time of notification (22 October 2016) continues with no mitigations or FEP's developed in the catchment.

**Scenario -1 – Stop Farming**

This represents a 'future' where all land (except native forest, roads, built, and river land uses) are changed to plantation forest. In this situation geothermal inputs and point sources such as Contact Energy's power station are still included. Inflow from Lake Taupo remains unchanged (e.g. Lake Taupo catchment remains developed).

**Scenario 2 – FEP and 'GFP' on all farms**

This represents a 'future' where all farms in the catchment prepared and completed a FEP. This is developed following the 5 protocols developed by WPL and GFP as considered determined by OVERSEER protocols (summarised in Mr Ford's evidence). This is consistent with the first 10 year actions considered by Dr Doole (Doole G.J 2016a[i]).

**Scenario 3 – FEP and 'BFP' on all farms**

This represents a 'future' where the conditions in Scenario 2 exist, except all farms have undertaken significant mitigation steps to "Best Farm Practice" as developed by Mr Ford (in his evidence).

**Scenario 4 – FEP and 75$^{th}$ Percentile limits on all farms**

This represents a 'future' where the conditions in Scenarios 2 exist, except all farms are limited to the 75$^{th}$ Percentile as proposed in the planning provisions under PC1.

**Scenario 5 – FEP then LUC limits applied**

This represents a 'future' where the conditions in Scenarios 2 exist, except all the farms are limited to the Land Use Capability limits for productivity as developed by Mr Ford (in his evidence). The land use changes in intensity follow the direction provided by Dr Doole (Doole et al 2016a).

**Scenario 6 – FEP then mitigations on Vulnerable Land**

This represents a 'future' where farming on Vulnerable Land is avoided and mitigated in proportion to the level of nitrogen risk at the farming location.

**Scenario 7 – FEP then mitigations plus land use changes on Vulnerable Land**

This represents a 'future' where farming on Vulnerable Land is avoided and mitigated similar to Scenario 6 except on land with very low nitrogen risk. At these locations land use changes in terms of intensity following the direction provided by Dr Doole. (Doole 2016a).

Scenario 1, Do Nothing) and Stop Farming are described by Mr Conland as the bookends of possible action. Scenario 2 (FEP and GFP), 3 (FEP and BFP), 4 ( FEP and the 75th Percentile) can all be compared as the PC1 provisions. The alternative scenarios which each represent a different range of on farm changes and costs are Scenario 5 (FEP and LUC), 6 (Vulnerable Land FEP and Mitigations), and 7 ( Vulnerable Land and land use change and mitigations) that can be compared with each other and with the PC1 provisions.

## 2.1 Farm Financial Modeling

The interrogation of the RDST shapefiles was completed for me by Mr Wright from Cardno. The results of his interrogation are shown in Table 1.

**Table 1: Land use split gained from interrogating the RDST Shapefiles**

| | Do Nothing | Stop Farming | FEP & GFP | FEP & BFP | FEP & 75th Percentile | FEP and LUC | FEP and Mitigations on Vulnerable Land | FEP and Mitigations + Land use change |
|---|---|---|---|---|---|---|---|---|
| Dairy | 43,660 | - | 45,427 | 45,427 | 45,427 | 9,031 | 45,427 | 27,013 |
| Dairy_Support | 16,494 | - | 15,386 | 15,386 | 15,386 | 97,556 | 15,386 | 36,664 |
| Dairy_Irrigated | 2,078 | - | 2,078 | 2,078 | 2,078 | - | 2,078 | 4,588 |
| Sheep_and_Beef | 19,774 | - | 19,774 | 19,774 | 19,774 | 44,277 | 19,774 | 23,452 |
| Lucerne_Cropping | 3,848 | - | 4,180 | 4,180 | 4,180 | - | 4,180 | 4,721 |
| Native_Forest | 13,244 | 13,244 | 13,563 | 13,563 | 13,563 | - | 13,563 | 33,623 |
| Forestry | 51,873 | 141,194 | 50,572 | 50,572 | 50,572 | 116 | 50,572 | 20,919 |
| Water | 1,841 | 1,841 | 1,841 | 1,841 | 1,841 | 1,841 | 1,841 | 1,841 |
| Built | 3,136 | 3,136 | 3,121 | 3,121 | 3,121 | 3,121 | 3,121 | 3,121 |
| Lifestyle | 3,468 | - | 3,473 | 3,473 | 3,473 | 3,473 | 3,473 | 3,473 |

As can be seen from Table 1 for the majority of the scenarios are based on the 2018 land use data. The Do Nothing scenario is based on the 2016/17 land use mix but the major differences are between the Stop Farming, FEP and LUC, and Vulnerable Land FEP and land use change and mitigations, where the land use mix changes considerably.

Mr Conland has described the mechanisms which drove the land use change assumptions in his evidence.

My financial models were first developed to match the OVERSEER files to enable a comparison with the APSIM modelling which was carried out to inform the RDST model, they are therefore a representation of the direct land uses that have been modelled. They were then adjusted to match the land uses described in Table 1 and constitute the present land use.

The financial models were then adjusted to represent the changes that were made to the various OVERSEER land use models as described in the nitrogen mitigation modelling report[1] (which is attached to this evidence as Appendix 3) which tested the range of mitigations possible and classified them as Low, Medium and High mitigations. An organic model which was also developed to represent the financial performance that was modelled across a range of the scenarios.

Some of these adjustments entailed changes to production parameters, some made changes to expenditure, and some entailed new capital expenditure. Where the farming property undertook capital expenditure it was capitalized into debt servicing. The financial models used represent a steady state so they do not represent the changes that would occur gradually as a farming property makes the transition from one farming system to another.

The models as presented report:

- Gross Revenue, which is the total revenue from all sources;
- Farm Working Expenses which report all of the working expenses of the farm;
- Cash Farm Surplus which reports Gross Revenue minus Farm Working Expenses; and

The Net Cash Position which reports the Cash Farm Surplus minus Interest, Taxation, Drawings, Capital Purchases, Development Expenditure and Principal repayments. Essentially it reports the true profit from the business.The individual financial models were then rated up against the land use mix to report the total performance of each of the scenarios.

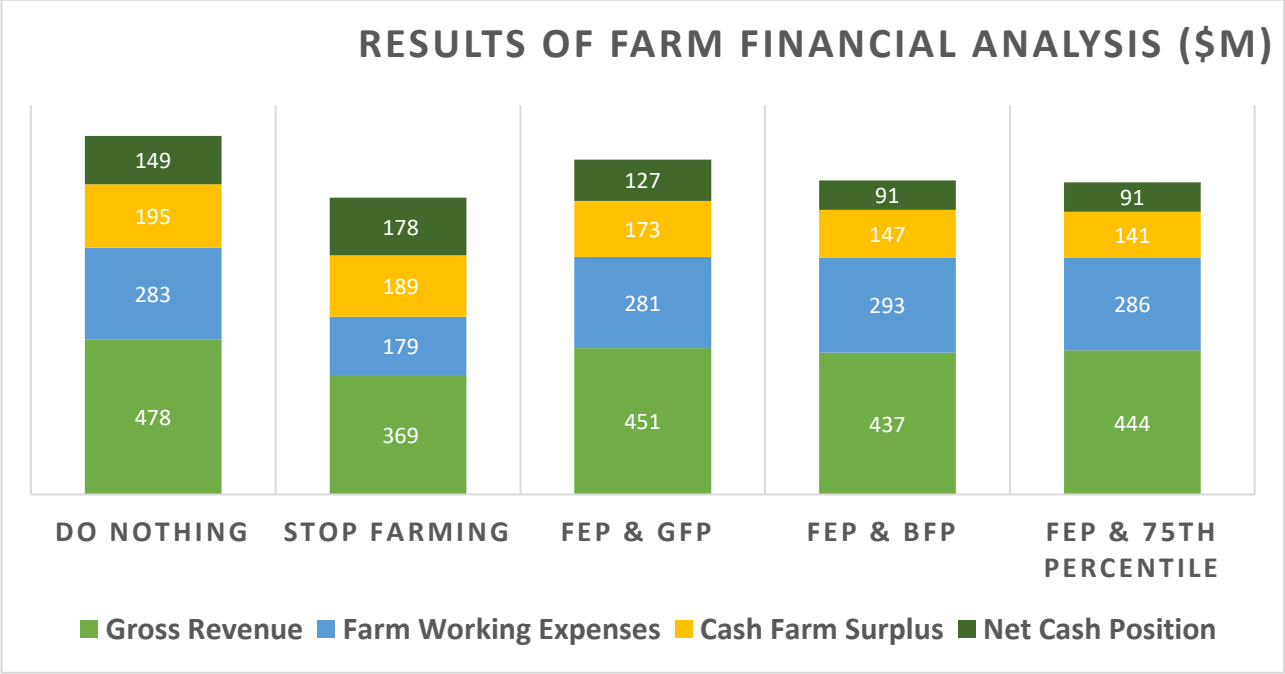
# 3 The Results of the Financial modelling

The results of my full financial modelling representing the PC1 provisions are shown in

Figure **1** and Figure 2.

[1] The AgriBusiness Group ( 2019): Wairakei Estate Nitrogen Mitigation Modelling using Overseer

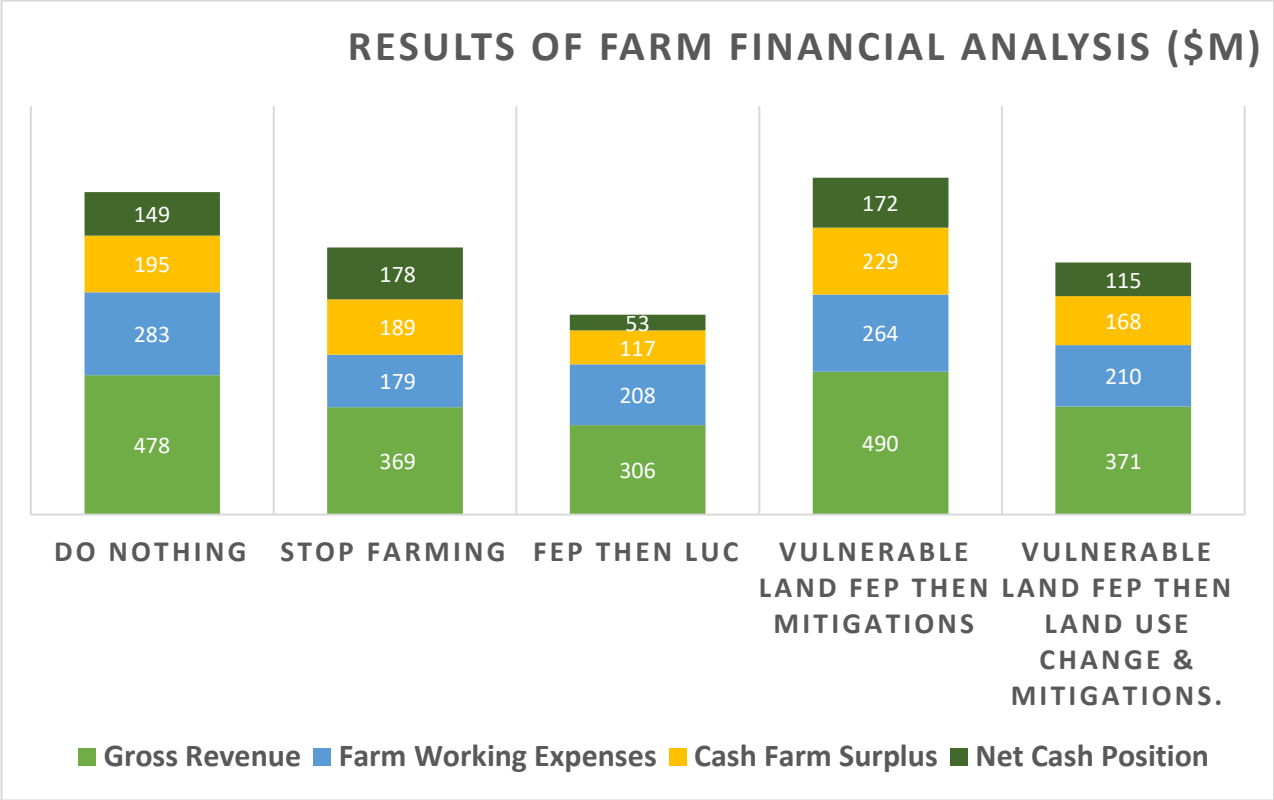
**Figure 1: Results of Financial Modelling of the PC1 Provisions ($m)**




**As can be seen from**

Figure 1 the Gross Revenue figure deteriorates between the scenarios, for example: FEP and GFP ($ 451 m), \FEP and BFP ($437 m), FEP and 75$^{th}$ Percentile ($444m).

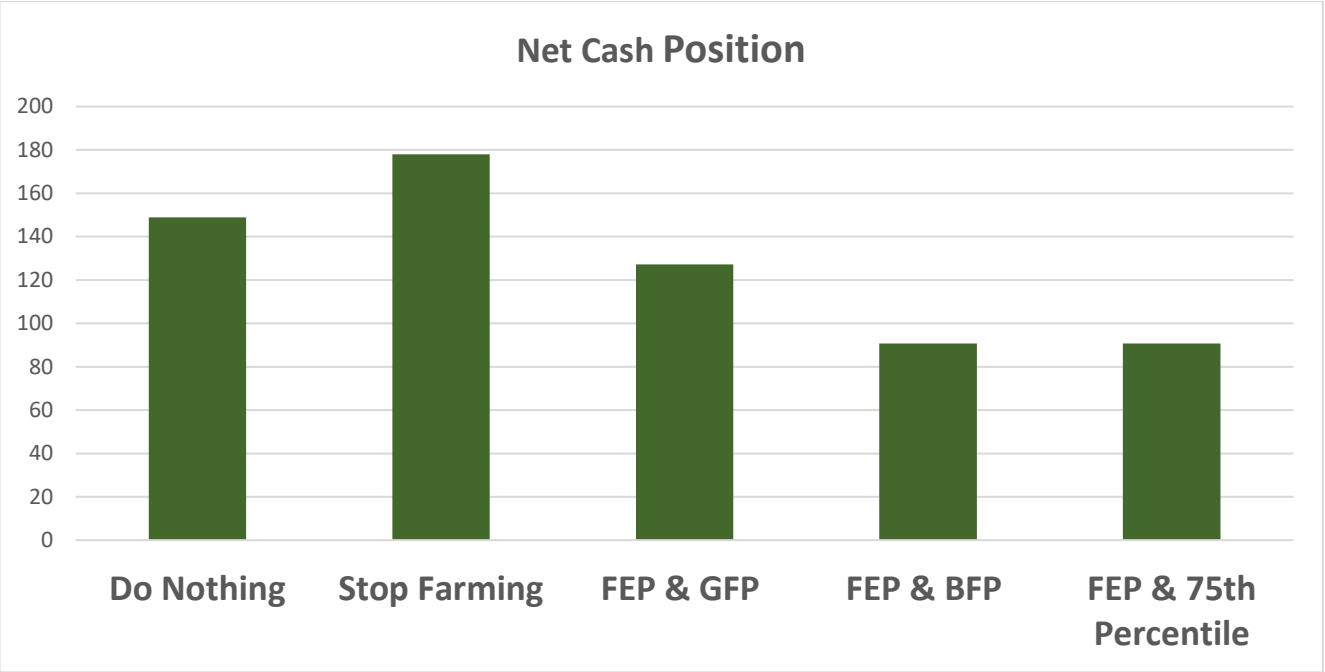
**Figure 2: Results of Financial Modelling of the alternative scenarios ($m)**



There is a considerable variation between the alternative scenarios with the FEP and LUC scenario ($306m) and then a considerable rise with the Vulnerable Land FEP and mitigations ($490m), and then a drop with the Vulnerable Land FEP and land use change and mitigations ($371m).

