BEFORE COMMISSIONERS ON
BEHALF OF SOUTHLAND REGIONAL COUNCIL

IN THE MATTER	**Applications for resource consents**
BY	**TITIPUA LIMITED PARTNERSHIP**
	Applicant

EVIDENCE OF
MONIQUE (MO) MARIE TOPHAM
24 MARCH 2022

BACKGROUND AND QUALIFICATIONS:

1. My name is Monique (Mo) Marie Topham. I hold a Bachelor of Agricultural Science Degree with First Class Honours (Dairy Systems) from Lincoln University. I am a member of the New Zealand Institute of Primary Industry Management (NZIPIM) and have been involved in the dairy industry in consultancy, facilitation and practical farming since 2013.

2. I am qualified to complete farm systems appraisals. I have developed my skills through my university studies followed by nine years working within the dairy industry in Southland, including operating our own dairy farm business with my husband. I am a Certified Dairy Farm Systems Consultant (certified in 2017) under the NZIPIM certification scheme.

3. I have completed the Sustainable Nutrient Management Courses (Intermediate and Advanced) and am a Certified Nutrient Management Adviser (certified in 2018). I have also completed a course in Greenhouse Gases and am a certified Greenhouse Gas Advisor (certified in 2018).

4. I am a Director and Shareholder of three dairy farming businesses - Fast Track Dairies Limited, Clover Milk Limited and Hedgehope Grazing Limited. These businesses operate two dairy farms in Southland totalling approximately 470ha (dairy platforms and support area). My involvement with these properties, with my other business partners, has been to develop profitable and sustainable farming businesses in all facets, including environmental.

5. Our business, Clover Milk Limited, has recently purchased the neighbouring dairy farm to Titipua Limited Partnership. We will take over this property on the 1st June 2022. This property was not on the market when I first started working on this consent application and Clove Milk Limited has no financial connection to Titipua LTd Partnership.

6. I was previously employed by DairyNZ as a Consulting Officer in the Southland, South Otago regional team. In this role I facilitated discussion and information transfer from dairy farmer to dairy farmer and from technical experts to dairy farmers. This resulted in the adoption of new practices and technologies on farm (including environmental).

7. Since resigning from DairyNZ in December 2016, I have been working as a farm systems and environmental consultant with LIC FarmWise and more latterly with my own company AgriAce Consulting Limited. I work with dairy farmers throughout Southland and Otago supporting them to design, analyse and implement dairy farm systems that meet their environmental, financial and personal goals. I am also involved in projects supporting the development and implementation of good management practices for farmers.

8. I have read the Code of Conduct for Expert Witnesses within the Environment Court Consolidated Practice Note 2014 and I agree to comply with that Code. This evidence is within my area of expertise, except where I state I am relying on what I have been told by another person. To the best of my knowledge, I have not omitted to consider any material facts known to me that might alter or detract from the opinions I express.

SCOPE OF EVIDENCE

9. This evidence addresses the following matters raised in the s42a report:

   (a) The auditor's report on the robustness of the Overseer modelling (section 2.4.4.j and the auditor's report in Attachment 1)

   (b) An error in the report in section 3.3.2.1 relating to which Overseer's ability to model good management practices (GMPs)

   (c) Commentary around the use, uncertainty, and accuracy of the Overseer model in light of the Government's Science Advisory Panel's review (section 3.3.2.1)

   (d) A comment regarding using plantain as a mitigation despite it being excluded from the Overseer modelling

BACKGROUND

10. These consent applications are part of a proposal to expand the applicants current dairy farm operation onto a recently purchased piece of land. For clarity, the recently purchased land has been called the "Schrama Block" and the original farm has been called the "Current Dairy Platform". They combine to form the "Proposed".

11. I have been involved in producing nutrient budgets for this application since late 2020.

12. The nutrient budgets were prepared using "Overseer Best Practice Data Input Standards, March 2018). No deviations from these protocols were made during the modelling assumptions. Farm systems information was provided by Stephen and Blake Korteweg on behalf of the Titipua Limited Partnership for the current dairy platform.

13. The applicant purchased the Schrama Block in mid-2020. Very limited farm system information for the Schrama Block was available from the previous owner and therefore assumptions were made from visual assessment, Google Earth imaging, the applicant's knowledge (as neighbours to the property), Beef and Lamb NZ Economic survey data and professional judgement. Soils areas were obtained from soils mapping provided by OverseerFM and soils settings from SMap. Climate settings were obtained from the Overseer climate station tool. This approach has been consistent throughout all of the nutrient budgets completed. All assumptions have been discussed in detail with the applicant. The applicants display a good level of understanding of the inputs and assumptions that have been used.

14. During these consent applications there have been multiple version changes to the Overseer model. There was also a request from the applicants that an additional mitigation measure, being the inclusion of a herd home, be added to the application. There have also been updates to the calculations regarding the mitigation potential of the proposed wetland. The most recent of these modelling reports was written in March 2022. The approach to producing the modelling has not changed however.

15. All eight Overseer modelling reports have been appended in their entirety to this evidence. For ease of understanding, I recommend the reports are read in the chronological order. In all the modelling, the Current Dairy Platform and the Schrama Block were modelled separately as per Overseer protocol. For ease of understanding I have added the combined losses from these two models below so that it is possible to make a direct comparison between the current system and proposed system. A summary of the results is given below. The titles refer to those used in the modelling reports:

(a) <u>Titipua Ltd Partnership – OverseerFM farm system modelling to support a consent application for expanded dairy – 23rd March 2021</u>

Overseer modelling was completed using Overseer version 6.3.5. Summarised results from this modelling are in Table 1 and estimate a decrease in N loss (6.7%) and P loss (11.3%). The proposed system included the use of a baleage grass system and the construction of a wetland. As these cannot be modelled effectively in Overseer, calculations were completed to quantify their impact on estimated nitrogen and phosphorus losses. Advice was sought from the Environment Southland Land Sustainability team on the nitrogen and phosphorus mitigation offered by a constructed wetland. This advice formed the basis of the wetlands calculations completed outside of Overseer.

Table 1.Predicted nitrogen and phosphorus losses in the current and proposed systems under Overseer version 6.3.5

	Current system	**Proposed system**	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	13,035	12,181 *(12,749 modelled plus 173 baleage grass wintering minus 741 wetlands calculated outside OverseerFM)*	6.7% decrease
N Loss/ha (kgN/ha/yr)	49	46	
Total Farm P Loss (kg)	645	572 *(615 modelled minus 43 wetlands calculated outside OverseerFM)*	11.3% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	

(b) <u>File note: Titipua Ltd Partnership – pasture grown – June 2021</u>

Council commissioned Irricon to complete a Nutrient Budget Review (included as Attachment 1 in s42a report). This file note explained the pasture grown figures in the proposed system modelling to provide council confidence that they were reasonable. This is discussed further in this evidence in paragraph19.

(c) <u>File note: Titipua Ltd Partnership – Overseer Version Change – September 2021</u>

On July 24th 2021, after the consent was lodged, Overseer released a new version (6.4.0). As is typical with Overseer version updates, this resulted in changes to the estimated losses of N and P from the current and proposed systems. A file note was written to update council on the nutrient loss figures. Calculations outside of Overseer were also updated considering the Overseer version change. These updated loss estimates are shown in table 2. When compared to previous modelling, there were changes in predicted losses. These are shown below in red.

The cumulative impact of the version change was a reduction in the modelled decrease of both nitrogen and phosphorus loss. The updated estimated reductions showed a decrease in N loss of 3.8% and a decrease in P loss of 11.3%

Table 2. Predicted nitrogen and phosphorus losses in the current and proposed systems under Overseer version 6.4.0.

	Current system	**Proposed system**	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11,881	11,434 *(11,656 modelled plus 444 baleage grass wintering minus 666 wetlands calculated outside OverseerFM)*	3.8% decrease
N Loss/ha (kgN/ha/yr)	45	43	
Total Farm P Loss (kg)	647	574 *(617 modelled minus 43 wetlands calculated outside OverseerFM)*	11.3% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	

(d) In mid-September 2021, Environment Southland consents staff recommended that the application be publicly notified. Regarding the estimated nitrogen and phosphorus losses from the property, concern was raised that the calculations completed to estimate the mitigation potential of the wetland were incorrect, and that the reduction in nitrogen losses was "negligible" and "given the uncertainty associated with Overseer modelling, does not demonstrate that water quality will be improved with regard to nitrogen"

(e) File note: TItipua Ltd Partnership – Wetland Mitigation Calculations – October 2021

A file note was written to address the concerns raised by the Environment Southland consents team regarding the wetland mitigation potential calculations completed outside of Overseer. A Technical Review of the wetland mitigation calculations for estimated nitrogen and phosphorus mitigation was undertaken by Andrea Richardson of Landpro. Andrea was considered qualified to write this review given her Bachelor of Engineering (Honours, Civil) training and previous work in Civil Engineering. This process refined the calculations estimating the potential nitrogen and phosphorus reduction offered by the wetland. The Project Memorandum written by Andrea Richardson is also appended to this evidence.

The file note concluded that "It is expected that the wetland will mitigate 38% of the nitrogen and 48% of the phosphorus losses from the catchment area. 34ha of the 44ha captured by the wetland are situated on the Titipua Ltd Partnership property. The wetland is expected to reduce nutrient loss from this 34ha by 476kgN and 39kgP."

(f) File note: Titipua Ltd Partnership – Additional mitigation strategies – October 2021

The applicant requested that further modelling be undertaken following a decision to install a 200-cow herd home on the property. Updates to the calculations outside of Overseer were also completed to ensure continuity of the application and to address concerns raised by Environment Southland around the wetland mitigation potential in the notification report.

Between Sep 2021 and Oct 2021, there was also another Overseer version released (6.4.1). These updated loss estimates, including the herd home installation and updates to the calculations outside of Overseer are shown in table 3. Once again, where there are changes compared to previous modelling, these are shown below in red. The updated estimated reductions showed a decrease in N loss of 7.1% and a decrease in P loss of 10.8%. When compared to loss reductions in the previous file note (paragraph 15c) the change in loss reductions is due to inclusion of the herd home, the related changes in farm system due to the herd home and the update to the wetland calculation. There was no change in loss reductions as a result of the Overseer version change.

Table 3. Predicted nitrogen and phosphorus losses in the current and proposed systems under Overseer version 6.4.1.

	Current system	**Proposed system**	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	12,034	11,180 *(11,075 modelled plus 581 baleage grass wintering minus 476 wetlands calculated outside OverseerFM)*	7.1% decrease
N Loss/ha (kgN/ha/yr)	45	42	
Total Farm P Loss (kg)	649	579 *(623 modelled minus 5 baleage grass wintering minus 39 wetlands calculated outside OverseerFM)*	10.8% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	

(g) <u>File note: Titipua Ltd Partnership – Updating OverseerFM outputs to version 6.4.2 – March 2022</u>

A new version of Overseer (version 6.4.2) was released on December 20th, 2021. Subsequently, Environment Southland requested that the modelling be rerun under the latest Overseer version, and the results be presented. The calculations outside of Overseer for the baleage grass and the proposed wetland have also been updated for continuity.

These updated loss estimates are shown in table 4. When compared to previous modelling, there were changes in predicted losses. These are shown below in red.

The cumulative impact of the version change was a reduction in the modelled decrease of both nitrogen and phosphorus loss. The updated estimated reductions showed a decrease in N loss of 8.6% and a decrease in P loss of 10.8%

Table 4. Predicted nitrogen and phosphorus losses in the current and proposed systems under Overseer version 6.4.2.

	Current system	Proposed system	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11809	10,789 *(10,647 modelled plus 603 baleage grass wintering minus 461 wetlands calculated outside OverseerFM)*	8.6% decrease
N Loss/ha (kgN/ha/yr)	44	41	
Total Farm P Loss (kg)	649	579 *(623 modelled minus 5 baleage grass wintering minus 39 wetlands calculated outside OverseerFM)*	10.8% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	

(h) File note: Titipua Ltd Partnership – Peer Reviewed Technical Wetland Update – 24 March 2022

While preparing for this hearing this file note was written to address concerns raised by Environment Southland in the recommending report and by Forest and Bird in a submission. The file note provides details of the proposed design of the wetland, a construction and planting timeline, confidence around the effectiveness of the wetland as it develops and quantification of the expected mitigation potential of the wetland. This file note was peer reviewed by Chris Tanner, NIWA Principal Scientist - Aquatic Pollution and author of the NIWA/DairyNZ Wetland Practitioners Guide.

During the writing of this file note, an error in the methodology (originally recommended by Environment Land Sustainability staff) to quantify phosphorus loss mitigation potential was identified. This error was rectified and the file note concluded *"Assuming the wetland is constructed following the guidelines of the "Wetland Practitioner Guide"(Tanner et al, 2022), the wetland proposed on the applicant's property is predicted to mitigate losses of nitrogen by 38% and mitigate the loss of total P by 15%. It is expected that the wetland will be 70-80% efficient after one growing season assuming plants are able to get well established."*

(i) <u>File Note: Titipua Ltd Partnership – Updating OverseerFM outputs considering updated wetland efficacy expectations – 24 March 2022</u>

During the preparation of evidence for the hearing and seeking advice from a leading NZ expert in wetlands it was identified that the Titipua wetland calculations required refining. This file note refines the original wetland calculations.

These updated loss estimates are shown in table 5. When compared to previous modelling, there were changes in predicted losses. These are shown below in red.

The cumulative impact of the version change was a reduction in the modelled decrease of both nitrogen and phosphorus loss. The updated estimated reductions showed a decrease in N loss of 8.6% and a decrease in P loss of 6.6%

Table 5. Predicted nitrogen and phosphorus losses in the current and proposed systems under Overseer version 6.4.2.

	Current system	**Proposed system**	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11809	10,789 *(10,647 modelled plus 603 baleage grass wintering minus 461 wetlands calculated outside OverseerFM)*	8.6% decrease
N Loss/ha (kgN/ha/yr)	44	41	
Total Farm P Loss (kg)	649	606 *(623 modelled minus 5 baleage grass wintering minus 12 wetlands calculated outside OverseerFM)*	6.6% decrease
P loss/ha (kgP/ha/yr)	2.4	2.3	

16. Given the number of reports written, for clarity, I have included a brief description of the three farm systems (Current Dairy Platform, Schrama block and the Proposed) as they have been modelled in the 24th of March 2022 file note (paragraph 14.i above)

(a) The current dairy platform:

(i) 500 cows milked at peak producing 212,000kg MS (424kg/cow)

(ii) 130 replacement calves reared on farm until 1st January, before being grazed with a grazier and returning as In Calf heifers (24mths old)

(iii) 30 beef type calves reared

(iv) 315 cows wintered on 12ha fodder beet on farm

(v) 613tDM imported feed including PKE, DDG, Hay, baleage and silage

(vi) Olsen P of 34

(vii) Fertiliser nitrogen of 239kgN/ha applied between September and April

(viii) Bark calving pad on farm utilised in Spring for up to 98 cows

(b) The Schrama block:

(i) The property was operated as a sheep breeding and finishing block.

(ii) Detailed information of the management of the block was unavailable due to the death of the previous owner. Therefore, a nutrient budget has been conservatively calculated using data from the Beef and Lamb NZ economic survey alongside information available from Google earth and the purchaser.

(iii) 5.4ha of swedes were planted on farm. This was determined using Google Earth imagery.

(iv) No feed is imported or exported.

(v) Olsen P of 34 as per soil tests taken at take over.

(vi) Nitrogen fertiliser use of 18kgN/ha as per fertiliser records provided by the vendor’s fertiliser company (with permission from the vendor’s wife)

(c) The proposed dairy platform:

(i) 600 cows milked at peak producing 254,400kg MS (424kg/cow)

(ii) 156 replacement calves reared on farm until May 1st. They are then grazed with a grazier and return as In Calf heifers (22mths old)

(iii) 420 cows wintered on farm on 10ha Fodder beet or 10 ha Baleage.

(iv) A further 200cows wintered on farm in a herd home. The herd home will also be utilised in the shoulders of the season for up to 490cows.

(v) 485tDM imported feed made up of PKE and DDG

(vi) Olsen P at agronomic optimum of 30

(vii) Fertiliser nitrogen of 175kgN/ha on the non-effluent area, and 154kgN/ha on the effluent area - all applied between September and April

(viii) Bark calving pad on farm utilised in Spring for up to 120cows

(ix) A constructed wetland of 2.2ha in the Southwestern corner of the property

17. The key drivers of a decrease of 8.6% in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

(a) Inclusion of a herd home and greater use of the calving pad in spring

(b) Construction of a wetland

(c) Reduced nitrogen fertiliser use (although an increase in use on the Schrama block)

(d) A change in culling policy meaning that culls leave the property earlier in the season

(e) Reduction in crop area and inclusion of grass baleage wintering

18. The key drivers of the 6.6% decrease in phosphorus loss are shown below. In comparison to the current system the proposed has:

(a) A reduction in Olsen P and therefore also maintenance fertiliser required

(b) A larger area available for spreading solid effluent

(c) The inclusion of a herd home and greater use of the calving pad

(d) Construction of a wetland

(e) Reduction in crop area and inclusion of grass baleage wintering

OVERSEER MODELLING AUDITORS REPORT

19. In June 2021, following the lodgement of the consent application, Environment Southland contracted Nicky Watt of Irricon, a Certified Nutrient Management Advisor (CNMA) to undertake a 'sensibility test' of the Overseer files provided as part of the consent application. This report is attached in full in Environment Southland s42a report.

20. The auditor's report concluded that "The data input protocols have been followed with no deviations. This leads to a high level of robustness for the relevant input data for example, climate, soils, and pasture type." She then went on to say that she considered the nutrient loss estimates of the current dairy and Schrama block budgets to be of a **high** robustness. However, she raised concern about the pasture grown estimate for the proposed farm system, hence rating the model at a **medium** level of robustness.

21. To address the concern raised around the pasture grown estimated, a file note was written in June 2021 titled "File note: Titipua Ltd Partnership – pasture grown." This file note is appended to this evidence in full. However, for completeness, the conclusions from that report are included below:

"*Due to differences in pasture management and its effect on pasture production, it is not justifiable to directly compare pasture grown figures rates for a sheep and dairy system. This comparison, by Irricon has led to incorrect conclusions regarding robustness of the modelling.*

Pasture production is estimated by Overseer using a back calculation and an assumed pasture quality. Overseer overestimates pasture production on Southland dairy farms due to an under estimation of pasture quality. After correcting for this error, Overseer estimates pasture production on the current and proposed scenarios to be 15.3 and 14.7TDM/ha respectively.

The Woodlands Research Station has measured pasture production for the last 20yrs. The average annual pasture production on a Nil Nitrogen site is 13.0TDM. Considering the nitrogen applied to the current and proposed system, and a 10:1 response rate, we would expect pasture production on the Titipua Ltd Partnership property to be 15.39 and 14.66TDM/ha in the current and proposed systems respectively.