To evaluate the performance of the various scenarios in terms of the most attractive from a farming business perspective, the Net Cash Position as shown Figure 3 and Figure 4 was examined.

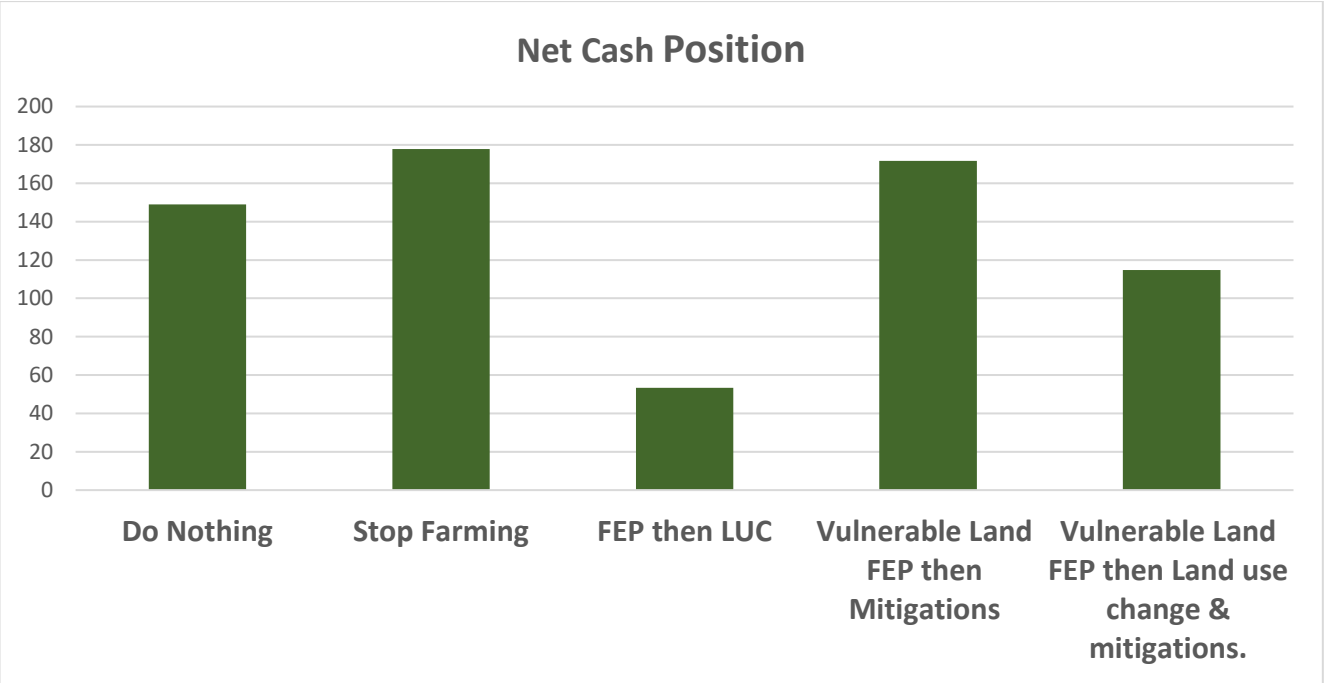
**Figure 3: Net Cash Position of the modelling of the PC1 Provisions ($m)**




As can be seen from Figure 3

Figure 3the Net Cash Position figure shows a more extreme difference than the Gross Revenue financial model although it shows a similar pattern. It deteriorates between the scenarios: FEP and GFP ($ 127 m), FEP and BFP ($91 m), FEP and 75$^{th}$ Percentile ($91m).

**Figure 4: Net Cash Position of the modelling of the alternative scenarios. ($m)**




As can be seen from Figure 4 there is a considerable downward change regarding the FEP and LUC ($53m), a considerable rise with the Vulnerable Land FEP and mitigations ($172m), and a lesser drop with the Vulnerable Land FEP and land use change and mitigations ($115m) scenario.

It can be concluded from the financial analysis from an overall perspective (and from an individual business owners perspective) that the FEP and GFP scenario is the most preferred of the three options that are relevant to PC 1 as notified.

Of the alternatives offered, the Vulnerable Land FEP and mitigations scenario would be the most preferred scenario over the FEP and LUC and the Vulnerable Land FEP with land use change and mitigations.

# 4 Flow on Impacts

The financial modelling reports the results at the “farm” or property gate. Past the farm gate there is a considerable amount of activity which results in a lot of additional economic activity or flow on impacts. The farm gate results, are referred to as the direct effects, the flow on effects are referred to as the indirect effects, and when they are added together they report the total economic effects of the activity.

The flow on impacts to the wider economy have been calculated by multiplying the results of the economic modelling by multipliers. The multipliers which are appropriate to be used were gained by purchasing a set of 2013 55 industry input / output tables from Insight Economics that were prepared for the Waikato Region.

The 2013 regional IO tables were derived using the standard methodology. Although the multipliers are derived from old data they are appropriately used to compare the alternatives. They were compiled after extensive reviews of the local and international literature to identify the most accurate and reliable methods for “regionalising” national IO tables. Then, based on these findings they were created as a robust and transparent method for converting New Zealand’s national IO table into a

corresponding set of regional tables. Once derived, the regional tables were subjected to detailed cross-checks against publicly available data to ensure accuracy and reliability. The end result is a full set of theoretically-sound and numerically-robust regional IO tables for 2013. Detailed checks were completed during the regionalisation process, which confirmed that all tables were accurate and reliable.

For this exercise three different factors are reported that can be derived with the use of multipliers:

- Gross Output which reports the total gross income generated by the activity.
- Value Added which reports the gross revenue minus all the costs of production.
- Employment which reports the total number of jobs expressed as full time equivalents (FTE).

The multipliers that were used in the analysis are shown in Table 2.

**Table 2: Multipliers used in the Waikato analysis**

| | Output | Value Added | Employment |
|---|---|---|---|
| Sheep and Beef | 1.43 | 0.57 | 4.35 |
| Dairy | 1.12 | 0.53 | 3.06 |
| Other farming | 1.20 | 0.35 | 4.42 |
| Forestry | 1.44 | 0.51 | 2.40 |

Each of the multipliers is used against the Gross Revenue as described in the financial analysis.

The results of the flow on impacts are shown in Table 3 and Table 4.

**Table 3: Results of the Flow on Impact of the scenarios which represent the PC1 provisions.**

| | Do Nothing | Stop Farming | FEP & GFP | FEP & BFP | FEP & 75th Percentile |
|---|---|---|---|---|---|
| Gross Output $ m | 532 | 524 | 510 | 517 | 517 |
| Value Added $ m | 555 | 361 | 349 | 356 | 356 |
| Employment FTE | 797 | 788 | 769 | 776 | 776 |

**Table 4: Results of the Flow on Impact of the scenarios which represent the alternative scenarios.**

| | Do Nothing | Stop Farming | FEP then LUC | FEP then Mitigations on Vulnerable Land | FEP then Mitigations + Land use change on vulnerable land. |
|---|---|---|---|---|---|
| Gross Output $ m | 532 | 524 | 330 | 563 | 414 |
| Value Added $ m | 555 | 361 | 282 | 400 | 307 |
| Employment FTE | 797 | 788 | 494 | 828 | 660 |

The conclusions that can be drawn from the flow on impact assessment of the scenarios run in the RDST model are:

- The three scenarios which represent PC 1 as notified are all very similar in terms of their flow on impacts. Therefore they would all be considered to contribute equally to the wellbeing of the community.
- The Vulnerable Land FEP and mitigations scenario is the most superior option in terms of the three alternatives of the flow on impacts reported and would be considered to be the preferred option in an economic sense.
- The FEP and LUC is the most inferior option of those tested.

**APPENDIX 2**

**Insight Report**

INSIGHT ECONOMICS

9 July 2014

# Wairakei Estate Financial and Economic Impact Assessment

**PREPARED FOR**

Tramco Limited

**Authorship**
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# Contents

# Executive Summary

**Context**
The Wairakei Estate is a 26,000 hectare forest estate just north of Taupo. Since 2004, it has been gradually converted to a range of other pastoral uses, mainly dairy farming. Currently, there are 9 dairy sheds and 10,000 dairy cows. By 2021 – nearing the end of the conversion process – there will be 40 dairy sheds and 43,000 cows. The balance of the land will be used for dairy support, Lucerne growing and forestry.

**Scope and Purpose of this Report**
This report estimates the financial and economic impacts of the various economic activities that will occur on the estate over time, including the conversion process itself.

**Summary of Key Findings**

- Once the conversion process is complete, the estate's dairy farming operations will be the largest in the Southern hemisphere, and will produce around 16 million kilograms (kg) of milk solids per annum.

- Annual Lucerne production will grow steadily to eventually reach about 10 million kg of dry matter, while 2.8 million tonnes of wood will be harvested over the next seven years.

- Revenues will grow by 9% per annum to reach $350 million by 2038, 87% of which will come from milk cheques.

- Operating expenses will also grow steadily to reach about $212 million by 2038. Dairy farming will account for 96% of this.

- Operating profits – as measured by EBITDA – will increase from $17 million in 2014 to $138 million in 2038, an annual growth rate of nearly 9%.

- By 2038, the estate will be paying around $36 million in company tax annually, and net profit after tax will be around $92 million (up from $6 million today).

- Once fully operational, and including flow-on effects, the daily operations of the estate will boost regional GDP by $134 million per annum, regional employment by 354 full-time equivalents, and regional incomes by $24 million per annum.

- The corresponding national impacts will be GDP of $90 million, fulltime employment for 776 people, and household incomes of $41 million.

- To complete the conversion process, around $326 million will be spent on dairy farm capital expenditure over the next 7 years. These expenditures will have significant additional impacts on the regional and national economies.

- For instance, the estimated regional impacts are increased GDP of $204 million, full-time employment for 3,241 people and incomes of $137 million (all spread out over 7 years). The corresponding national impacts will be even higher.

# 1 Introduction

## 1.1 Context

In 2004, Wairakei Pastoral Ltd (WPL) purchased a 26,000 hectare forest estate in Wairakei, just north of Taupo. Since then, the land has been gradually converted to a range of other uses, mainly dairy farming. Currently, there are 9 dairy sheds and 10,000 dairy cows. By 2021 – at the end of the conversion process – there will be 40 sheds and 43,000 cows. The remaining land will be used for dairy support, Lucerne growing and forestry.

## 1.2 Scope, Purpose and Approach of this Report

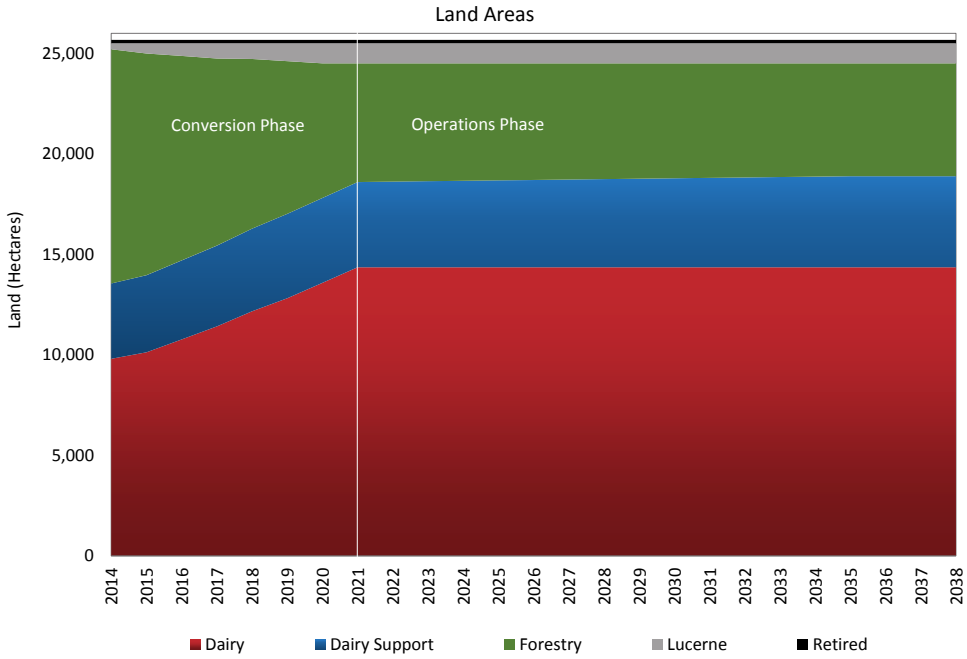
This report estimates the financial and economic impacts of activities on the estate, including the conversion process itself. It starts by identifying the land use mix each year and converting it to estimates of production by activity. These estimates are then converted to measures of financial impact using detailed financial models before finally being translated to economic impacts (on GDP, incomes and employment).