Given that the corrected Overseer pasture grown estimates are within 0.1TDM/ha of the Woodlands + nitrogen estimates, it can be concluded that the pasture grown is feasible and sensible."

22. I note that in the s42a report, section 3.3.2.1 the Ms McRae has not raised any further concerns regarding the appropriateness and robustness of the Overseer modelling completed. Furthermore, I note that no further audits of more recent nutrient budgets have been requested by Ms McRae.

OVERSEER'S ABILITY TO MODEL GOOD MANAGEMENT PRACTICES

23. The s42a report contains an error regarding Overseer's ability to model Good Management Practices (section 3.2.2.1). The report states that "*Overseer assumes that GMPs are being used, which means some of the GMPs are already accounted for in Overseer. Others are not accounted for in Overseer and are therefore not taken into account by the budget, and so they can be considered a mitigation as they represent something additional that the applicant is putting in place to mitigate the effects."*

24. This statement is not entirely correct. Overseer assumes the property is managed at industry good management practice for a specific list of factors. These include having sufficient effluent storage so that effluent can be applied when conditions are appropriate and at an appropriate rate, and applying fertiliser evenly and in a manner that does not result in direct contamination of waterways. All the other Good Management Practices identified in the table on page 6 and 7 of the s42a report (below) are not assumed by Overseer.

Table 6. Good management practices (GMPs) and mitigation measures which have either occurred or are proposed to be undertaken on farm (taken from page 6 and 7 of the s42a report).

Mitigation/GMP	Implementation timeframe	Mitigation measure or GMP?
Fence off all waterways	Done	Good management practice
Plant all riparian margins	Ongoing – riparian margin between new land and waterway to be planted	Good management practice
Provide sufficient effluent storage to enable deferred application	Done	Good management practice
Defer effluent application when soil conditions are unsuitable	Currently happens	Good management practice
Minimising run-off from tracks, gateways, and crossings by ensuring they are designed and maintained adequately	From first exercise of new consent for Schrama block	Good management practice
Plant/enhance wetland	From first exercise of new consent	Mitigation measure
Ecotain plantain seeds used in re-grassing programme	Has been occurring for the past four years	Mitigation measure
Apply effluent at low rates and depths	Low rate rain gun used	Good management practice
Re-sow bare soils as soon as possible	Currently happens	Good management practice
Back fence stock off land that has already been grazed	Currently happens	Good management practice
Use portable water troughs and portable feeders when baleage is fed on crop paddocks.	Currently happens	Good management practice
Mob sizes less than 120 cattle when intensively winter grazing	Currently happens	Good management practice
CSAs are identified and protected	Currently happens	Good management practice
Avoid applying fertiliser to excessively dry, saturated or when soil temp is less than 7 degrees	Currently happens	Good management practice
Reducing Olsen P levels from 34/35 to 30	From first exercise of new consent	Good management practice

OVERSEER UNCERTAINTY, LIMITATIONS AND ASSUMPTIONS

25. Overseer is designed as a decision support tool and allows comparisons between farm management scenarios. As with any model there are assumptions and limitations (as outlined report[1]).

26. Overseer Assumptions:

(a) Long term annual average model. The model uses annual average input and produces annual average outputs.

(b) Near equilibrium conditions. Model assumes that that the farm is at a state where there is minimal change each year.

(c) Actual and reasonable inputs. It is assumed that input data is reasonable and a reflection of the actual farm system. If any parameter changes, it is assumed that all other parameters affected will also be changed.

(d) Good management practices are followed. OverseerFM assumes the property is managed at industry agreed good management practice for a specific list of factors including effluent and fertiliser applications. OverseerFM does not assume that all industry agreed good management practices are undertaken on farm.

27. Overseer Limitations:

(a) Overseer does not predict transformations, attenuation or dilution of nutrients between the root zone or farm boundary and the eventual receiving water body. A catchment model is needed to estimate the effects of the nutrient losses from farms on groundwater, river or lake water quality.

(b) Overseer does not calculate outcomes from extreme events (floods and droughts), but provides a typical years result based on a long-term average.

(c) Overseer does not calculate the impacts of a conversion process, rather it predicts the long-term annual average nutrient budgets for changed land use.

(d) Overseer is not spatially explicit beyond the level of defined blocks.

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[1] Titipua Ltd Partnership – OverseerFM farm system modelling to support a consent application for expanded dairy, March 2021, page 19

(e) Not all management practices or activities that have an impact on nutrient losses are captured in the Overseer model.

(f) Overseer does not provide for modelling of all farm systems in New Zealand.

(g) Components of Overseer have not been calibrated against measured data from every combination of farm systems and environment.

28. Overseer Uncertainty

(a) Overseer modelling uncertainties are acknowledged. This uncertainty centres around the model's ability to accurately determine nutrient losses, however these are practically impossible to measure accurately. Measured results from parts of paddocks or more rarely whole paddocks have been carried out using lysimeters, suctions cups and other collection technologies but it is not practicable to capture nutrient losses from a whole farm and across the multiple soil and landscape variations that may occur. This means there are few benchmarks to compare against.

(b) Overseer is used for modelling a wide range of farm systems in many different geographical settings; validation or calibration data for all circumstances is not possible, therefore the issue of uncertainty associated with whole farm nutrient loss estimates will increase for situations that are well outside the calibration /validation range.

(c) Pastoral blocks within Overseer have been through the most calibration and testing (most of which has been on dairy farms) but more data from calibration/validation of the Overseer model is required to reduce the uncertainty, most notably for:

- Cropping and Sheep and Beef
- Clay and shallow and light textured soils
- High (and low) rainfall locations >1200mm

(d) Traditionally Overseer has been calibrated against a set of farmlet trials however Version 6 (2012) has also undergone a range of logic tests. The farmlet trials utilised in the calibration and validation of Overseer are outlined in Table 6 below. Calibration trials completed in Southland have occurred at Tussock Creek and Edendale (both within 20km of the applicant's property):

Table 7 – Overseer Calibration and Validation (Parliamentary Commissioner for the Environment, 2018[1])

Management block	Nitrogen calibration	Phosphorus calibration
Pastoral	Calibration (undertaken in 2012) used nutrient loss measurements from farmlet studies at eight locations. These were: Edendale, Southland (intensive beef); Tussock Creek, Southland (dairy); Kelso, Otago (dairy); Lincoln University Dairy Farm, Canterbury (dairy); Massey University Dairy Farm, Manawatū-Whanganui (dairy); Ruakura, Waikato (dairy); Scott Farm, Waikato (dairy); and Wharenui, Bay of Plenty (dairy). A recalibration exercise is currently underway.	Calibration (undertaken in 2005) used data from 23 sites: Canterbury (2), Otago (3), Southland (2), Manawatū (5), Northland (2), Waikato (4), West Coast (2), Wellington (1), Hawkes Bay (2).
Crop	Arable crops – very limited calibration (one Lincoln site).	Arable crops – none due to a lack of experimental sites. Forage crops – limited to 2 sites in Otago and 1 in Southland.
Fruit crop	None due to a lack of experimental sites.	None due to a lack of experimental sites.
Trees and scrub	None due to a lack of experimental sites.	None due to a lack of experimental sites.
Wetlands and riparian	Very limited calibration based on published studies.	Very limited calibration based on published studies.
House	Very limited calibration (based on one international study).	None.

(e) Uncertainty around Overseer outputs tends to be much lower within the range of the calibration data set outlined in Table 1. Most of the calibration and validation data used to date is focused on flat, pastoral, dairy enterprises, with primarily free draining soils and moderate rainfall located in the Waikato, Southland, Canterbury and Manawatu. All the modelling of the applicant's property fits into the calibration range with the exception of the baleage grass wintering system.

29. The following steps were taken during the modelling process to minimise the impact of uncertainties:

(a) Adherence to Best Practice Data Input Standards (BPDIS)

(No deviations to BPDIS were made, no work arounds required)

(b) Use of Overseer is within the model's parameters (for soils, climate and farm system)

(Standard approach)

(c) Method and consistent methodology between scenarios

(Standard approach)

(d) Site visit to cross check information

(Standard approach - Understanding the property and the management blocks is critical to blocking in Overseer)

(e) Blocking completed taking into account land use, management systems, soils, topography and enterprise

(Standard approach – consistent with BPDIS)

(f) Consistency in modelling between the current and proposed files (Standard approach - "apples with apples")

(g) Expertise, experience and qualifications of the user

(Standard approach - Certified Nutrient Management Adviser and Dairy Farm Systems Expertise)

(h) Outputs are reviewed against expected results relative to soils, climate, land use and inputs

(Standard approach – reviewed against previous modelling results and research trials)

(i) Overseer files are internally peer reviewed (for adherence to BPDIS, feasible farm systems and data entry)

(Standard approach - Certified Nutrient Management Adviser and Dairy Farm Systems Expertise)

The use of Overseer as a modelling tool is recognised in the Proposed Southland Water and Land Plan[2] (PSWLP). Appendix N (of PSWLP) indicates that the latest version of the Overseer model (or an approved alternative model) should be used on properties over 20ha or when a material change in land use occurs. As far as I am aware no alternative to Overseer has been approved by Environment Southland.