**Figure 1:** Overall Approach to the Analysis


## 1.3 Annual Land Use Mix

Figure 2 shows the assumed land use mix over time.

**Figure 2:** Assumed Land use Mix over Time



Since the conversion process will be largely complete by 2021, we refer to the period to 2021 as the conversion phase, and the period thereafter as the operation phase.

## 1.4 Structure of this Report

The remainder of this report is structured as follows:

- **Section 2** describes our **approach to the modelling**
- **Section 3** summarises our **annual production estimates** for each land use.
- **Section 4** presents the estimated annual **financial impacts**, and
- **Section 5** shows the corresponding estimates of **economic impacts**.

# 2 Approach to the Modelling

This section briefly explains our approach to modelling the financial and economic impacts of the estate.

## 2.1 Financial/Operating Models

As noted above, we constructed detailed operating models to estimate annual production levels and corresponding financial impacts for each land use. Since dairy farming is the main land use, it was modelled in the greatest detail.

Our dairy farming model captures the entire operating process right from the purchase of livestock through to subsequent livestock sale and replacement. It includes the number of cow numbers, average milk solids production, total milk-solids production, milk cheque income, Fonterra share purchases and all on-farm expenses. In addition, it covers all off-farm expenses, such as tax and depreciation, and also models the capital expenditures required to undertake the conversion process.

The models for dairy support and lucerne production are less complex. This is partly because the underlying production processes are simpler, and partly because those activities will be undertaken at arms-length by third parties.

The final operating model covered forestry. Like the dairy model, this was fairly complex. Not only did it have to capture the costs and revenues of growing and harvesting each hectare of trees, but it also had to model the subsequent conversion of significant chunks of forestry land to alternative uses.

Collectively, these models provide a detailed view of the likely financial impacts of the estate over the next 25 years (to 2038). Despite being modelled separately, all activities are considered together – the model calculates productive and financial statistics of the estate as a whole. In addition, it provides the key inputs to our analysis of economic impacts, which are discussed further below.

## 2.2 Approach to the Economic Impacts

The daily ongoing operations of the estate – and the conversion process itself – will stimulate the regional and national economies. We measured the resulting impacts using a special type of analysis called multiplier analysis. This estimates both the direct economic impacts and also the flow on effects in terms of GDP, incomes and employment.

These economic impacts are based on detailed inter-industry tables supplied by Butcher Partners, which show how the various sectors of the regional and national economies are interrelated. Using these, it is possible to determine how activity on the estate will stimulate the wider regional and national economies.

## 2.3 Assumptions Used in the Operating/Financial Models

The following table shows the key inputs and assumptions in our operating and financial models. These have been grounded in real-world data to the greatest extent possible and many have been set based on advice from the estate itself.

**Table 1:** List of Key Assumptions in the Operating/Financial Models

| **General Assumptions** | | | |
|---|---|---|---|
| WACC | 9.2% | | |
| Corporate Tax Rate | 28% | | |
| General Rates per $1 of land value | $0.0025 | | |
| | | | |
| **Land Uses over Time (ha)** | **Now** | **5-Years' Time** | **Completion** |
| Dairy | 9,807 | 12,820 | 14,360 |
| Dairy Support | 3,748 | 4,200 | 4,532 |
| Lucerne | 309 | 490 | 1,015 |
| Cutover | 4,595 | 949 | 0 |
| Forestry | 7,057 | 6,504 | 4,625 |
| Retired | 168 | 721 | 1,152 |
| | | | |
| **Inflation** | **Dairy** | **Lucerne** | **Forestry** |
| Outputs (except Milk Solids) | 4.0% | 1.1% | 1.4% |
| Inputs | 3.0% | 3.1% | 1.5% |
| Milk Solids Prices | 3.5% | | |
| | | | |
| **Production Assumptions** | | | |
| Cows/Ha | 3 | | |
| Milk Yield (2014, kgMS/cow) | 354 | | |
| Lucerne Yield (kgDM/ha) | 10,000 | | |
| | | | |
| **Price Assumptions** | | | |
| **Dairy** | | | |
| Farm Land Value/Ha | $24,000 | | |
| Milk Price ($/kgMS) | $7 | | |
| Cow Purchase Price ($/cow) | $2,000 | | |
| Cow Sale Price ($/cow) | $900 | | |
| Shed ($/Farm) | $2,000,000 | | |
| House ($/Farm) | $1,000,000 | | |
| Office Costs | $300,000 | | |
| Irrigation (per the full development) | $32,000,000 | | |
| Land Development Spend ($/ha) | $6,500 | | |
| On-Farm Operational Costs | $5 | | |
| Shares (price/kgMS capacity) | $6 | | |
| **Dairy Support** | | | |
| Land Value/Ha | $15,000 | | |
| Capital Spend ($/Ha) | $5,000 | | |
| Revenue ($/Ha) | $720 | | |
| Rent ($/Ha) | $300 | | |
| **Lucerne** | | | |
| Land Value/Ha | $20,000 | | |
| Capital Spend ($/Ha) | $5,000 | | |
| Lucerne Price ($/Ha) | $0.27 | | |
| Rent ($/Ha) | $1,000 | | |
| Operational Expenses ($/Ha) | $400 | | |
| **Forestry** | | | |
| Land Value/Ha | $2,500 | | |
| Log Price ($/Ha) | $10,000 | | |
| Rent ($/Ha) | $260 | | |
| Replanting Price ($/Ha) | $1,900 | | |
| | | | |
| **Employment/Wage Assumptions** | **FTE/Farm** | **Wage** | |
| Manager | 1.00 | $80,000 | |
| 2IC | 1.00 | $65,000 | |
| Dairy Assistant | 2.00 | $45,000 | |
| Farm Business Manager | 0.29 | $120,000 | |
| Office Workers | 0.85 | $80,000 | |

# 3 Production Estimates

This section summarises our annual production estimates by land use.

## 3.1 Dairy Farming

Figure 3 shows our estimates of annual dairy cows, while Figure 4 shows our corresponding estimates of annual milk solids production.

**Figure 3**: Estimated Number of Dairy Cows

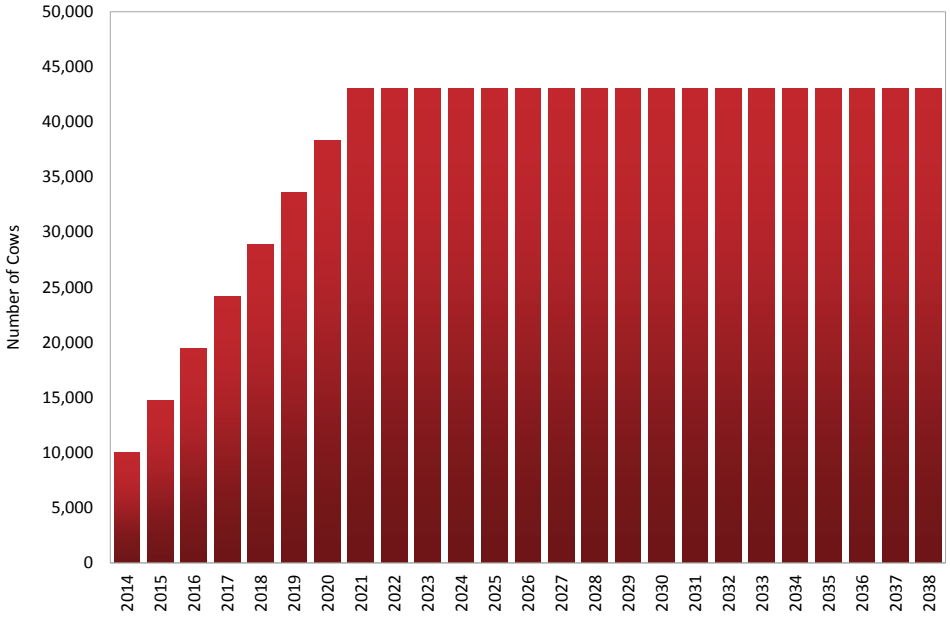
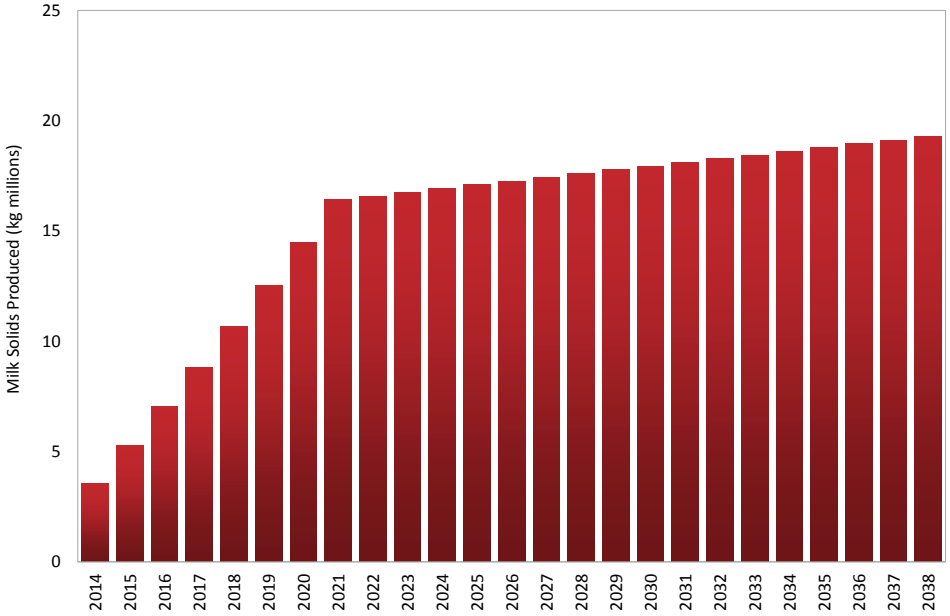



**Figure 4**: Estimated Milk Solids Production (millions of kg)



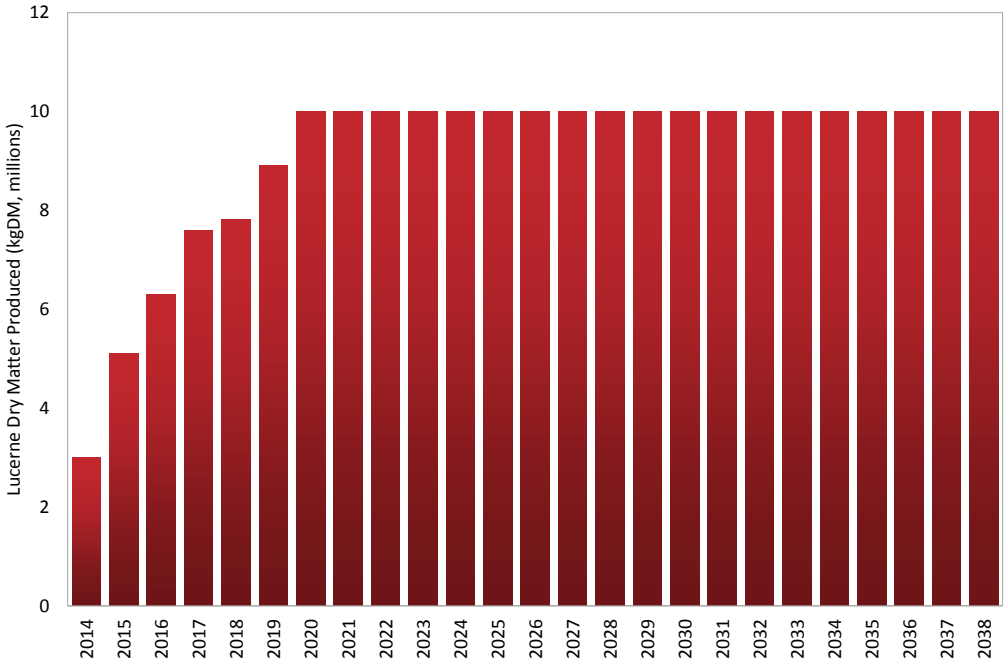
As shown above, herd numbers are forecast to increase rapidly during the conversion phase, but remain fairly constant thereafter. Similarly, milk production is expected to increase rapidly during the conversion phase. However, unlike herd numbers, annual milk solids production is projected to continue growing over the longer term due to increasing productivity. Specifically, the annual yield per cow is forecast to grow from 350kg of milk solids in 2014 to 450kg in 2038.

Overall, annual milk solid production is expected to grow from about 3.5 million kg in 2014 to about 19.3 million kg in 2038.

## 3.2 Lucerne

The amount of land earmarked for Lucerne production is expected to increase each year till 2035, with corresponding increases in the amount produced. The figure below shows our estimates of Lucerne production (which are measured as kilograms of dry matter).

**Figure 5**: Estimated Lucerne Production (millions of kilograms of dry matter)

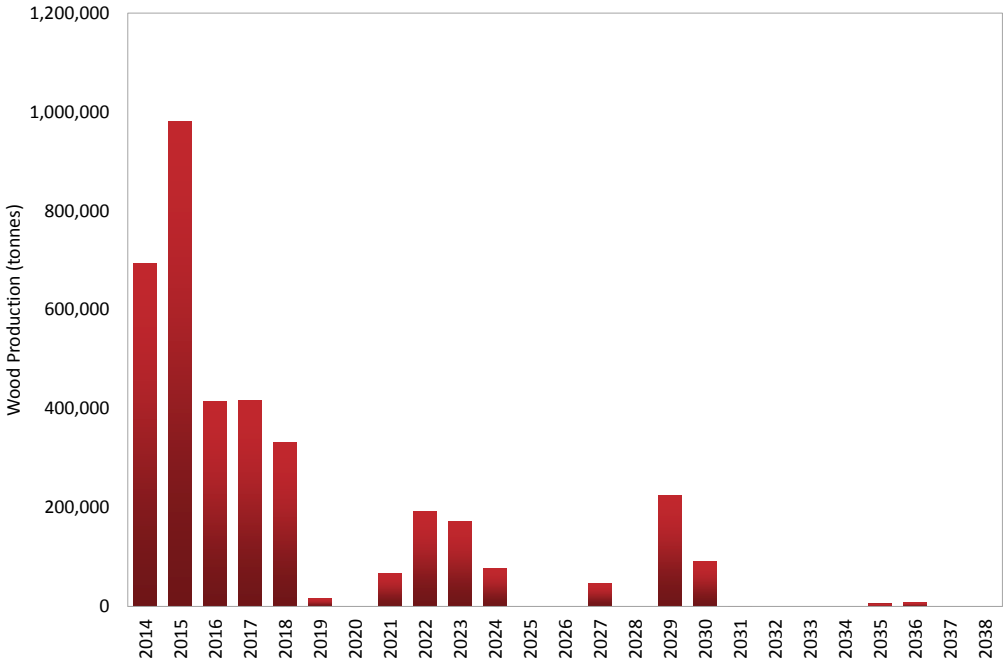



Overall, lucerne production is estimated to grow from 3 million kg of dry matter in 2014 to 10 million kg in 2035.