30. Uncertainty around Overseer model estimates tends to be lower within the range of the calibration data set i.e. where we have the most information. Most of the calibration data used to date is focused on flat, pastoral, dairy enterprises, with primarily free-draining soils and moderate rainfall. Pastoral farms in the Waikato, Southland, Canterbury and Manawatu, form the OVERSEER calibration data set. Consistency in modelling when developing scenarios is a key to creating equivalence in uncertainty. When scenarios are compared focus should be on the difference in estimated outputs, rather than absolute numbers.

31. In July 2021, a report "Overseer whole model review – assessment of the model approach" was released by[3] the Science Advisory Panel for the Ministry for the environment. The report raised concerns that Overseer:

(a) Assumes a steady state system when farm systems are in reality dynamic

(b) Assumes average climate data and therefore cannot model episodic events

(c) Uses monthly time steps

(d) Does not balance mass

(e) Does not account for variation in water and nutrient distribution through the soil profile

(f) Does not adequately accommodate deep rooting plants

(g) Focuses on nitrates (and omits ammoniacal N and organic matter)

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[1]Parliamentary Commissioner for the Environment (2018). *Overseer and regulatory oversight: Models, uncertainty and cleaning up our waterways.* Pg 31.
[2] Proposed Southland Water and Land Plan, Decisions Version, 4th April 2018
[3] Science Advisory Panel to the Ministry for the Environment (2021). *Overseer whole-model review Assessment of the model approach* (2021). Pg 95.

(h) Is not spatially explicit with regards to surface water, nutrient transport and critical landscape factors

32. The government responded to the Science Advisory Panel report described in the previous paragraph in August 2021. The government identified four options to address the concerns raised in the report including the creation of a *new risk index tool,* development of a next generation Overseer, to have greater use of *controls on practices and inputs* to manage nitrogen loss or a completely new approach to managing and understanding diffuse nutrient loss risk. I note that, of the options given by the government, only the option of *greater use of controls on practices and inputs* is available to regulators currently.

33. The recommended consent conditions proffered by Environment Southland in the s42a report include both Overseer output figures and farm system input parameters. The farm system input parameters that have been recommended to be consented include those identified as key reasons for a nutrient loss reduction in the proposed system (paragraphs 17 and 18), as well as other mitigations (such as planting plantain and riparian planting) that were included in the farm environmental management plan.

PLANTAIN AS A MITIGATION DESPITE IT NOT BEING MODELLED

34. Throughout the s42a report, the inclusion of Plantain into the regrassing seed mix has been identified as a "crucial mitigation". Research does show that plantain can reduce urinary Nitrogen and in turn nitrogen leaching, and the inclusion of plantain into the diet is therefore a potential nitrogen loss mitigation tool.

35. The use of plantain has <u>not</u> been modelled in Overseer in the current or proposed models. This is because, due to relatively poor persistence in the pasture, seasonal variation and difficulty measuring pasture plantain content, it is very difficult to collect enough information to determine the percentage of the pasture that is plantain to provide certainty on the level of mitigation.

36. It is expected that if the use of plantain was included in the current dairy platform, and proposed dairy platform models, that the estimated nitrogen losses would be lower. It is difficult to determine the magnitude of this reduction given the reasons explained in paragraph 35.

CONCLUSION

37. Concerns raised in the auditor’s report around pasture grown were addressed in a file note written in June 2021. The file note concluded that the pasture grown estimate was realistic and feasible, and therefore the council could have confidence in the modelling.

38. Overseer assumes that a specific range of industry agreed good management practices are followed. All other industry agreed good management practices are not assumed to be followed by Overseer.

39. Overseer modelling uncertainties, assumptions and limitations are acknowledged, and steps have been taken to minimise the impact of these factors.

40. The use of plantain in the regrassing mix has been recommended as a consent condition but has not been modelled in Overseer due to the difficulty of maintaining the species in the pasture. It is predicted that the inclusion of plantain into the modelling would lower the predicted losses of nitrogen.

41. Modelling using Overseer version 6.4.2 and adjustments outside of Overseer estimate that losses of Nitrogen and Phosphorus would decrease by 8.6% and 6.6% respectively.

Monique (Mo) Topham

AgriAce Consulting Limited

24 March 2022

APPENDICES TO THIS REPORT

The file notes described in the Background section of this evidence are all included as Appendices in chronological order. These are:

(a) Titipua Ltd Partnership – OverseerFM farm system modelling to support a consent application for expanded dairy – 23rd March 2021

(b) Overseer Nutrient Budget Review – June 2021 – Written by Nicky Watt (CNMA), Irricon

(c) File note: Titipua Ltd Partnership – pasture grown – June 2021

(d) File note: Titipua Ltd Partnership – Overseer Version Change – September 2021

(e) File note: Titipua Ltd Partnership – Wetland Mitigation Calculations – October 2021

(f) Project Memorandum – Titipua Ltd Partnership – review of the Wetland Mitigation – Written by Andrea Richardson (Landpro)

(g) File note: Titipua Ltd Partnership – Additional mitigation strategies – October 2021

(h) File note: Titipua Ltd Partnership – Updating OverseerFM outputs to version 6.4.2 – March 2022

(i) File note: Titipua Ltd Partnership – Peer Reviewed Technical Wetland Update – 24 March 2022

(j) File Note: Titipua Ltd Partnership – Updating OverseerFM outputs considering updated wetland efficacy expectations – 24 March 2022

Titipua Ltd Partnership

OverseerFM farm system modelling to support a consent application for expanded dairy

Report prepared for:
Titipua Ltd Partnership
336 Hedgehope Block road
Invercargill

Property Address:
425 Hedgehope Block road
RD2
Invercargill 9872

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23rd March 2021

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Contents

1.0 Executive summary:

Titipua Ltd Partnership operate a 181.5ha dairy farm located south of Hedgehope in Central Southland. The farm is currently consented to milk 600 cows. Over the last three seasons the property has milked on average 500 cows at peak, producing 212,000kgMS. Most of the property is rolling although there is a small amount of flat land at the back of the farm running along the Titipua Stream. Currently, 315 cows are wintered on farm on 12ha of Fodder beet.

In mid 2020, the Titipua Ltd Partnership purchased a neighbouring 87.2ha sheep property known as the Schrama block. Upon purchasing the property, the Titipua Ltd Partnership started the process of subdividing and selling 3ha of the Schrama block (including the house and yards).

It is proposed to convert the remaining Schrama block land (84.2ha) and incorporate it into the dairy platform. Cow numbers would increase to 600 at peak producing 254,400kgMS. All cows would be wintered on farm on either a Fodder beet crop or on a grass/baleage system.

Nutrient budgeting has been completed using Overseer version 6.3.5 to support a consent application for expanded dairy. These budgets estimate the nitrogen and phosphorus losses from the farm. Three budgets have been completed:

- The current dairy farm system
  This has been modelled as the average of the last three seasons (17-18, 18-19 and 19-20 seasons).
- The Schrama block
  Please note, detailed records of how the block was operated were not available as the previous owner has died since the property was purchased. As a result, the property has been modelled as an average "Class 7 South Island Finishing" using information in the Beef and Lamb NZ Economic survey (a link to this report is given in the appendices).
- The proposed dairy system
  This has been modelled as a status quo system milking 600cows at peak. Further calculations outside of OverseerFM have been completed to quantify the effect of wintering approximately half of the herd on a baleage/grass system and installing a wetland on farm.

1.1 Nutrient loss estimates including calculations outside of OverseerFM

The table below shows the estimated nutrient losses from the current landuse on the dairy farm and Schrama blocks.

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	11,315	1,738	13,053
N Loss/ha (kgN/ha/yr)	62	21	49
Total Farm P Loss (kg)	455	190	645
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

The table below compares the estimated nutrient losses from the current landuse with the estimated losses under the proposed system.

	Total current (same as above)	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	13,035	12,181 *(12,749 modelled plus 173 baleage grass wintering minus 741 wetlands calculated outside OverseerFM)*	6.7% decrease
N Loss/ha (kgN/ha/yr)	49	46	
Total Farm P Loss (kg)	645	572 *(615 modelled minus 43 wetlands calculated outside OverseerFM)*	11.3% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in section 4.2.*

1.2 Drivers of changes in nutrient losses

1.2.1 Nitrogen loss estimates

Nitrogen losses from a farm system can have negative impacts on water quality downstream. This in turn can have negative implications on aquatic life and human health. The use of OverseerFM alongside external calculations has estimated a 6.7% decrease in nitrogen losses between the current and proposed scenarios. This is the cumulative result of many changes to the farm system including:

- A change in culling policy meaning that culls leave the property earlier in the season
- A reduction in imported feed
- Greater use of the calving pad in spring
- Reduced nitrogen fertiliser use

It should also be noted that in the proposed system there will be a reduction in the off-site effect of wintering as all cows will be wintered on farm. There will also be a reduction in the off site effect of the young stock grazing due to a change in grazing policy with these animals. These reductions in offsite effects have not been quantified.

1.2.2 Phosphorus loss estimates

Phosphorus losses from the farm can cause algal growth in surface waterways. The use of OverseerFM alongside external calculations has estimated a 11.3% decrease in Phosphorus losses in the proposed system. Key changes include:

- Reducing the farm Olsen P to 30 and therefore reduce maintenance fertiliser P requirements
- A larger area available for spreading solid effluent

2.0 Report purpose

The results of the budgets will be utilised to support a land use consent application for expanded dairying and the introduction of dairy support.

This report will emphasise the relevant requirements in the proposed Southland Water and Land Plan, and the National Environmental Standards from a nutrient budgeting perspective. The broader range of requirements should be captured in the Farm Environmental Management Plan (FEMP). This report will inform the FEMP which will be completed separately.