## 3.3 Forestry

The estate currently has around 7,000 hectares of forestry land at various stages of the growing cycle. 5,700 hectares of this will be harvested over the next 25 years, producing the following levels of wood production.

**Figure 6**: Estimated wood production (tonnes)




Over the first five years the estate will produce a total of 2.8 million tonnes of wood, growing to 3.7 million tonnes by 2038.

# 4 Financial Analysis

This section summarises the estimated financial impacts of the estate.

## 4.1 Revenues

Figure 7 shows our estimates of annual operating revenues by land use land. These are forecast to grow rapidly, especially during the conversion phase. For example, annual revenues are forecast to grow from just over $41 million in 2014 to $168 million by 2021 – an annual growth rate of 22%. From 2021 on, revenues are expected to grow at lower rate of 4.4% to reach $350 million by 2038. The long run growth rate over the next 25 years is just under 9% per annum.

**Figure 7**: Estimated Revenues of the Wairakei Estate

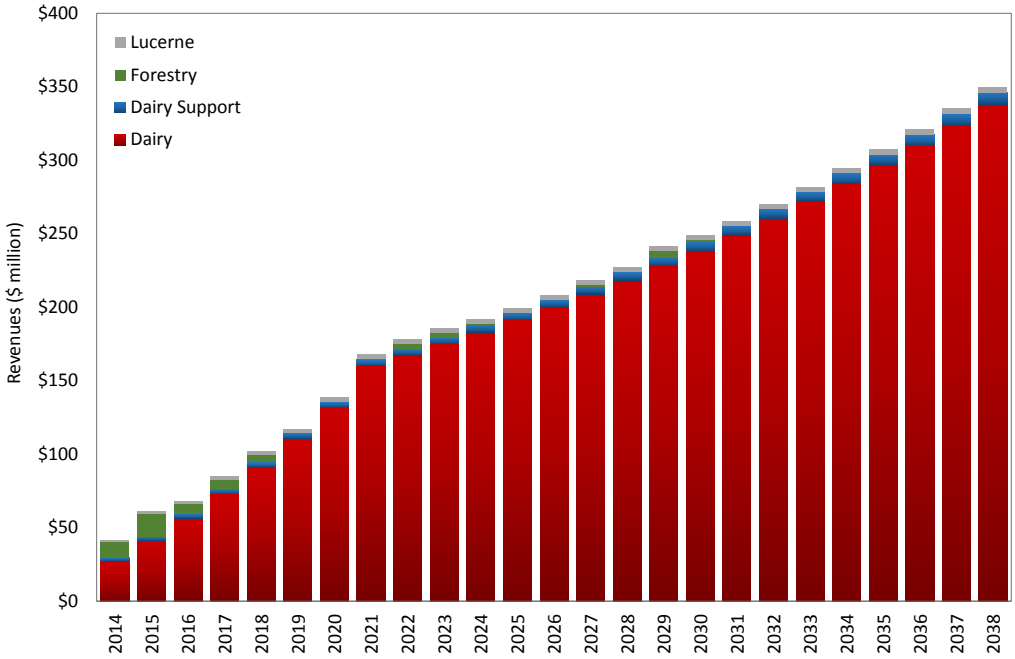
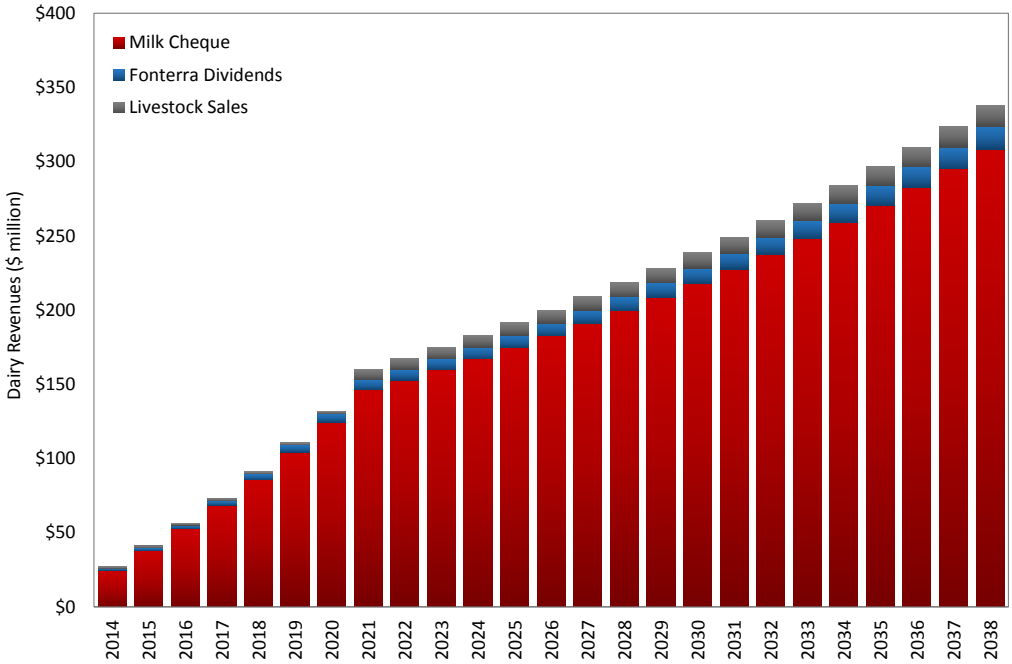



Figure 8 shows that dairy farming is expected to account for the lion's share of future revenues. To understand these a little better, the following figure breaks forecast dairy revenues down by type. As expected, milk cheque revenues are the most significant, with only relatively minor contributions coming from Fonterra shareholder dividends and the proceeds of livestock sales. Over the next 25 years, milk cheques are expected to account for 92% of dairy revenues and 87% of total estate revenues.

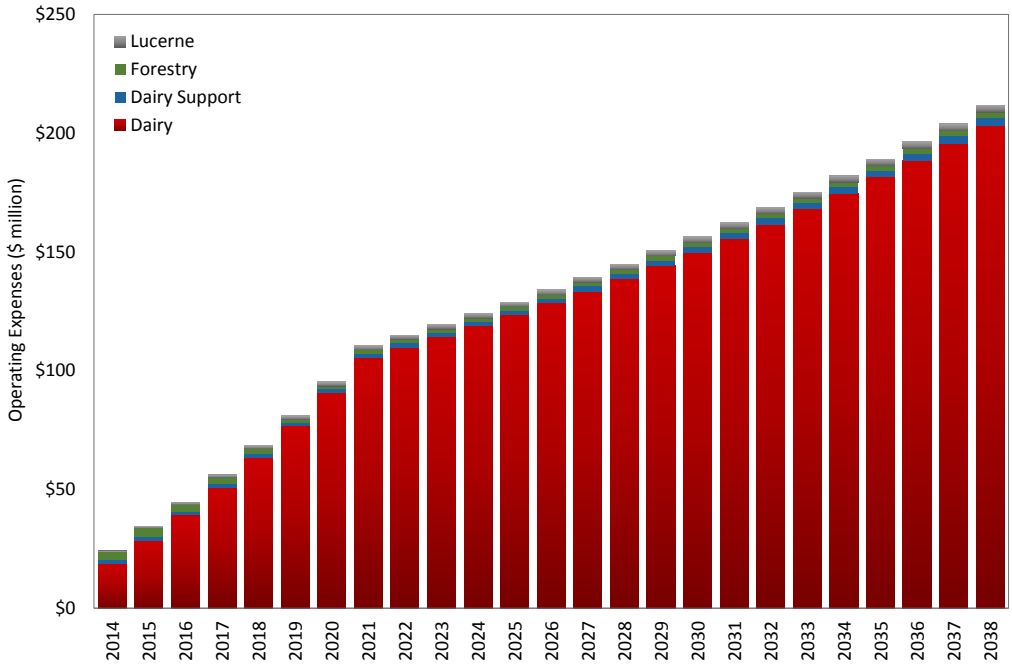
**Figure 8**: Composition of Dairy Revenues ($ million)




## 4.2 Operating Expenses

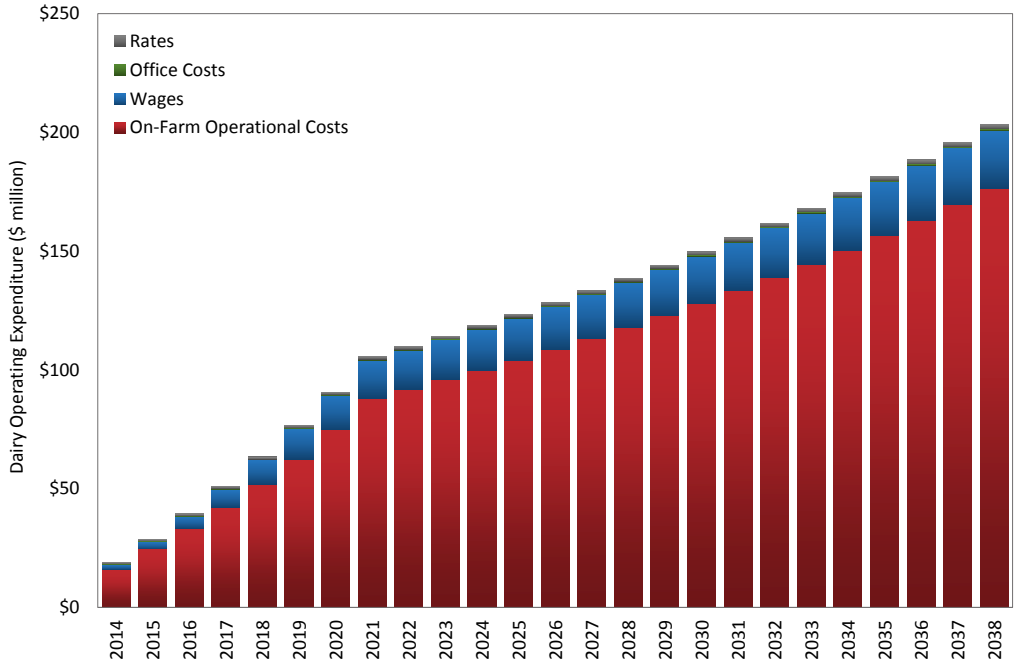
Figure 9 shows our estimates of annual operating expenses. Like our estimates of revenues, these are also forecast to grow rapidly during the conversion phase, and then at a slower rate thereafter. Overall, operating expenses are projected to grow from $24 million in 2014 to $212 million in 2038, an annual growth rate of 10%.

**Figure 9**: Operational Expenditure of the Wairakei Estate



As shown above, dairy accounts for the bulk of operating expenses. To better understand the nature of those expenses, Figure 10 breaks them down by type.

**Figure 10**: Dairy-Related Operating Expenses




The graph above shows that on-farm operational costs account for the majority (85%) of dairy farming expenses. They are forecast to grow from around $16 million in 2014 to $177 million by 2038. The other main category of dairy expenses are wages. These are forecast to grow from $2 million now to about $24 million by 2038.

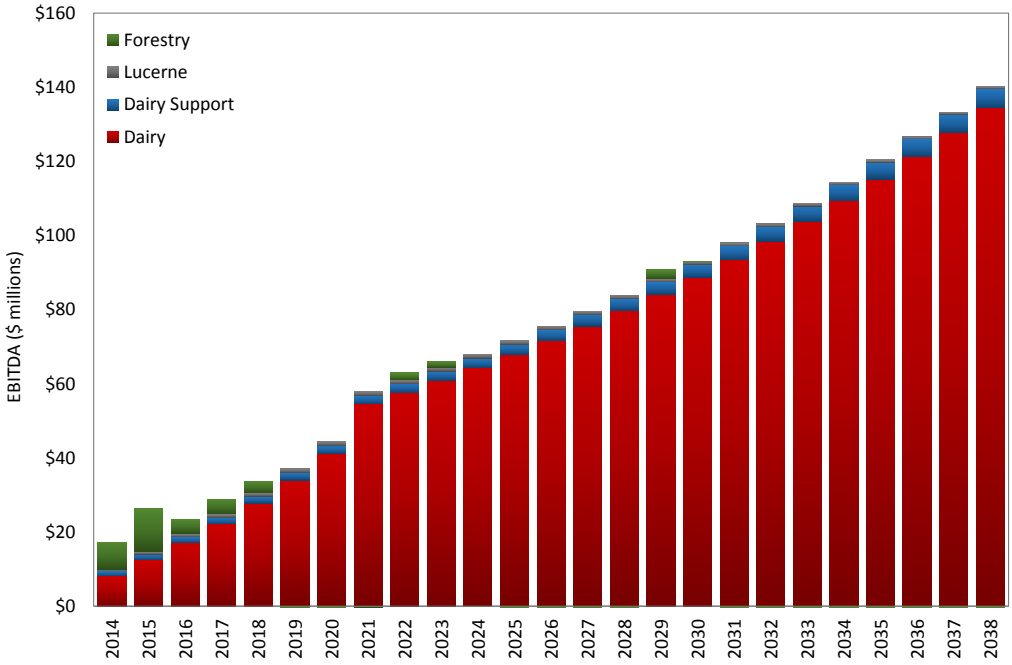
## 4.3 Operating Profits (EBITDA)

Having profiled operating revenues and expenses, we now consider the estate's likely operating profits. These are measured using EBITDA – which stands for earnings before interest, tax, depreciation, and amortisation. This is an industry-standard measure of profitability and is widely used to assess different sectors and organisations.

Figure 11 shows our estimates of the estate's operating profits by year. As expected, these follow the same general pattern as revenues and operational expenditure, with rapid growth during the conversion phase, and steady growth thereafter. Overall, we estimate that operating profits will increase from around $17 million in 2014 to around $138 million in 2038, an annual growth rate of 8.7%.