Potential environmental risks on the property have been considered and should be included in the FEMP. These include:

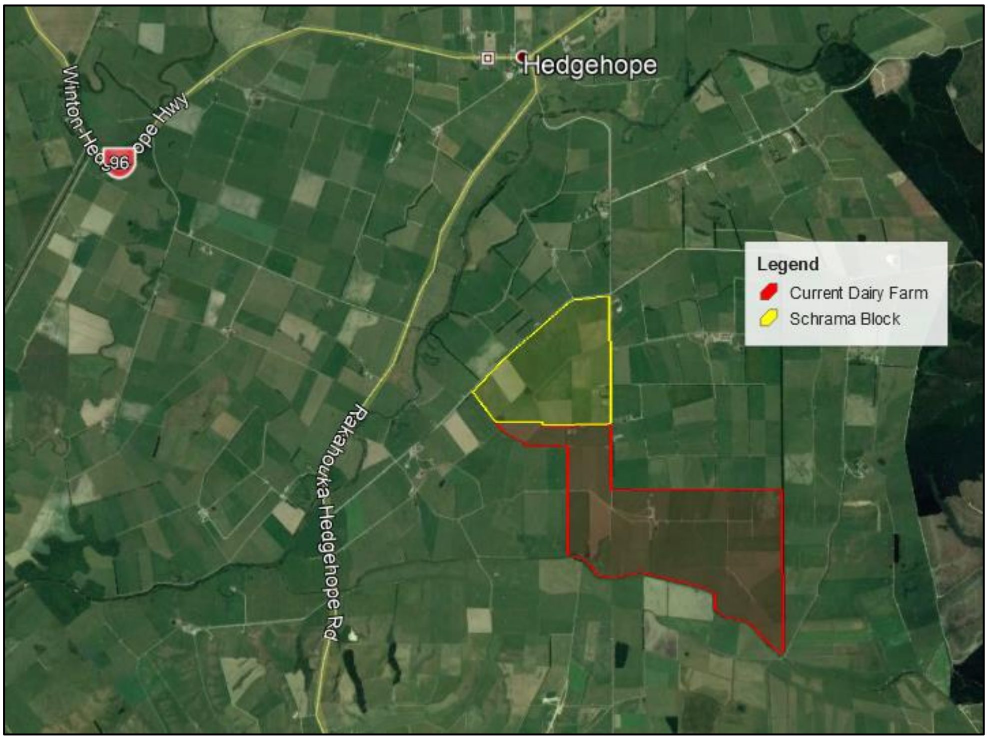
- Contamination of ground water
- Contamination of surface water
- Undesired changes in soil nutrient status
- Nutrient application to non-target land
- Accumulation of non-nutrient impurities in the soil profile
- Excess stocking rate
- Pugging and compaction
- Poor cultivation methods

3.0 Farm overview

3.1 Ownership

The property is owned by the Titipua Ltd Partnership.

3.2 Location



3.3 Farm particulars:

Address	Titipua Ltd Partnership 425 Hedgehope Block road RD2 Invercargill 9872
Legal Description	Current Dairy Platform: • Lot 1 and 2 Deposited Plan 386399 • Lot 1 Deposited Plan 470872 • Lot 2 Deposited Plan 4406 • Lot 2 Deposited Plan 420431 • Lot 3 Deposited Plan 1494 Schrama block • Lot 1 Deposited Plan 4406 – please note, 3ha (the house and stock yards) is in process of being subdivided from this block and sold.
Area	Current dairy platform: 181.5ha Schrama block: 87.2ha (before subdivision) - 3.0ha to be subdivided and sold from Schramas Total area for proposed system: 265.7744ha

3.4 Farm system overview

A detailed description of the modelling methodology and Overseer input data is given in the appendices of this report. This section gives an overview of the farm system modelled in each budget.

3.4.1 Current Dairy Platform

A budget was completed for the average of the last three seasons (2017-18, 2018-19 and 2019-20)

Stock and production:

- 500 cows were milked at peak
- Average seasonal production of 212,000kgMS
- 130 dairy young stock were reared on farm. They were grazed at a third party graziers property from 1st January until returning as incalf heifers
- 30 beef type calves were reared on farm each year and sold in early January
- 315 cows were wintered on the platform on a fodder beet crop while the remaining cows were wintered off farm with a third party grazier

Feed

- Imported feed was:
  - PKE - 200tDM fed in shed
  - Hay – 13tDMfed on the pad
  - DDG – 130tDM fed in shed
  - Baleage – 120tDM fed on the crop
  - Silage – 150TDM fed in paddock or on the calving pad
- An average of 17tDM hay and 24tDM Baleage were harvested on the property each year
- The farm has grown on average 12ha of Fodder beet each year. This is utilised on the shoulders of the season as well as for wintering 315 cows.

Fertiliser

- Soil test results from July 2019 have been used in the nutrient budget. These tests show that the property is operating at, or slightly higher than, optimum soil fertility levels.
- Maintenance fertiliser rates have been entered into Overseer.
- Farm nitrogen was 239kgN/ha applied in split dressings from September to April.

Structures

- Dairy effluent is separated into solids and liquids. The liquid portion is applied to a 99.7ha effluent area using a cobra rain gun. The solid portion is applied during dry weather (usually December) to the non-effluent portion of the property.
- The farm has a calving pad. This is utilised in Aug, Sep and Oct for springer cows. The structure is uncovered with a bark chip base and is fully lined. Liquid effluent is added to the dairy shed effluent system. The solid effluent portion is spread on the non effluent blocks when conditions allow (usually December).

- There is an inshed feeding system installed on farm. This is utilised throughout the milking season when there is a pasture deficit

3.4.2 Schrama Block current system

A budget was completed to estimate the nitrogen and phosphorus losses from the current management of the Schrama block.

Please note, detailed information of the management of the block was unavailable due to the death of the previous owner. Therefore, a nutrient budget has been created using data from the Beef and Lamb NZ economic survey alongside information available from Google earth and the purchaser.

The Schrama block is 87.2ha in total. Upon purchasing the property, the Titipua Ltd Partnership started the process of subdividing and selling 3ha of the Schrama block (including the house and yards).

Stock and production:

- The farm was operated as a sheep property wintering on swedes
- Stock numbers and production have been assumed using information from the Beef and Lamb NZ economic survey. It was considered that the farm is most similar to the “Class 7 South Island, Finishing Otago/Southland” benchmark.
- Wintered sheep numbers are assumed to be:
  - 577MA ewes
  - 218 Hoggets
  - 16 rams
- A 137% lambing rate is achieved (measured as lambs at tailing compared to those mated)
- 4650kg greasy wool is sold

Feed

- An average of 5.4 ha of swedes were planted over the last three seasons. This was verified using Google earth imagery. Fertiliser records were utilised to determine an average crop fertiliser policy for the three years.
- No feed is imported or exported from the property

Fertiliser

- Soil test taken in Nov 2019 and Nov 17 were available. They show that the farm Olsen P averaged 34 and 35 respectively.
- Maintenance fertiliser rates have been entered into Overseer for the pastoral blocks.
- Fertiliser purchase records show that a small application of nitrogen was made to the pastoral area each year. Therefore, it has been assumed that an application of 18kgN/ha is made in March each year.

3.4.3 Proposed Dairy System

A budget was completed for the proposed dairy system

Stock and production:

- 600 cows will be milked at peak
- Production is expected to be 254,400kgMS
- 156 dairy young stock would be reared on farm. They would be grazed on farm until the 1st May when they would be grazed at a third party graziers property. In the following May, 140 in calf heifers will return to the property and be wintered on farm
- The entire herd would be wintered on farm on either a fodder beet crop or a baleage grass wintering system

Feed

- Imported feed in an average season is estimated to be:
  - PKE – 265tDM fed in shed
  - DDG – 175tDM fed in shed
- It is expected that the farm will harvest 48tDM of silage, 349tDM baleage and 36tDM hay
- No feed will be exported
- The farm will grow 12ha of Fodder beet each year. This would be utilised on the shoulders of the season as well as for wintering. A further 10ha would be utilised for a baleage grass wintering system.

Fertiliser

- Soil fertility will target the agronomic optimum. This will mean a decrease in Olsen P from 34 to 30.
- Maintenance fertiliser rates have been entered into Overseer.
- Farm nitrogen use will be reduced on the dairy platform although there will be an increase in nitrogen applied to the Schrama Block.
  - 175kgN/ha on the non effluent blocks (Sep – Apr)
  - 154kgN/ha on the effluent blocks (Sep- Apr)

Structures

- Dairy effluent is separated into solids and liquids. The liquid portion is applied to a 99.7ha effluent area using a cobra rain gun. The solid portion is during dry weather (usually December) to the non-effluent portion of the property.
- The farm has a calving pad. This is utilised in Aug, Sep and Oct for springer cows. The structure is uncovered with a bark chip base and is fully lined. Liquid effluent is added to the dairy shed effluent system. The solid effluent portion is spread on the non-effluent blocks when conditions allow (usually December).

4.0 OverseerFM nutrient loss estimates

4.1 OverseerFM loss estimates

Nutrient budgets have been prepared to support the assessment of effects of the current and proposed dairy systems. The table below shows the OverseerFM version 6.3.5 estimated nutrient losses from the current landuse on the dairy farm and Schrama blocks.

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	11,315	1,738	13,053
N Loss/ha (kgN/ha/yr)	62	21	49
Total Farm P Loss (kg)	455	190	645
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

The table below compares the OverseerFM version 6.3.5 estimated nutrient losses from the current landuse with the estimated losses under the proposed system.