Note that revenues from forestry are high in early years as the existing forestry is harvested, falling later on in the development.

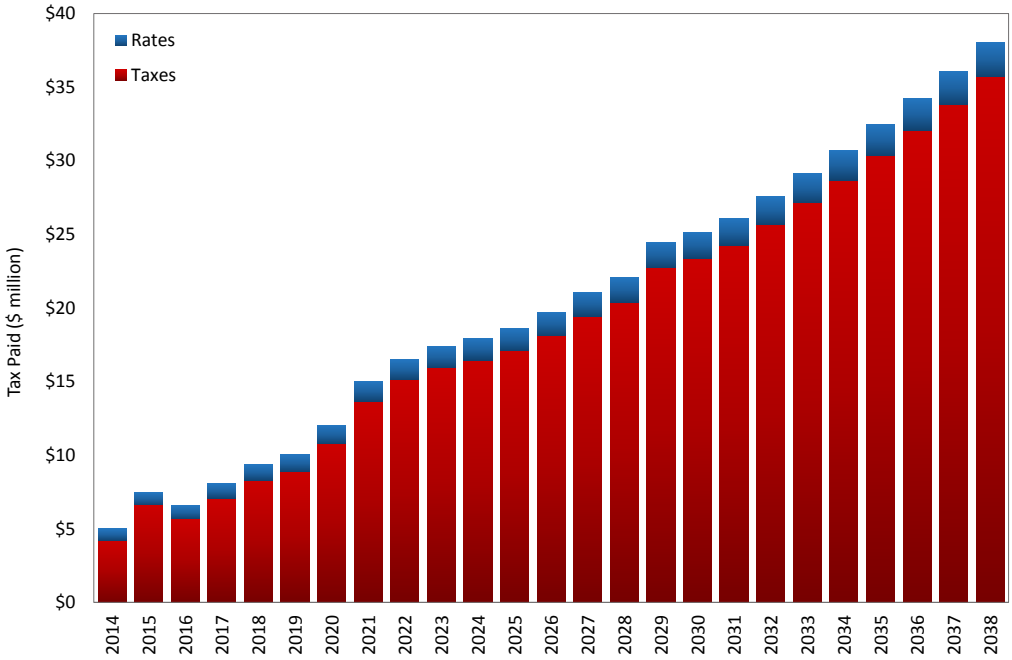
**Figure 11:** Estimated Operating Profits ($ million)




## 4.4 Tax and Rates Contributions

Next, we modelled the estate's likely contributions to company taxes and general rates. These are shown in the chart below.

**Figure 12**: Estimated Company Tax and General Rates Contributions

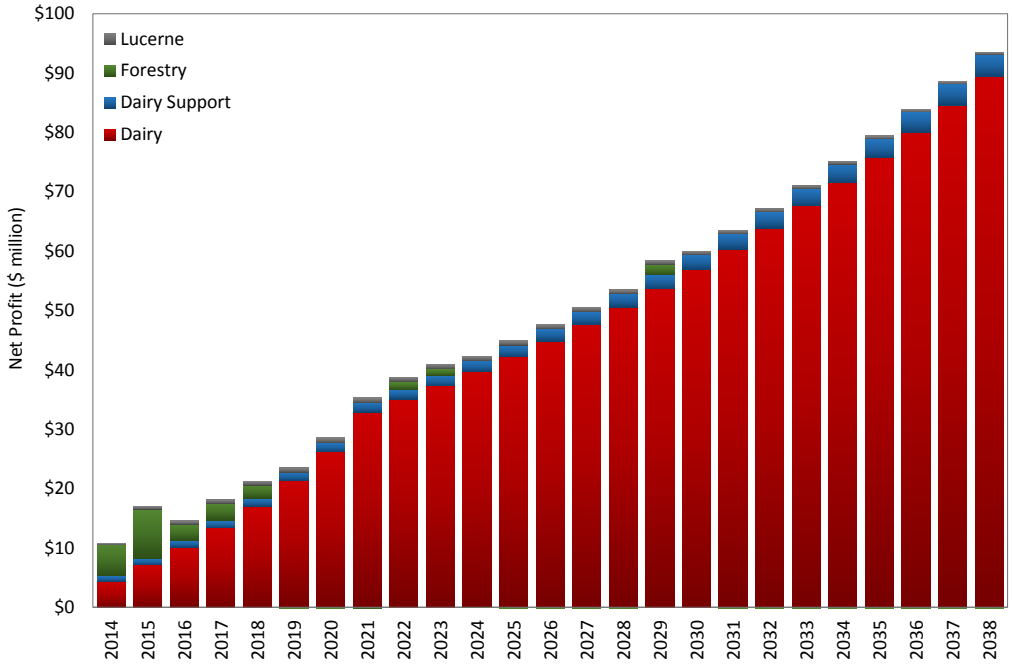


The estimated contributions to taxes and rates follow the same general pattern as the other financial metrics. By 2038, we estimate that the estate will pay around $36 million in company taxes and $2 million in general rates, giving a combined tax/rates bill of $38 million.

## 4.5 Net Profit after Tax

Figure 13 shows our estimates of net profit after tax. These are forecast to grow from $11 million in 2014 to $92 million in 2038, which represents an annual growth rate of 9%.

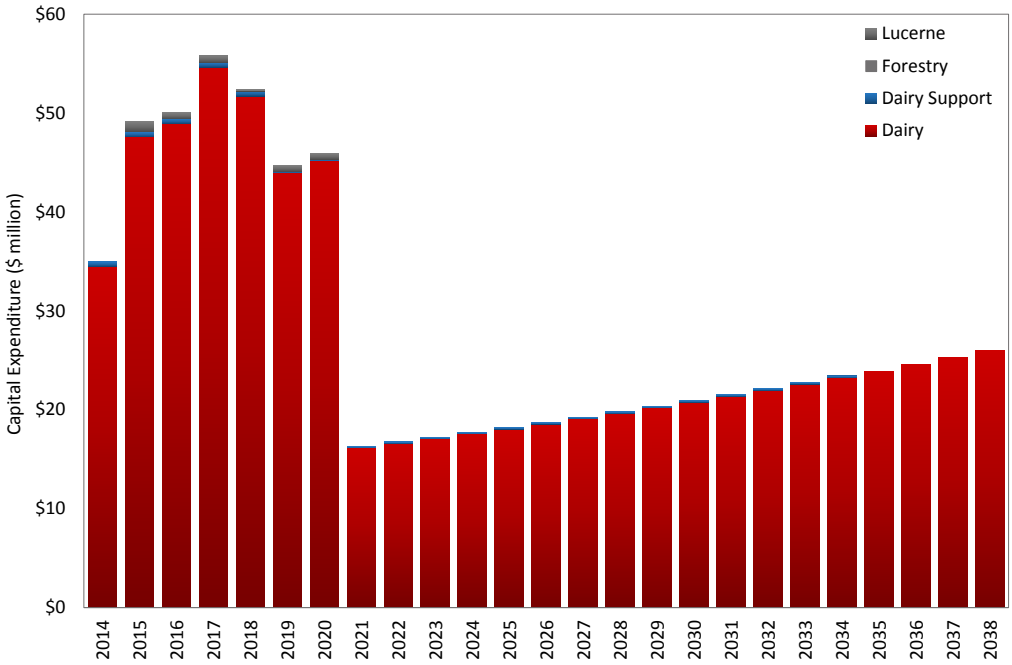
**Figure 13**: Estimated Net Profits after Tax




## 4.6 Capital Expenses

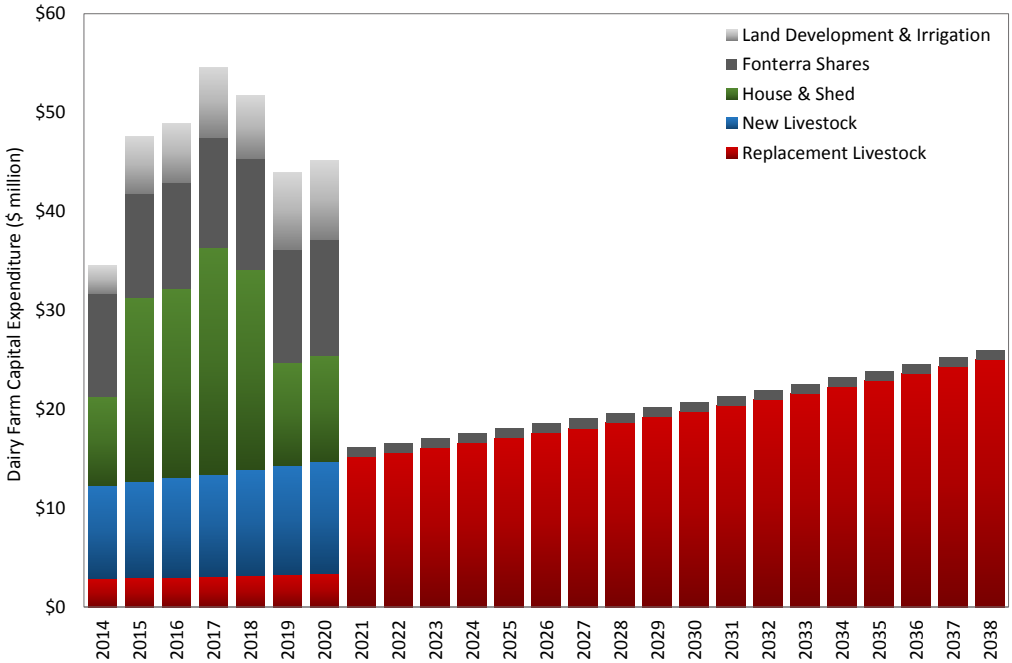
Significant capital expenditure will be required to complete the conversion process, and to maintain and operate the estate over the longer term. The following chart shows our estimates of these capital expenses by year to 2038.

**Figure 14**: Estimated Capital Expenditures




As always, dairy farming comprises the largest chunk, so the following graph explores that component in more detail.

**Figure 15:** Dairy Farm Capital Expenditure



According to our analysis, over $326 million will be spent on developing the new dairy farms during the conversion phase. Thereafter, dairy-related capital expenditures will reduce to about $16 million in 2021 (growing at 2.8% per annum due to cost inflation).

The most consistent component of dairy capital expenditure is the purchase of new and replacement livestock. Over the early years of the project 33,000 new cows will be purchased to bring the farms up to an operating level of 3 cows per hectare. Once the estate enters the operational phase around 6,000 cows will be replaced each year.

34 new dairy farms will be built in the conversion phase, each requiring housing, sheds, irrigation, land development, shares in Fonterra, and new stock. The cost of these drives the significant capital expenditure in Figure 15.

## 4.7 Cash Flows

Finally, Figure 16 shows the estimated annual cashflows of the estate. These include operating revenues, operating expenses, capital expenses, taxes and rates contributions.

**Figure 16**: Estimated Cash Flows

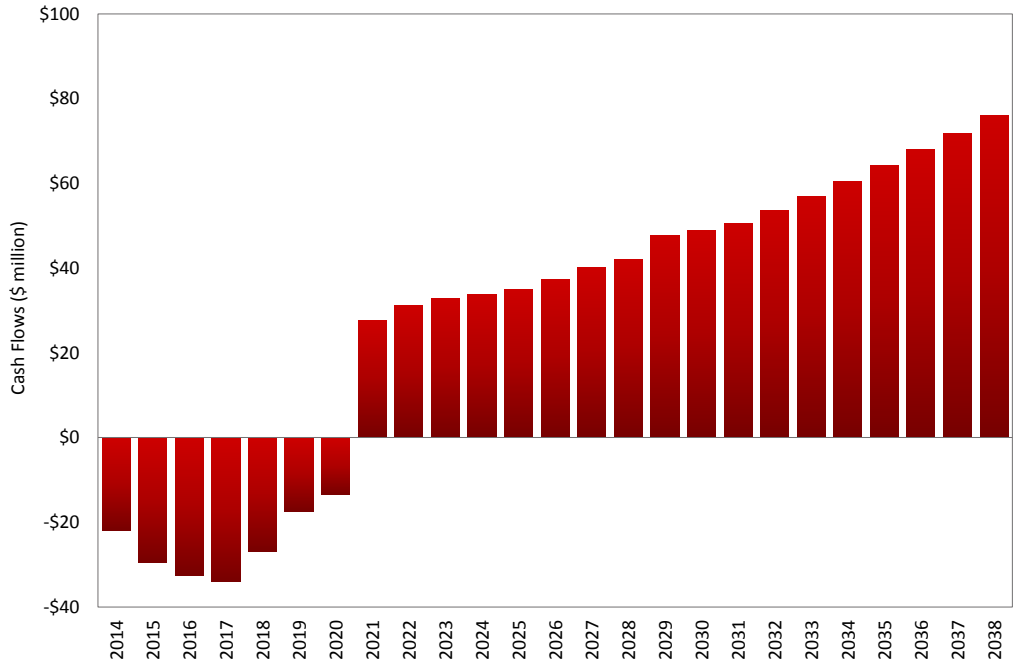



Figure 16 reveals significant net cash outflows over the next 7 years as the conversion process is completed, after which net cashflows will become positive.

## 4.8 Summary

For ease of reference, Table 2 summarises our estimates of key financial metrics over the next 25 years.