	Total current (same as above)	Proposed
Area (ha)	265.7	265.7
Total Farm N Loss (kg)	13,053	12,749
N Loss/ha (kgN/ha/yr)	49	48
Total Farm P Loss (kg)	645	615
P loss/ha (kgP/ha/yr)	2.4	2.3
Pasture Grown (tDM/ha)		16.1

4.1.1 Notes for interpretation of OverseerFM outputs

Estimated pasture grown

It should be noted that the estimated pasture grown outputs from Overseer are higher than expected. Overseer uses a default value for ryegrass/white clover pasture quality irrespective of the land use and management. The default Overseer value in Southland ranges from 10.5 to 11.17 MJ ME/ kg DM depending on the month (reference: Characteristics of pasture, June 2018, D M Wheeler AgResearch Ltd). Pasture cuts from an Eastern Southland monitor farm show MEs of 11.5 to 12.2 (reference: Pasture growth and quality on Southland and Otago dairy farms, D. E. Dalley and T. Geddes, DairyNZ, NZ Grasslands Publication 2012).

The Overseer default values have been used throughout the entirety of this modelling as the Best Practice Data Input Standards state that "*there needs to be a very good long-term average evidence of clover content, pasture utilisation, pasture N content and pasture quality to justify changes from the default OVERSEER values. This level of information would be rare.*"

To ensure that comparisons are valid between the baseline and proposed the same method has been used to ensure that an "apples with apples" approach is taken.

4.2 Calculations outside of OverseerFM

Calculations outside of OverseerFM have been completed to account for the baleage grass wintering system and the installation of a wetland on farm. These mitigations cannot be modelled within OverseerFM.

4.2.1 Baleage grass wintering:

OverseerFM has estimated that the loss of nitrogen from the grass baleage system is 523kgN (or 52kgN/ha). Modelling of the grass baleage wintering system in OverseerFM is likely to underestimate nitrogen losses as OverseerFM is not able to adequately reflect the on-farm realities of this system. OverseerFM assumes that the pasture plants will regrow post grazing and take up urinary N from the wintering activity. However, due to the soil type and climate on the applicant's property, the plants are not viable following the winter grazing. As a result, the area is cultivated and regrassed in spring.

I am unaware of any research that has quantified the impact of baleage grass wintering in terms of nitrate and phosphorus loss. I have therefore completed a desktop modelling exercise that attempts to estimate the nutrient losses from this system more accurately.

The following assumptions have been made:

- Same as the proposed system file
  - Soils / climatic conditions
  - Tile drains
  - Stock numbers
  - Imported / exported supplement
  - Fertiliser and nitrogen use

- Different from the proposed system file
  - Used kale instead of pasture to allow a defoliation event and regrassing activity
  - Used kale as has a similar crude protein to average quality pasture
  - Reduced yield of kale to 3TDM/ha to reflect pasture accumulated for winter in practice
  - Regrassed the area in October in line with when the applicant would usually regrass following a grass baleage wintering event
  - Direct drilled kale (rather than conventional cultivation to minimise the impact of the mineralisation of N during cultivation)

Overseer predicted that the losses from the Kale block would be 70kgN/ha (total of 696kgN lost for the 10ha wintered on). Without comparative research, it is difficult to assess the accuracy of the above results. However, from a common sense perspective, losses from the baleage grass system are likely to be more comparable to a traditional fodder crop paddock than a permanent pasture paddock.

Therefore, it is predicted that the losses from the grass baleage wintering system will be 173kgN higher than estimated in the OverseerFM Proposed scenario.

4.2.2 Installation of a wetland

Titipua Ltd Partnership have sought advice from David Moate of the Environment Southland Land Sustainability team regarding the opportunity to install a wetland on the property. David Moate visited the property in January 2021 to identify potential wetland locations, construction, and effectiveness. A short report was then completed to give an estimate of the potential effectiveness of a wetland. This report is attached in full in the appendices.

Titipua Ltd Partnership have agreed to install a wetland in the South Western corner of the property as per David Moate's recommendation. The photo below, taken from David's report, shows the site of the wetland (blue), the catchment area (green outline) and the land titles (red). For orientation purposes, I have marked on the map where the cowshed is with a blue cross.

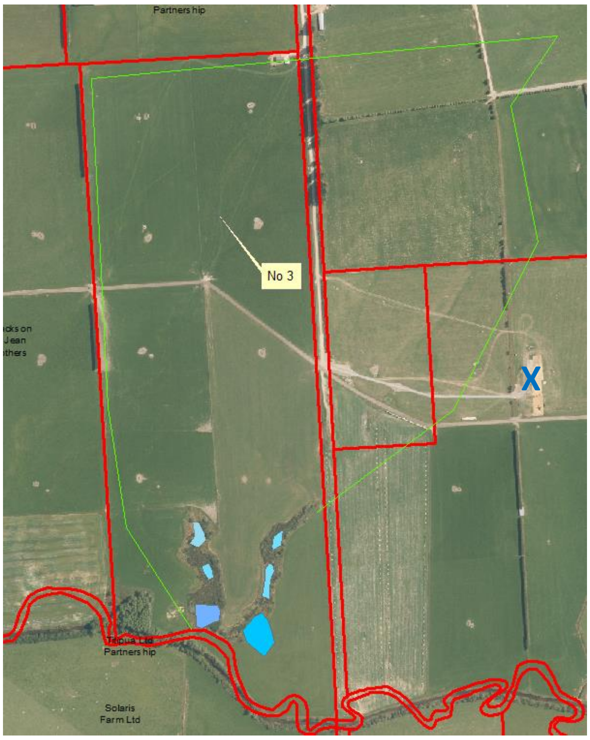


Figure 1. Site of wetland (from David Moate report)

David has estimated that this wetland has a 50ha catchment of land. However, some of this catchment area is outside the Titipua Ltd Partnership farm boundary (North eastern corner). Of the 50ha in the wetland catchment, approximately 38ha is within the Titipua Ltd Partnership farm boundary. The tables below calculate expected reduction in nitrogen and phosphorus loss from the 38ha within the farm boundary.

The table below calculates the expected amount of nitrogen captured by the wetland. Total nitrogen losses captured in the wetland are estimated to be 741kgN/annum.

Overseer block name	Area (ha)	OverseerFM estimated nitrogen leaching loss (kgN/ha)	Reduction in N leaching due to wetland (from David Moate's report) (%)	Total reduction (kgN) (Ha x kgN/ha x %)
Non-Eff, Rolling – Puke, Apar	32.2	40.6	50	653.66
Eff, Rolling – Puke, Apar	2.1	43.0	50	45.15
Non effective area (laneways and tracks) – the losses from this area are accounted for in "other sources" below.	3.7			
Total block Nitrogen loss mitigated	**38.0**			**698.81**
Plus reduction in other sources losses	38/265.7	589	50	42.12
Total farm Nitrogen loss mitigated				**740.93**

The table below calculates the expected amount of phosphorus captured by the wetland. Total phosphorus losses captured in the wetland are estimated to be 43.13kgP/annum.

Overseer block name	Area (ha)	OverseerFM estimated P loss (kgP/ha)	Reduction in P loss due to wetland (from David Moate's report) (%)	Total reduction (kgP) (Ha x kgP/ha x %)
Non-Eff, Rolling – Puke, Apar	32.2	2.14	48	33.08
Eff, Rolling – Puke, Apar	2.1	2.20	48	2.22
Non effective area (laneways and tracks) – the losses from this area are accounted for in "other sources" below.	3.7			
Total block Phosphorus loss mitigated	**38.0**			**35.3**
Plus reduction in other sources losses	38/265.7	114	48	7.83
Total farm Phosphorus loss mitigated				**43.13**

Therefore, it is predicted that the wetland will reduce nutrient losses from the proposed dairy system by 741kgN and 43kgP.

5.0 Conclusions

5.1 Nutrient loss estimates including calculations outside of OverseerFM

The table below shows the estimated nutrient losses from the current landuse on the dairy farm and Schrama blocks.

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	11,315	1,738	13,053
N Loss/ha (kgN/ha/yr)	62	21	49
Total Farm P Loss (kg)	455	190	645
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

The table below compares the estimated nutrient losses from the current landuse with the estimated losses under the proposed system.

	Total current (same as above)	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	13,053	12,181 *(12,749 modelled plus 173 baleage grass wintering minus 741 calculated outside OverseerFM)*	6.7% decrease
N Loss/ha (kgN/ha/yr)	49	46	
Total Farm P Loss (kg)	645	572 *(615 modelled minus 43 calculated outside OverseerFM)*	11.3% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

5.2 Drivers of changes in nutrient losses

5.2.1 Nitrogen Loss estimates

Nitrogen losses from a farm system can have negative impacts on water quality downstream. This in turn can have negative implications on aquatic life and human health.

OverseerFM has estimated a 6.7% decrease in nitrogen losses between the current and proposed scenarios. This is the cumulative result of many changes to the farm system including:

- A change in culling policy meaning that culls leave the property earlier in the season
- A reduction in imported feed
- Greater use of the calving pad in spring
- Reduced nitrogen fertiliser use

It should also be noted that in the proposed system there will be a reduction in the off-site effect of wintering as all cows will be wintered on farm. There will also be a reduction in the off site effect of the young stock grazing due to a change in grazing policy with these animals. This reduction in offsite effects has not been quantified.

5.2.2 Phosphorus loss estimates

Phosphorus losses from the farm can cause algal growth in surface waterways. OverseerFM has estimated a 11.3% decrease in Phosphorus losses in the proposed system. Key changes include:

- Reducing the farm Olsen P to 30 and therefore reduce maintenance fertiliser P requirements
- A larger area available for spreading solid effluent

5.3 Recommendations from here

OverseerFM can model a specific range of good management practices. Below is a summary of the potential environmental risks on this property and gives recommendations to mitigate these risks.

Good practice for fertiliser use:

- Regular soil testing is used to inform fertiliser recommendations that target agronomic optimum P, K, S, Mg and Ca levels.
- Develop a fertiliser plan with your fertiliser representative. Recommend you make this OverseerFM modelling available to your fertiliser representative to assist them in developing the fertiliser recommendations.
- Apply using a Spreadmark accredited company for fertiliser application – apply at correct rate and with a buffer to waterways.
- Use of Fertmark registered products.
- Record fertiliser applications (location, date of application and amount applied).

Nitrogen:

- Apply nitrogen strategically to meet plant demand.
- Applications should generally be avoided in May due to rapidly declining growth rates.
- Spring nitrogen applications should not be on soil less than 7 degrees Celsius.

Phosphorus:

- OverseerFM is not spatially explicit and a phosphorus mitigation plan should be developed to reduce phosphorus losses.

Critical source areas:

- These include laneways, gateways, swales in paddocks and wallows.
- Review your Farm Environmental Management Plan to update as required and take action on mitigating risk on any new critical source areas identified.

The Proposed Water and Land Plan is currently in the appeals process and is partially operative. It will be important to stay up to date with developments in Environment Southland policy and rules, including the limit setting process which will develop over the next few years.

A National Environmental Standard (NES) has recently been gazetted. This has implications for the wintering of stock on crop, stock exclusion from waterways, nitrogen fertiliser use, changes in landuse and the use of stockholding areas for cattle.

Both the Proposed Water and Land Plan and the National Environmental Standards require a farm of this size to have a farm environmental management plan. This should be updated to include the recommendations within this report.

Appendices

Appendix 1. Modelling Methodology

Nutrient losses have been estimated using the OverseerFM Version 6.3.5 model. OverseerFM is a software application that models nutrient movements within a farm system. Input data detailing the farm system is entered into the software and interpreted through the use of a series of sub-model that calculate the flow of seven major farm nutrients (Nitrogen, Phosphorus, Sulphur, Calcium, Magnesium and Sodium). Output data is reported for interpretation and to inform farm management practices. It currently requires an expert user to describe the physical and management details of a farm.

OverseerFM assumptions

Within the OverseerFM software, assumptions have been made of the farm management:

- Long term annual average model
  The model uses annual average input and produces annual average outputs.
- Near equilibrium conditions
  Model assumes that that the farm is at a state where there is minimal change each year.
- Actual and reasonable inputs
  It is assumed that input data is reasonable and a reflection of the actual farm system. If any parameter changes, it is assumed that all other parameters affected will also be changed.
- Good management practices are followed
  OverseerFM assumes the property is managed at industry agreed good management practice for a specific list of factors including effluent and fertiliser applications. OverseerFM does not assume that all industry agreed good management practices are undertaken on farm.

OverseerFM limitations

Key limitations of the OverseerFM model are:

- OverseerFM does not predict transformations, attenuation or dilution of nutrients between the root zone or farm boundary and the eventual receiving water body. A catchment model is needed to estimate the effects of the nutrient losses from farms on groundwater, river or lake water quality.
- OverseerFM does not calculate outcomes from extreme events (floods and droughts) but provides a typical years result based on a long-term average.
- OverseerFM does not calculate the impacts of a conversion process, rather it predicts the long-term annual average nutrient budgets for changed land use.
- OverseerFM is not spatially explicit beyond the level of defined blocks.
- Not all management practices or activities that have an impact on nutrient losses are captured in the OverseerFM model.
- OverseerFM does not represent all farm systems in New Zealand.
- Components of OverseerFM have not been calibrated against measured data from every combination of farm systems and environment.

Information on OverseerFM can be obtained from the following reports:

- Technical Description of OVERSEER for Regional Councils, September 2015
- Review of the phosphorus loss submodel in OVERSEER®, September 2016
- Using OVERSEER® in Regulation – Technical Resources and Guidance for Regional Councils, August 2016

Data input standards

Nutrient budgets have been constructed using the OverseerFM Version 6.3.5 model.

The nutrient budgets have been developed in accordance with the Overseer data input protocols - "Overseer, Best Practice Data Input Standards, March 2018" and the "OverseerFM User Guide, October 2019." No deviations have been made from these protocols.

Appendix 2. Modelling Inputs

Soil types

Soil type has a large bearing on nutrient loss levels from a property. This is due to different soil types having different water holding capacities, and drainage characteristics. It is therefore important that soil type is inputted correctly.

The table below gives a brief description of the soil types found on the Titipua Ltd Partnership and Schrama property.

S-map ref	Soil Order and Group	Drainage class	Description
Pukem_6a.1	Pallic, Recent/yge/bge	Poor	Moderately deep, poorly drained, silt over clay
Apar_2a.1	Brown, Sedimentary	Imperfect	Deep, imperfectly drained, silt over clay
Makar_3b.1	Gley, Sedimentary	Poor	Deep, poorly drained, clay
Paro_4a.1	Gley, Sedimentary	Poor	Deep, poorly drained, silt
Ymai_25a.1	Gley, Sedimentary	Poor	Deep, poorly drained, loamy peat over silt
Makar_4c.1	Gley, Sedimentary	Poor	Moderately deep, poorly drained, clay

The table below shows the area and the proportion of the block that the soils identified covered:

S-map ref	Total area	% of productive blocks
Pukem_6a.1	127.7 ha	50.0%
Apar_2a.1	85.1 ha	33.3%
Makar_3b.1	22 ha	8.6%
Paro_4a.1	9.2 ha	3.6%
Ymai_25a.1	6.1 ha	2.4%
Makar_4c.1	5.4 ha	2.1%

Climate Data

The following climate information has been used from the OverseerFM climate station tool:

	Current dairy platform	Current Schrama block	Proposed dairy platform
Annual Rainfall (mm)	1122 – 1130	1122	1121 – 1130
Mean Annual Temp (°C)	10 – 10.1	10	10 – 10.1
Annual PET (mm)	735 – 744	734	734 – 744

Blocks

The farms have been split into the following pastoral, riparian and fodder crop blocks based on soil type, contour, drainage and land use.

	Topography	Current dairy platform	Current Schrama block	Proposed dairy platform
			Area (ha)	
Pasture blocks				
Non-effluent				
Non eff, flat - makar, paro	Flat	18.2		18.2
Non eff, flat - ymai	Flat	2.8		2.8
Non eff, rolling - makar	Rolling	4.3		4.1
Non eff, rolling - puke, apar	Rolling	49.5		47.3
Non eff, rolling - makar, paro	Rolling	0.5		0.5
Effluent				
Eff, flat - makar, paro	Flat	2.0		2.0
Eff, flat - puke, apar	Flat	7.2		7.2
Eff, flat - ymai	Flat	3.3		3.3
Eff, rolling - makar, paro	Rolling	2.3		2.3
Eff, rolling - puke, apar	Rolling	84.9		80.9
Schrama block				
Schrama, non eff, rolling - puke, apar	Rolling		71.2	68.0
Schramas, non eff, rolling makar	Rolling		9.3	8.9
Baleage Grass Wintering Blocks				
Baleage/Grass – Non Eff, Makar	Rolling			0.2
Baleage/Grass – Non Eff, Puke Apar	Rolling			2.2
Baleage/Grass – Eff, Puke Apar	Rolling			4.0
Baleage grass - schrama, rolling puke apar	Rolling			3.2
Baleage grass - schrama, rolling, makar	Rolling			0.4
	Productive Block Area	**175.0**	**80.5**	**255.5**
	Riparian area	1.9		1.9
	Non-effective area	4.6	3.7	8.3
	Total area	**181.5**	**84.2**	**265.7**
Rotating fodder crops				
Fodder beet		12		12
Swedes			5.4	

Titipua Ltd Partnership

Farm System Inputs

<table>
<tr><th>Description</th><th>Current Dairy Farm</th><th>Current Schrama's Block</th><th>Proposed Dairy platform</th></tr>
<tr><td>Area</td><td>Total: 181.5ha (as per LINZ website)
Productive farm area: 175.0ha</td><td>Total: 84.2ha (excluding the 3ha lifestyle block)
Productive farm area: 80.5ha</td><td>Total: 265.7ha
Productive farm area: 255.5ha</td></tr>
<tr><td>Dairy cows</td><td>Production: 212,000kgMS (424kgMS/cow at peak)

Mean calving date: 25 Aug
Dry off date: 28 May

<table>
<tr><th>Month</th><th>Dairy Herd – Friesian
Default LWT used</th></tr>
<tr><td>Jul</td><td>315</td></tr>
<tr><td>Aug</td><td>515</td></tr>
<tr><td>Sep</td><td>508</td></tr>
<tr><td>Oct</td><td>500</td></tr>
<tr><td>Nov</td><td>500</td></tr>
<tr><td>Dec</td><td>500</td></tr>
<tr><td>Jan</td><td>500</td></tr>
<tr><td>Feb</td><td>500</td></tr>
<tr><td>Mar</td><td>485</td></tr>
<tr><td>Apr</td><td>485</td></tr>
<tr><td>May</td><td>440</td></tr>
<tr><td>Jun</td><td>315</td></tr>
</table>

Breeding bulls: 8 Jerseys, Dec and Jan</td><td>NA</td><td>Production: 254,400kgMS (424kgMS/cow at peak)

Mean calving date: 25 Aug
Dry off date: 28 May

<table>
<tr><th>Month</th><th>Dairy Herd - Friesian
Default LWT used</th></tr>
<tr><td>Jul</td><td>620</td></tr>
<tr><td>Aug</td><td>620</td></tr>
<tr><td>Sep</td><td>610</td></tr>
<tr><td>Oct</td><td>600</td></tr>
<tr><td>Nov</td><td>600</td></tr>
<tr><td>Dec</td><td>600</td></tr>
<tr><td>Jan</td><td>600</td></tr>
<tr><td>Feb</td><td>580</td></tr>
<tr><td>Mar</td><td>550</td></tr>
<tr><td>Apr</td><td>520</td></tr>
<tr><td>May</td><td>490</td></tr>
<tr><td>Jun</td><td>620</td></tr>
</table>

Breeding bulls: 9 Jerseys Dec and Jan

Note: earlier culling in proposed system</td></tr>
<tr><td>Beef calves and replacements</td><td>Calves are reared on farm until early January. The dairy replacements are then grazed at a third-party grazier until their return as in calf heifers in late July (18 months later). The beef type calves are sold.