**Table 2:** Summary of Estimated Financial Performance

| Year | Operating Revenues | Operating Expenses | EBITDA | Depreciation | Loss on Livestock | Tax | NPAT |
|---|---|---|---|---|---|---|---|
| 2014 | $41.3 | $24.1 | $17.2 | $1.0 | $1.1 | $4.2 | $10.8 |
| 2015 | $60.7 | $34.5 | $26.2 | $1.5 | $1.1 | $6.6 | $17.0 |
| 2016 | $67.8 | $44.5 | $23.3 | $1.9 | $1.1 | $5.7 | $14.5 |
| 2017 | $85.1 | $56.2 | $28.9 | $2.5 | $1.2 | $7.1 | $18.1 |
| 2018 | $102.1 | $68.5 | $33.7 | $3.0 | $1.2 | $8.3 | $21.2 |
| 2019 | $117.1 | $81.0 | $36.1 | $3.3 | $1.2 | $8.9 | $22.8 |
| 2020 | $138.5 | $95.3 | $43.2 | $3.5 | $1.2 | $10.8 | $27.6 |
| 2021 | $168.2 | $110.6 | $57.7 | $3.5 | $5.4 | $13.7 | $35.1 |
| 2022 | $177.9 | $115.0 | $62.9 | $3.5 | $5.5 | $15.1 | $38.8 |
| 2023 | $185.5 | $119.5 | $66.0 | $3.5 | $5.6 | $15.9 | $40.9 |
| 2024 | $192.0 | $124.1 | $67.9 | $3.5 | $5.7 | $16.5 | $42.3 |
| 2025 | $199.2 | $128.9 | $70.3 | $3.5 | $5.7 | $17.1 | $43.9 |
| 2026 | $208.1 | $134.0 | $74.1 | $3.5 | $5.8 | $18.1 | $46.6 |
| 2027 | $218.2 | $139.4 | $78.8 | $3.5 | $5.9 | $19.4 | $49.9 |
| 2028 | $227.0 | $144.8 | $82.3 | $3.5 | $6.0 | $20.4 | $52.4 |
| 2029 | $241.4 | $150.6 | $90.8 | $3.5 | $6.1 | $22.7 | $58.4 |
| 2030 | $249.4 | $156.3 | $93.1 | $3.5 | $6.2 | $23.4 | $60.0 |
| 2031 | $258.6 | $162.3 | $96.3 | $3.5 | $6.2 | $24.3 | $62.3 |
| 2032 | $270.1 | $168.6 | $101.4 | $3.5 | $6.3 | $25.7 | $65.9 |
| 2033 | $282.0 | $175.2 | $106.8 | $3.5 | $6.4 | $27.1 | $69.7 |
| 2034 | $294.5 | $182.0 | $112.4 | $3.5 | $6.5 | $28.7 | $73.7 |
| 2035 | $307.5 | $189.1 | $118.4 | $3.5 | $6.6 | $30.4 | $78.0 |
| 2036 | $321.1 | $196.4 | $124.7 | $3.5 | $6.6 | $32.1 | $82.4 |
| 2037 | $335.0 | $204.0 | $131.0 | $3.5 | $6.7 | $33.8 | $86.9 |
| 2038 | $349.6 | $211.8 | $137.8 | $3.5 | $6.8 | $35.7 | $91.8 |

# 5 Economic Impacts

This section translates the financial impacts above into estimates of economic impacts.

## 5.1 Impacts of Daily Operations

First we estimate the economic impacts of the estate's daily operations. These are shown in the two tables below, where the first shows the regional impacts, and the second the national impacts. These are reported for both 2014 and 2021, the latter reflecting the point at which the conversion process is expected to be complete.

Table 3: Estimated **Regional** Impacts of Daily Operations

| **GDP ($ millions)** | **2014** | **2021** |
|---|---|---|
| Direct | $20 | $90 |
| Flow-On | $13 | $44 |
| Total | $33 | $134 |
| | | |
| **Employment (FTEs)** | **2014** | **2021** |
| Direct | 56 | 201 |
| Flow-On | 92 | 154 |
| Total | 148 | 354 |
| | | |
| **Household Income ($m)** | **2014** | **2021** |
| Direct | $3 | $14 |
| Flow-On | $5 | $10 |
| Total | $8 | $24 |

Table 4: Estimated **National** Impacts of Daily Operations

| **GDP ($ millions)** | **2014** | **2021** |
|---|---|---|
| Direct | $20 | $90 |
| Flow-On | $28 | $106 |
| Total | $48 | $196 |
| | | |
| **Employment (FTEs)** | **2014** | **2021** |
| Direct | 79 | 246 |
| Flow-On | 167 | 530 |
| Total | 246 | 776 |
| | | |
| **Household Income ($m)** | **2014** | **2021** |
| Direct | $5 | $18 |
| Flow-On | $6 | $22 |
| Total | $11 | $41 |

The tables above reveal a number of interesting insights about the impacts that daily operations are likely to have on the regional and national economies. For instance, by 2021 and including flow-on effects the estate is expected to boost regional GDP by $134 million, regional employment by 354 full-time jobs and regional incomes by $24 million.

The corresponding national impacts are GDP of $196 million, employment of 776, and incomes by $41 million.

## 5.2 Impacts of Capital Expenditures

Table 5 shows the estimated economic impacts of capital expenditures over the next 7 years. These are also significant, and are additional to the impacts reported above.

**Table 5**: Estimated Impacts Capital Expenditures to 2021

| **GDP ($ millions)** | **Regional** | **National** |
|---|---|---|
| Direct | $85 | $95 |
| Flow-On | $119 | $185 |
| Total | $204 | $279 |
| | | |
| **Employment (FTEs)** | **Regional** | **National** |
| Direct | 1,459 | 1,692 |
| Flow-On | 1,782 | 2,034 |
| Total | 3,241 | 3,726 |
| | | |
| **Household Income ($m)** | **Regional** | **National** |
| Direct | $64 | $64 |
| Flow-On | $71 | $82 |
| Total | $134 | $139 |

In short, capital expenditures required to complete the conversion process are expected to boost regional GDP by $204 million, regional employment by 3,241 people-years and regional incomes by $134 million (all spread over 7 years). The corresponding national impacts are even higher.

## 5.3 Compared to the Status Quo

If the development had not taken place, the entire estate would have remained as forestry. Being a less productive industry than pastoral farming and lucerne cropping, production on the estate would be far less, as shown in a comparison of the forecast financial performance in 2038:

| **Performance in 2038** | **Status Quo (Forestry)** | **Estate Development** |
|---|---|---|
| Operating Revenues | $14 | $350 |
| Operating Expenses | $12 | $212 |
| **EBITDA** | **$3** | **$138** |
| Depreciation | $0 | $4 |
| Loss on Livestock | $0 | $7 |
| Tax | $1 | $36 |
| **NPAT** | **$2** | **$92** |

In lieu of the development the estate would perform at a significantly lower level, generating net profit after tax of only $2 million in 2038, compared to the $92 million expected for the completed development.

Similarly, the economic impacts in the tables below are only a fraction of those expected from the developed estate:

Table 6: Estimated **Regional** Impacts of Daily Operations with **no land conversion**

| **GDP ($ millions)** | **2014** | **2021** |
|---|---|---|
| Direct | $3 | $4 |
| Flow-On | $5 | $6 |
| Total | $8 | $9 |
| | | |
| **Employment (FTEs)** | **2014** | **2021** |
| Direct | 11 | 12 |
| Flow-On | 58 | 63 |
| Total | 68 | 75 |
| | | |
| **Household Income ($m)** | **2014** | **2021** |
| Direct | $0 | $0 |
| Flow-On | $3 | $3 |
| Total | $3 | $4 |

Table 7: Estimated **National** Impacts of Daily Operations with **no land conversion**

| **GDP ($ millions)** | **2014** | **2021** |
|---|---|---|
| Direct | $3 | $4 |
| Flow-On | $8 | $9 |
| Total | $11 | $12 |
| | | |
| **Employment (FTEs)** | **2014** | **2021** |
| Direct | 19 | 21 |
| Flow-On | 69 | 76 |
| Total | 88 | 97 |
| | | |
| **Household Income ($m)** | **2014** | **2021** |
| Direct | $2 | $2 |
| Flow-On | $4 | $4 |
| Total | $5 | $6 |

Where the development is expected to generate national GDP of $196 million in 2021, it would only generate $12 million if left as forestry. Similarly 776 national jobs earning $41 million in household incomes would be reduced to 97 only earning $6 million.

**APPENDIX 3**

**Wairakei Estate Nitrogen Mitigation Modelling using Overseer,**

**Prepared for Wairakei Estate**

**Prepared by the AgriBusiness Group, Deecmber 2018**

"Achieving Outcomes by Building Capability"

The AgriBusiness Group™

# Wairakei Estate Nitrogen Mitigation Modelling using Overseer

**Prepared for Wairakei Estate**

**Prepared by The AgriBusiness Group**

**December 2018**

## Please Read

The information in this report is accurate to the best of the knowledge and belief of the consultants acting on behalf of the Wairakei Pastoral Ltd. While the consultant has exercised all reasonable skill and care in the preparation of information in this report neither the consultant nor the Wairakei Pastoral Ltd accept any liability in contract, tort or otherwise for any loss, damage, injury or expense, whether direct, indirect or consequential, arising out of the provision of information in this report.

# Contents

# 1 Executive Summary

Wairakei Pastoral Limited (WPL) have identified the need to determine the impact of nitrogen mitigations on the nitrogen load from the Estate. Understanding the effectiveness of applying nitrogen mitigation strategies to the Estate's land uses is integral to informed on-farm adoption. WPL's future development will involve continued land use changes to establish the appropriate balance between farming activities and retired areas, that achieves environmental and economic sustainability. This information will help inform future land use decisions. In addition, it will be useful for WPL to use in their evidence in the Waikato Regional Council Plan Change 1 hearings, to demonstrate meeting the Freshwater Objectives.

WPL have asked The AgriBusiness Group to apply cumulative nitrogen mitigation bundles (low, medium and high mitigation practices in terms of their impact to reduce nitrogen loss) to eight existing representative Overseer land use files for Wairakei Estate:

- LFL Dairy Irrigated (herd home)
- LFL Dairy Dryland (herd home)
- LFL Dairy Irrigated
- LFL Dairy Dryland
- LFL Dairy Support
- KGL Beef Grazing and Dairy Support
- Fibre Fresh Crop and Grazing
- Lucerne Cut-Carry.

These representative baseline files were derived from the 2016-17 Nitrogen Reference Point (NRP) files which were created for each individual business unit, as part of the recent consent application to Waikato Regional Council. For each of the land uses, farm biophysical (e.g. climate, topography) and management (e.g. stock, production, fertiliser, supplements, effluent and irrigation applications) factors were weighted by total hectares, to create "average" representative files.

The results show that substantial reductions in nitrogen leaching can be successfully made in the future. Nitrogen losses were reduced cumulatively over each mitigation bundle. The largest individual reductions occurred from reducing or removing winter and autumn nitrogen fertiliser. The largest total reductions were achieved from the high mitigation bundles. These involve significant investment in infrastructure (e.g. off-paddock structures) and could be disruptive to the farm system, requiring management to upskill. It is recommended that the economic viability of these high-risk mitigations is determined prior to investment; an economic analysis was beyond the scope of this report.

It is important to note that these nitrogen mitigations will have differing effectiveness based on what individual business unit they are applied on. There is no 'one size fits all' approach to mitigating nitrogen losses from farms, as these factors need to be considered on a farm specific and farm system basis. In addition, natural biophysical factors such as soil drainage type, terrain, climatic conditions and natural waterbodies influence the amount and type of contaminants lost, and significant impact the effectiveness of nitrogen mitigation strategies. Each individual business unit is in a different stage of conversion from forestry, which is likely to impact their ability to apply mitigations.

In Table 1, we have listed the N mitigation factors for the low, medium, and high regime for each of the eight farms, and have also presented a weighted whole farm enterprise N loss figure for the Wairakei Pastoral Limited.

**Table 1: Whole farm enterprise (eight combined farms) summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr)**

| Representative Land Use | Baseline | Low Mitigation (kg N / ha) | Medium Mitigation (kg N / ha) | High Mitigation (kg N / ha) |
|---|---|---|---|---|
| Dairy Irrigated Herd Home | 39 | 32 | 23 | 21 |
| Dairy Dryland Herd Home | 18 | 13 | 13 | 11 |
| Dairy Irrigated | 53 | 46 | 31 | 27 |
| Dairy Dryland | 33 | 24 | 21 | 19 |
| Dairy Support (LFL) | 23 | 19 | 19 | 17 |
| Dairy Support (KGL) | 20 | 18 | 18 | 17 |
| Fibre Fresh | 18 | 16 | 15 | 14 |
| Lucerne Cut and Carry | 7 | 7 | 7 | 6 |
| **Whole Enterprise* N loss** | **24** | **20** | **18** | **17** |
| **Reduction from Baseline** | | **-17%** | **-24%** | **-30%** |

* Average weighted by total ha.

As can be seen from **Table 1**:

- Original baseline figure of 24kg N / ha / yr has decreased using low mitigations to 20kg N / ha / yr, a 17% reduction.
- Medium mitigation decreased N loss to 18kg N / ha / yr, a 24% reduction, and
- High mitigation to 17kg N / ha / yr, a 30% decrease in total N loss to water from the original baseline figure.

It is evident that the cumulative mitigation strategies have worked successfully overall to reduce the whole farm total N loss to water. Most mitigation methods provided have been chosen to give options with minimal change to farm operation and production, but some require substantial changes. Although the report succeeds in pragmatic N loss reduction approaches, it does not consider the economic and time feasibility with some of the mitigation methods. With regard to high mitigation, some of the strategies require large scale capital investment, for what are considered small additional returns on N loss reduction as modelled by Overseer. For example, installing a winter feed pad requires a large investment of time, money and changes in herd management practices, for only discrete N loss reductions overall from the mitigation instalment. A full-scale economic analysis would be recommended to achieve certainty around the cost benefit of the low, medium, and high mitigations.

From analysis of the farm results tables and whole farm summary results table, low and medium mitigation have the greatest returns on percentage decreases in N loss from the baseline figures, with the seemingly least amount of effect to farm operation and productivity. From a logical perspective without economic analysis, these mitigation scenarios also seem to be the most realistic and feasible implications if looking at N loss mitigation when considering environment, economic, and social responsibility.

# 2 Objective

The objective of this work was to:

- **Apply low, medium and high nitrogen mitigation bundles to existing land use at Wairakei Estate, using the most recent Overseer model (Version 6.3.0) and**
- **Determine the quantitative percentage reductions in nitrogen loss (total and per land use) as a result of the mitigations.**

An economic analysis of the cost of the mitigations was beyond the scope of this report, however mitigations were bundled in terms of low, medium and high cost/impact on the farm operations.

# 3 Methodology and Results

Nitrogen mitigation scenarios were applied to the Overseer baseline files of eight farm blocks located in the Wairakei Estate:

- LFL Dairy Irrigated (herd home)
- LFL Dairy Dryland (herd home)
- LFL Dairy Irrigated
- LFL Dairy Dryland
- LFL Dairy Support
- KGL Beef Grazing and Dairy Support
- Fibre Fresh Crop and Grazing
- Lucerne Cut-Carry.

The representative baseline files were derived from the 2016-17 NRP files which were created for each individual business unit, as part of the recent consent application to Waikato Regional Council. Representative files were used, as it would be very time intensive to apply nitrogen mitigations to each of the 38 files for the individual business units. For each of the land uses, farm biophysical (e.g. climate, topography) and management (e.g. stock, production, fertiliser, supplements, effluent and irrigation applications) factors were weighted by total hectares, to create “average” representative files. There is only one individual business unit that is an ‘irrigated dairy platform with a herd home’, and one which is a ‘dryland dairy platform with a herd home’, so the actual farm files were used for these two land uses.

A workshop was held in April to discuss the mitigation practices for these farm systems. Although other nitrogen mitigations are available, these were considered the most cost-effective method to reduce nitrogen leaching practically and are recognised by the current version of Overseer. The mitigation bundles determined from this discussion are shown in **Table 2**. The farm inputs used in the Overseer mitigation modelling in this report may be applied to existing APSIM Ruahawai farm systems models.

**Table 2**: **Low, medium, and high mitigation strategies for all seven farms (Fibre Fresh farm is not displayed in this table).**

| Mitigation practices across land use types | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Lucerne** | **Dairy HH** | **Dairy** | **Dairy Support (LFL)** | **Dairy Irr** | **Dairy HH Irr** | **DS KGL (kiwi grazing)** |
| **Low** | No fodder | Eff fert (Remove winter and autumn N), ,drying off percentage of cows (changing urine, and changing feed demand),N value in feed (urine N), pasture | Direct drill kalen(C/N ratio),Eff fert, drying off percentage of cows (changing urine, | Eff fert, low N feed,Dung beetles | Eff fert,drying off percentage of cows (changing urine, and changing feed | Eff fert,low N feed,pasture utilisation,Dung beetles | Eff fert.low N feed,Dung beetles |
| **Med** | No grazing | Effluent reduction ,fodder reduction,drying off percentage of cows,stock reduction (10%),Clover content increase | and consequences, low protein food, eliminate fodder, winter off grazing (reducin the | Direct drill (change CN ratio),8 to 4 % fodder | Efficient irrigation (10%), stock reduction, N feeds,eliminate fodder | Efficient irrigation,stock reduction(10%), N feeds,eliminate fodder | |
| **High** | no fert | Complete housing 75%, significant reduction in urine patch (25 % urine, off all winter, and half summer,stock reduction (20%) | Feed pad,stock reduction (20%) | Feed Pad (change urine area, more effluent,reduce the supplements),cover crop(effluent, fodder) | Feed Pad,,stock reduction (20%) | Dairy HH,,stock reduction (20%) | Feed Pad |
| **Notes** | | | | | | | concentration of N urine patch is lower. 22 - 24 N kg/ha |
| | | | | | | | |
| | | | | | | | |
| **Project Object** | **Maximize the WPL dairy application, maximize the revenue** | | | | | | |
| | **Meet NRP value** | | | | | | |
| | **Meet fresh water management requirement** | | | | | | |

Overseer assumes that the farm is in quasi-equilibrium (inputs and farm management practices commensurate with farm productivity, and feed demand and supply are balanced). Therefore, it is imperative to include changes in farm productivity when applying nutrient mitigation scenarios. This involves considering how each mitigation would impact feed supply and balancing feed demand accordingly.

The next section of this report displays the low, medium, and high mitigations for each of the eight farms with each of the defined activities below each heading. Many of the same mitigations have been applied to more than one farm, and the mitigations below are only explained once to save repetition.

## 3.1 Dairy Irrigated Herd Home (Dairy Irr HH)

The range of mitigations applied to this class of property is as follows:

### Low Mitigation

- Remove autumn and winter N fertiliser inputs.
- Dry off a percentage of cows.

### Medium Mitigation

- Increase irrigation efficiency by implementing soil moisture monitoring.
- Reduce stocking rate by 5%.
- Reduce high N feeds.

### High Mitigation

- Reduce stocking rate by 10%.

### 3.1.1 Methodology

### Low Mitigation

### Remove autumn and winter N fertilisers inputs

Fertiliser applications that contained N were deleted from all blocks on the Dairy Dryland (herd home) in the months of May, June, July, and half of August (total 55kg N / ha / yr). Due to the decrease in plant available N (assuming the response rate of 7:1 kg DM / kg N) a calculation was completed to model the decrease in pasture production. Milk solids production was also decreased (assuming 1kg MS / 11 kg DM) and the bottom cows were removed as an adjustment for pasture loss (assuming 1 cow consumes 16kg DM per day).

### Dry off a percentage of cows

Cow lactation was reduced for a period of 7 days (from 268 to 261-day lactation). Cows were exported off the farm a week earlier. Drying off cows earlier will decrease the values of N added from animal impacts during the milking season and winter season.

### Medium Mitigation

### Increase irrigation efficiency by implementing soil moisture monitoring

The irrigation management in Overseer was changed from “visually access/digging holes” to “soil moisture sensors”. Inputting the respective soil type Profile Available Water (PAW) will dictate

irrigation event management. Establishing more efficient irrigation by utilising soil moisture monitoring will mean water is only applied to soils when required, alleviating the soil profile of excess water containing N to be leached.

### Reduce stocking rate by 5%

The stocking rate was reduced in total numbers by 5%, reducing peak cow numbers from 730 to 656. Milk solid production decreased from 243,528kg / yr to 219,175kg / yr. Supplements fed in the herd home also reduced from a total of 54 t dry matter to 53 t dry matter. Cows represent the greatest input of organic N and a reduction in stocking rate will decrease the organic N inputs significantly.

### Reduce high N feeds

The total amount of supplements fed as pasture silage were swapped to maize silage, remaining at the same weight. Maize silage is a lower protein feed and when digested in a ruminant, releases lower levels of N outputs from animals.

### High Mitigation

### Reduce stocking rate by 10%

Calculate the reduction in overall stocking rate a further 5% from initial 5% reduction to equate a 10% reduction in overall cow numbers. Peak cow numbers were reduced from 730 to 591, meaning a decrease in milk solid production from 243,528kg / yr to 175,340kg / yr. Supplements fed in the herd home also reduced from 54 t dry matter to 48 t dry matter.

## 3.1.2 Results

The results of the mitigation analysis are shown in **Table 2**. A more detailed description of the results of the Overseer modelling of each of the farm types are included in the **Appendix 1**.

**Table 3: Dairy Irrigated Herd Home summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) .**

| | Baseline | Low Mitigation (kg N / ha) | Medium Mitigation (kg N / ha) | High Mitigation (kg N / ha) |
|---|---|---|---|---|
| N loss | 39 | 32 | 23 | 21 |
| Reduction from Baseline (%) | | -17 | -41 | -46 |

**Table 3** shows:

- Low mitigation decreased N loss from the baseline figure of 39kg N / ha / yr to 32kg N / ha / yr, equating to a 17% reduction.
- Medium mitigation reduced N to 23kg N / ha / yr, a 41% decrease.
- High mitigation to 21kg N / ha / yr, a 46% total reduction in N loss to water from the original baseline figure.

## 3.2 Dairy Dryland Herd Home (Dairy DL HH)

The range of mitigations applied to this class of property is as follows:

### Low Mitigation

- Remove autumn and winter N fertiliser inputs
- Dry off a percentage of cows early

### Medium Mitigation

- Increase effluent application area by 25% to reduce effluent concentrations
- Reduce stocking rate by 5%
- Reduce high N feeds

### High Mitigation

- Reduce stocking rate by 10%
- Increase the time that cows are in the herd home

### 3.2.1 Methodology

### Low Mitigation

### Medium Mitigation

### Increase effluent application area

The effluent area was increased by 32 ha on the flat milking platform area. Increasing the size in effluent area allows the concentration of nutrients to be diluted over a larger pastoral area.

### High Mitigation

### Increase the time that cows are in the herd home

Cow numbers are reduced from 10 hours per day to 4 hours per day on grazing pasture.

### 3.2.2 Results

**Table 4**: **Dairy Dryland Herd Home summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) .**

| | Baseline | Low Mitigation (kg N / ha) | Medium Mitigation (kg N / ha) | High Mitigation (kg N / ha) |
|---|---|---|---|---|
| N loss | 18 | 13 | 13 | 11 |
| Reduction from Baseline (%) | | -25 | -28 | -38 |

**Table 4** shows:

- Low mitigation decreased N loss to water over the whole farm from the baseline figure of 18kg N / ha / yr to 13kg N / ha / yr, equating to a 25% reduction.
- Medium mitigation reduced N to 13kg N / ha / yr, a 28% decrease
- High mitigation to 11kg N / ha / yr, a totalled a 38% reduction in N loss to water from the original baseline figure.

## 3.3 Dairy Irrigated (Dairy Irr)

The range of mitigations applied to this class of property is as follows:

### Low Mitigation

- Remove autumn and winter N fertiliser inputs
- Dry off a percentage of cows

### Medium Mitigation

- Increase irrigation efficiency by implementing soil moisture monitoring
- Reduce stocking rate by 5%

### High Mitigation

- Reduce stocking rate by 10%
- Install a winter feed pad

### 3.3.1 Methodology

### High Mitigation

### Install a winter feed pad

Added a winter feed pad to the model. Cow grazing on fodder paddocks is reduced to 10 hours as they will be fed supplements on the feed pad for the remainder of the day. Supplements purchased or produced are now fed onto the feed pad rather than on pasture during this period. Solid and liquid effluent from the feed pad is captured and applied to 100 ha of pastured area. Effluent is stored for two months. Fertiliser applications are also dropped by 5% over the effluent discharge area to match N nutrient inputs to non-effluent blocks.

### 3.3.2 Results

**Table 5: Dairy Irrigated summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| | Baseline | Low Mitigation (kg N / ha) | Medium Mitigation (kg N / ha) | High Mitigation (kg N / ha) |
|---|---|---|---|---|
| N loss | 53 | 46 | 31 | 27 |
| Reduction from Baseline (%) | | -13 | -42 | -50 |

**Table 5** concludes:

- Low mitigation decreased N loss to water from the baseline figure of 53kg N / ha / yr to 46kg N / ha / yr, equating to a 13% reduction.
- Medium mitigation reduced N to 31kg N / ha / yr, a 42% decrease.
- High mitigation to 27kg N / ha / yr, a 50% total reduction in N loss to water from the original baseline figure.

## 3.4 Dairy Dryland (Dairy DL)

The range of mitigations applied to this class of property is as follows:

### Low Mitigation

- Remove autumn and winter N fertiliser inputs
- Dry off a percentage of cows

### Medium Mitigation

- Remove high N feeds
- Winter cows off farm

### High Mitigation

- Install a winter feed pad
- Reduce stocking rate by 10%

### 3.4.1 Methodology

### High Mitigation

### Winter cows off farm

Removed the herd from the farm for 60 days (June-July). Assuming the wintered cows were offered 15kg DM / ha / day (4kg DM silage / cow / day), remove the silage used to support these cows during that period, and increase milk-solids production due to increase in available pasture when cows come back in August (assuming 12kg DM / 1kg MS)

### 3.4.2 Results

**Table 6: Dairy Dryland summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| | Baseline | Low Mitigation (kg N / ha) | Medium Mitigation (kg N / ha) | High Mitigation (kg N / ha) |
|---|---|---|---|---|
| N loss | 33 | 24 | 21 | 20 |
| Reduction from Baseline (%) | | -27 | -37 | -40 |

**Table 6** shows:

- Low mitigation decreased N loss to water over the whole farm from the baseline figure of 33kg N / ha / yr to 24kg N / ha / yr, equating to a 27% reduction.
- Medium mitigation reduced N to 21kg N / ha / yr, a 37% decrease.
- High mitigation to 20kg N / ha / yr, a 40% total reduction in N loss to water from the original baseline figure.

## 3.5 Landcorp Farming Limited Dairy Support

The range of mitigations applied to this class of property is as follows:

### Low Mitigation

- Remove autumn and winter N fertiliser inputs

### Medium Mitigation

- Direct drill fodder crops

### High Mitigation

- Install a winter feed pad
- Add cover crops into fodder rotation

### 3.5.1 Methodology

### Medium Mitigation

### Direct drill fodder crops

All the crop block cultivation practices were changed from conventional cultivation to direct drill.

### High Mitigation

### Add cover crops in fodder rotation

A forage oats crop was added into the fodder crop rotations after fodder crops had been grazed with the residuals being left in the soil as organic matter.

### 3.5.2 Results

**Table 7: Landcorp Farming Limited Dairy Support summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| | Baseline | Low Mitigation (kg N / ha) | Medium Mitigation (kg N / ha) | High Mitigation (kg N / ha) |
|---|---|---|---|---|
| N loss | 23 | 19 | 19 | 17 |
| Reduction from Baseline (%) | | -16 | -17 | -24 |

**Table 7** presents:

- Low mitigation reduced from the baseline figure of 23kg N / ha / yr to 19kg N / ha / yr, a 16% reduction.
- Medium mitigation did not change the average N loss quantitatively due to the rounding up of figures.
- High mitigation decreased N loss to 17kg N / ha / yr, a 24% total reduction in N loss to water from the original baseline figure.

## 3.6 Kiwi Grazing Limited Beef Grazing/Dairy Support

The range of mitigations applied to this class of property is as follows:

### Low Mitigation

- Remove autumn and winter N fertiliser inputs
- Release dung beetles onto farm

### Medium Mitigation

- Direct drill fodder crops

### High Mitigation

- Install a winter feed pad

### 3.6.1 Results

**Table 8: Kiwi Grazing Limited Beef Grazing/Dairy Support summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| | Baseline | Low Mitigation (kg N / ha) | Medium Mitigation (kg N / ha) | High Mitigation (kg N / ha) |
|---|---|---|---|---|
| N loss | 20 | 18 | 18 | 17 |
| Reduction from Baseline (%) | | -8 | -8 | -14 |

**Table 8** concludes:

- Low mitigation decreased N loss from the baseline figure of 20kg N / ha / yr to 18kg N / ha / yr, equating to an 8% reduction.
- Medium mitigation was insignificant.
- High mitigation to 17kg N / ha / yr, a -14% total reduction in N loss to water from the original baseline figure.

## 3.7 Lucerne Cut-Carry

The range of mitigations applied to this class of property is as follows:

### High Mitigation

- Remove fertiliser applications

### 3.7.1 Methodology

### High Mitigation

Removed all N fertiliser applications from the farm assuming the response rate of 5:1 kg DM / kg N.

### 3.7.2 Results

**Table 9: Lucerne Cut-Carry summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| | Baseline | Low Mitigation (kg N / ha) | Medium Mitigation (kg N / ha) | High Mitigation (kg N / ha) |
|---|---|---|---|---|
| N loss | 7 | N/A | N/A | 6 |
| Reduction from Baseline (%) | | N/A | N/A | -14 |

**Table 9** shows:

- N loss reductions from the baseline figure of 7kg N / ha / yr to 6kg N / ha / yr, giving a 14% reduction overall in total N loss. Mitigations for this block are limited as the outputs of N from this block are very low.

## 3.8 Fibre Fresh Crop and Grazing

The range of mitigations applied to this class of property is as follows:

### Low Mitigation

- Direct drill crops

### Medium Mitigation

- Reduce stocking rate and forage crop area by 10%

### High Mitigation

- Reduce stocking rate and forage crop area by 20%

### 3.8.1 Methodology

### Medium Mitigation

### Reduce stocking rate and forage crop area by 10%

Reduced the stocking rate from 1030 to 927 cattle, and the forage crop area from 206 ha to 185.4 ha.

### High Mitigation

### Reduce stocking rate and forage crop area by 20%

Reduced the stocking rate from 927 to 835 cattle, and the forage crop area from 185.4 ha to 167 ha.

### 3.8.2 Results

**Table 10: Fibre Fresh summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| | Baseline | Low Mitigation (kg N / ha) | Medium Mitigation (kg N / ha) | High Mitigation (kg N / ha) |
|---|---|---|---|---|
| N loss | 18 | 16 | 15 | 14 |
| Reduction from Baseline (%) | | -11 | -17 | -22 |

**Table 10** shows:

- Low mitigation decreased N loss to water over the whole farm from the baseline figure of 18kg N / ha / yr to 16kg N / ha / yr, equating to a 11% reduction.
- Medium mitigation reduced N to 15kg N / ha / yr, a 17% decrease.
- High mitigation to 14kg N / ha / yr, a totalled a 22% reduction in N loss to water from the original baseline figure.

# 4 Summary Results

In **Table 11**, we have listed the N mitigation factors for the low, medium, and high regime for each of the eight farms, and have also presented a weighted whole farm enterprise N loss figure for the Wairakei Pastoral Limited.

**Table 11: Whole farm enterprise (eight combined farms) summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018**

| Representative Land Use | Baseline | Low Mitigation (kg N / ha) | Medium Mitigation (kg N / ha) | High Mitigation (kg N / ha) |
|---|---|---|---|---|
| Dairy Irr HH | 39 | 32 | 23 | 21 |
| Dairy DL HH | 18 | 13 | 13 | 11 |
| Dairy Irr | 53 | 46 | 31 | 27 |
| Dairy DL | 33 | 24 | 21 | 19 |
| Dairy Support LFL | 23 | 19 | 19 | 17 |
| Dairy Support KGL | 20 | 18 | 18 | 17 |
| Fibre Fresh | 18 | 16 | 15 | 14 |
| Lucerne Cut and Carry | 7 | 7 | 7 | 6 |
| **Whole Enterprise* N loss** | **24** | **20** | **18** | **17** |
| **Reduction from Baseline** | | **-17%** | **-24%** | **-30%** |

*Average weighted by total ha.

**Table 11** shows:

- The original baseline figure of 24kg N / ha / yr has decreased using low mitigations to 20kg N / ha / yr, a 17% reduction.
- Medium mitigation decreased N loss to 18kg N / ha / yr, a 24% reduction.
- High mitigation to 17kg N / ha / yr, a 30% decrease in total N loss to water from the original baseline figure.

It is evident that the cumulative mitigation strategies have worked successfully overall to reduce the whole farm total N loss to water. Moderate percentage reductions throughout each farm have accumulated to present low, medium, and high N loss figures. The mitigation methods provided have been chosen to give options with minimal change to farm operation and production. Although the report succeeds in pragmatic N loss reduction approaches, it does not consider the economic and time feasibility with some of the mitigation methods. With particular regard to the high mitigation, some of the strategies require large scale capital investment, for what are considered small additional returns on N loss reduction as modelled by Overseer. For example, installing a winter feed pad requires a large investment of time, money and changes in herd management practices, for only discrete N loss reductions overall from the mitigation instalment. A full-scale economic analysis would be recommended to achieve certainty around the cost benefit of the low, medium, and high mitigations.

From analysis of the farm results tables and whole farm summary results table, low and medium mitigation deem to have the greatest returns on percentage decreases in N loss from the baseline figures, with the seemingly least amount of effect to farm operation and productivity. From a logical

perspective without economic analysis, these mitigation scenarios also seem to be the most realistic and feasible implications if looking at N loss mitigation from a holistic view considering environment, economic, and social responsibility.

# 5 Appendix 1; Individual Farm Scenario Comprehensive Results

**Table 1: Dairy Irr HH summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| BLOCKS - DAIRY IRR HH | Type | Area | Baseline (N) | Mit Low (N) | Mit Med (N) | Mit High (N) |
|---|---|---|---|---|---|---|
| Pumice, NE, dry, flat | Pasture | 42.7 | 31 | 21 | 19 | 18 |
| Pumice, NE, dry, rolling | Pasture | 2.9 | 15 | 13 | 12 | 11 |
| Pumice, Eff, dry, flat | Pasture | 45.7 | 20 | 16 | 14 | 13 |
| Pumice, Eff, dry, rolling | Pasture | 2.5 | 18 | 15 | 14 | 13 |
| Pumice, NE, irr, flat | Pasture | 74.8 | 57 | 46 | 26 | 24 |
| Pumice, NE, irr, rolling | Pasture | 3.4 | 35 | 31 | 17 | 15 |
| Pumice, Eff, irr, flat | Pasture | 73.4 | 39 | 32 | 18 | 16 |
| Pumice, LFL DS, fodderbeet, May | Crop | 3.3 | 56 | 55 | 51 | 34 |
| Pumice, LFL DS, fodderbeet July | Crop | 1.7 | 90 | 87 | 86 | 73 |
| Pumice, LFL DS, irr, fodderbeet May | Crop | 5.3 | 48 | 47 | 58 | 40 |
| Pumice, LFL DS, irr, fodderbeet July | Crop | 2.7 | 78 | 77 | 84 | 71 |
| Pine Forestry | Trees/scrub | 2.9 | 2 | 2 | 2 | 2 |
| Riparian Native | Riparian | 34.1 | 3 | 3 | 3 | 3 |
| **Total N loss (whole farm)** | | **303** | **11,780** | **9,791** | **6,977** | **6,329** |
| **Average N loss (weighted by ha)** | | | **38.8** | **32.3** | **23.0** | **20.9** |
| **Percentage Reduction from Baseline** | | | | **-17%** | **-41%** | **-46%** |

**Table 2: Dairy DL HH summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| BLOCKS - DAIRY DL HH | Type | Area | Baseline (N) | Mit Low (N) | Mit Med (N) | Mit High (N) |
|---|---|---|---|---|---|---|
| Pumice, NE, dry, flat | Pasture | 724.6 | 17 | 13 | 13 | 11 |
| Pumice, NE, dry, rolling | Pasture | 36.4 | 15 | 12 | 12 | 10 |
| Pumice, NE, dry, easy hill | Pasture | 2.4 | 14 | 12 | 11 | 10 |
| Pumice, Eff, dry, flat | Pasture | 127.2 | 25 | 15 | 14 | 12 |
| Pumice, Eff, dry, rolling | Pasture | 11.4 | 23 | 15 | 14 | 12 |
| Pumice, Eff, dry, easy hill | Pasture | 1.4 | 23 | 16 | 14 | 12 |
| Pine Forestry | Trees/scrub | 71.4 | 2 | 2 | 2 | 2 |
| **Total N loss (whole farm)** | | **1003** | **17,755** | **13,331** | **12,726** | **10,994** |
| **Average N loss (weighted by ha)** | | | **17.7** | **13.3** | **12.7** | **11.0** |
| **Percentage Reduction from Baseline** | | | | **-25%** | **-28%** | **-38%** |

**Table 3: Dairy Irr summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| BLOCKS - DAIRY IRR | Type | Area | Baseline (N) | Mit Low (N) | Mit Med (N) | Mit High (N) |
|---|---|---|---|---|---|---|
| Irrigated Effluent | Pastoral | 88 | 70 | 62 | 37 | 40 |
| Irrigated Non-Effluent | Pastoral | 196 | 66 | 58 | 35 | 26 |
| Dryland Effluent | Pastoral | 18 | 45 | 36 | 33 | 37 |
| Dryland Non-Effluent | Pastoral | 118 | 33 | 27 | 25 | 19 |
| **Total N loss (whole farm)** | | **460** | **24,480** | **21,250** | **14,282** | **12,251** |
| **Average N loss (weighted by ha)** | | | **53.2** | **46.2** | **31.0** | **26.6** |
| **Percentage Reduction from Baseline** | | | | **-13%** | **-42%** | **-50%** |

**Table 4: Dairy DL summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| BLOCKS - DAIRY DL | Type | Area (ha) | Baseline (N) | Mit Low (N) | Mit Med (N) | Mit High (N) |
|---|---|---|---|---|---|---|
| Dryland Effluent | Pastoral | 149 | 38 | 26 | 25 | 30 |
| Dryland Non-Effluent | Pastoral | 431 | 37 | 27 | 22 | 18 |
| Pines | Trees/scrub | 64 | 2 | 2 | 2 | 2 |
| Riparian | Riparian | 24.6 | 3 | 3 | 3 | 3 |
| **Total N loss (whole farm)** | | **692** | **22,588** | **16,566** | **14,333** | **13,472** |
| **Average N loss (weighted by ha)** | | | **32.6** | **23.9** | **20.7** | **19.5** |
| **Percentage Reduction from Baseline** | | | | **-27%** | **-37%** | **-40%** |

**Table 5: LFL Dairy Support summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| BLOCKS - DAIRY SUPPORT LFL | Type | Area (ha) | Baseline (N) | Mit Low (N) | Mit Med (N) | Mit High (N) |
|---|---|---|---|---|---|---|
| Pasture Flat | Pastoral | 242.6 | 23 | 18 | 18 | 22 |
| Fodderbeet May/June | Crop | 32.2 | 95 | 83 | 78 | 52 |
| Fodderbeet July | Crop | 11.4 | 101 | 98 | 101 | 110 |
| Pines | Trees/Scrub | 147.3 | 2 | 2 | 2 | 2 |
| Riparian | Riparian | 18.7 | 3 | 3 | 3 | 3 |
| **Total N loss (whole farm)** | | **462.3** | **10,415** | **8,793** | **8,647** | **7,949** |
| **Average N loss (weighted by ha)** | | | **22.5** | **19.0** | **18.7** | **17.2** |
| **Percentage Reduction from Baseline** | | | | **-16%** | **-17%** | **-24%** |

**Table 6: KGL Beef Grazing/Dairy Support summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| BLOCKS - DAIRY SUPPORT KGL | Type | Area (ha) | Baseline (N) | Mit Low (N) | Mit Med (N) | Mit High (N) |
|---|---|---|---|---|---|---|
| Pasture Flat | Pastoral | 1169 | 38 | 35 | 35 | 32 |
| Kale Flat | Crop | 22 | 84 | 82 | 76 | 67 |
| Oats Flat | Crop | 17.5 | 69 | 65 | 64 | 60 |
| Pine Forestry | Trees/Scrub | 1187.3 | 2 | 2 | 2 | 2 |
| Riparian/Native | Riparian | 162.4 | 3 | 3 | 3 | 3 |
| **Total N loss (whole farm)** | | **2598.8** | **51,419** | **47,460** | **47,310** | **44,368** |
| **Average N loss (weighted by ha)** | | | **19.8** | **18.3** | **18.2** | **17.1** |
| **Percentage Reduction from Baseline** | | | | **-8%** | **-8%** | **-14%** |

**Table 7: Lucerne Cut-Carry summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| BLOCKS - LUCERNE | Type | Area (ha) | Baseline (N) | Mit Low (N) | Mit Med (N) | Mit High (N) |
|---|---|---|---|---|---|---|
| Pumice - Cut and Carry | C/C | 106.6 | 7 | NA | NA | 6 |
| **Total N loss (whole farm)** | | | | | | |
| **Average N loss (weighted by ha)** | | **106.6** | **7** | **NA** | **NA** | **6** |
| **Percentage Reduction from Baseline** | | | | **N/A** | **N/A** | **-14%** |

**Table 8: Fibre Fresh Crop and Grazig summary of baseline, low, medium, and high mitigation N loss results (kg N / ha / yr) 2018.**

| BLOCKS - Fibre Fresh | Type | Area (ha) | Baseline (N) | Mit Low (N) | Mit Med (N) | Mit High (N) |
|---|---|---|---|---|---|---|
| Pumice, Pasture>Swedes,1-5yr | Crop | 19.1 | 61 | 51 | 51 | 51 |
| Pumice, Swedes>Pasture,1-5yr | Crop | 5.1 | 69 | 59 | 59 | 60 |
| Pumice, Swedes>Oats,1-5yr | Crop | 14 | 149 | 132 | 132 | 132 |
| Pumice, Oats>Pasture,1-5yr | Crop | 14 | 55 | 49 | 49 | 49 |
| Pumice, Lucerne,1-5yr | Cut/Carry | 154.1 | 8 | 8 | 8 | 8 |
| Pumice, Pasture,1-5yr,Rolling | Pasture | 10.4 | 26 | 22 | 22 | 22 |
| Pine Forestry | Trees/Scrub | 74.3 | 2 | 2 | 2 | 2 |
| Riparian/Native | Riparian | 1 | 3 | 3 | 3 | 3 |
| **Total N loss (whole farm)** | | **350** | **18** | **16** | **15** | **14** |
| **Average N loss (weighted by ha)** | | | **0.1** | **0.0** | **0.0** | **0.0** |
| **Percentage Reduction from Baseline** | | | | **-11%** | **-17%** | **-22%** |