<table>
<tr><th></th><th>Dairy Calves
Breed: Friesian
Age: 1month</th><th>Beef Calves
Breed: Beef type</th></tr>
<tr><td>Jul</td><td></td><td></td></tr>
<tr><td>Aug</td><td>78</td><td>15</td></tr>
<tr><td>Sep</td><td>130</td><td>30</td></tr>
<tr><td>Oct</td><td>130</td><td>30</td></tr>
<tr><td>Nov</td><td>130</td><td>30</td></tr>
<tr><td>Dec</td><td>130</td><td>30</td></tr>
</table></td><td>NA</td><td>Calves are reared on farm and remain on farm until May 1st. The dairy replacements are then grazed at a third-party grazier until their return as in calf heifers in May (12 months later).

<table>
<tr><th></th><th>Dairy Calves
Breed: Friesian
Age: 1month</th><th>In calf heifers
Breed: Friesian
Age: 22months</th></tr>
<tr><td>Jul</td><td></td><td></td></tr>
<tr><td>Aug</td><td>96</td><td></td></tr>
<tr><td>Sep</td><td>156</td><td></td></tr>
<tr><td>Oct</td><td>156</td><td></td></tr>
<tr><td>Nov</td><td>156</td><td></td></tr>
<tr><td>Dec</td><td>156</td><td></td></tr>
<tr><td>Jan</td><td>156</td><td></td></tr>
<tr><td>Feb</td><td>156</td><td></td></tr>
<tr><td>Mar</td><td>156</td><td></td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Description</th><th>Current Dairy Farm</th><th>Current Schrama’s Block</th><th>Proposed Dairy platform</th></tr>
<tr><td></td><td></td><td></td><td><table><tr><td>Apr</td><td>156</td><td></td></tr><tr><td>May</td><td></td><td>140</td></tr><tr><td>Jun</td><td></td><td>140</td></tr></table>
Note: Change in young stock policy and removal of beef stock reared.</td></tr>
<tr><td>Sheep</td><td>NA</td><td>Modelled as an average “class 7, S.I. Finishing Otago/Southland” property using benchmarking data from Beef and Lamb NZ. The report is attached to this document.

Lambing percentage: 137%

Breed: Coopworth

<table><tr><th></th><th>Ewes</th><th>Hoggets</th><th>Rams</th><th>Lambs</th></tr><tr><td>Jul</td><td>577</td><td>218</td><td>16</td><td></td></tr><tr><td>Aug</td><td>577</td><td>218</td><td>16</td><td></td></tr><tr><td>Sep</td><td>562</td><td>208</td><td>16</td><td></td></tr><tr><td>Oct</td><td>562</td><td>208</td><td>16</td><td></td></tr><tr><td>Nov</td><td>547</td><td>208</td><td>16</td><td>1002</td></tr><tr><td>Dec</td><td>547</td><td>208</td><td>16</td><td>868</td></tr><tr><td>Jan</td><td>532</td><td>208</td><td>16</td><td>738</td></tr><tr><td>Feb</td><td>532</td><td>208</td><td>16</td><td>608</td></tr><tr><td>Mar</td><td>521</td><td>208</td><td>16</td><td>478</td></tr><tr><td>Apr</td><td>521</td><td>208</td><td>16</td><td>348</td></tr><tr><td>May</td><td>379</td><td>198</td><td>16</td><td>218</td></tr><tr><td>Jun</td><td>379</td><td>198</td><td>16</td><td>218</td></tr></table>
Greasy wool: 4650kg</td><td>NA</td></tr>
<tr><td>In shed feeding</td><td>100% of herd fed inshed Aug – May</td><td>NA</td><td>100% of herd fed inshed Aug - May</td></tr>
<tr><td>Structures</td><td>Uncovered calving pad
Carbon rich surface (bark)
Lined

Management:
All animals on for24hrs/day
Aug – 19% of animals (98 cows)
Sep – 12% of animals (61 cows)
Oct – 2% of animals (10 cows)

Effluent:
Liquid effluent added to farm effluent system
Solids are spread on the non effluent blocks in December</td><td>NA</td><td>Uncovered calving pad
Carbon rich surface (bark)
Lined

Management:
All animals on for24hrs/day
Aug – 19% of animals (118 cows)
Sep – 12% of animals (73 cows)
Oct – 2% of animals (12 cows)

Effluent:
Liquid effluent added to farm effluent system
Solids are spread on the non effluent blocks in December</td></tr>
</table>

Description	Current Dairy Farm	Current Schrama's Block	Proposed Dairy platform
Animal distribution	No difference between blocks	No difference between blocks	No difference between blocks
Crop management	<u>Fodder Beet</u> 12ha planted 22TDM/ha yield Rotating through the "rolling" pasture blocks Planted in Nov – conventional cultivation 200kg/ha Cropzeal Boron boost at sowing 500kg/ha Fodder beet base at sowing 120kg/ha sustaiN applied in Jan Grazed in May and Sep for 2hr, and wintered on in June, Jul, Aug 24hrs/day. Sown into permanent pasture in October	<u>Swedes</u> 5.4ha planted (average as seen on Google earth) 12TDM/ha yield Rotating through the pasture blocks Planted in Dec – Conventional cultivation 325kg/ha Cropzeal boron boost at sowing 70kg/ha MOP at sowing 100kg/ha N-rich Urea in February Grazed in Jun, Jul, Aug (24hrs/day) Sown into permanent pasture in November	All cows are wintered on farm on either Fodder Beet or a Baleage/Grass system <u>Fodder Beet</u> 12ha planted 22TDM/ha yield Rotating through the "rolling" pasture blocks Planted in Nov – conventional cultivation 200kg/ha Cropzeal Boron boost at sowing 500kg/ha Fodder Beet Base mix at sowing 120kg/ha of SustaiN applied in Jan Grazed in May and Sep for 2hr, and wintered on in June, Jul, Aug 24hrs/day. Sown into permanent pasture in October <u>10ha Baleage/Grass wintering</u> This area rotates around the "rolling" pasture blocks. 205TDM baleage is fed out in paddock throughout the winter. The paddocks are then regrassed following the winter *Note: OverseerFM is not able to effectively model a Southland Baleage Grass wintering system. This block has therefore been modelled as a pastoral block and an adjustment to expected losses has been calculated outside of OverseerFM*
Imported Supplements	Silage – 150tDM fed in paddock and on pad Hay – 13TDM fed on pad PKE – 200TDM fed in shed DDG – 130TDM fed in shed Baleage – 120TDM fed on the crop	None	PKE – 265TDM fed in shed DDG – 175TDM fed in shed
Exported supplements	None	None	None
Harvested supplements	Hay – 17TDM fed on the pad Baleage – 24TDM fed on the crop	None	Hay – 36TDM fed on the pad Baleage – 144TDM fed on the Fodder beet

Description	Current Dairy Farm	Current Schrama's Block	Proposed Dairy platform
			Baleage – 205TDM fed on the baleage grass wintering paddocks Silage – 48TDM fed on the pad
Soil Fertility	Soil tests were completed in July 2019 Olsen P of 34 QT K of 7 QT Ca of 9 QT Mg of 17 QT Na of 6 SO_4 of 13	Soil tests were completed in November 2019 Olsen P of 34 QT K of 9 QT Ca of 9 QT Mg of 17 QT Na of 9 SO_4 of 13	Soil fertility would be targeted at agronomic optimum Olsen P of 30 QT K of 7 QT Ca of 9 QT Mg of 17 QT Na of 6 SO_4 of 13
Fertiliser	Fertiliser applied to maintenance level. Total P applied – 5,380kg Total K applied – 814kg Total S applied – 3,642kg	Fertiliser applied to maintenance level. Total P applied – 2,070kg Total K applied – 357kg Total S applied – 1,2750kg	Fertiliser applied to maintenance level. Total P applied – 7,728kg Total K applied – 7,222kg Total S applied – 5,855kg
Pastoral Nitrogen Fertiliser	239kgN/ha was applied to the pasture area in split application between Sep and Apr	Taken from fertiliser purchase records 18kg/ha N applied in March	Non Effluent paddocks – 175kgN/ha applied in split applications from Sep – Apr Effluent paddocks – 154kgN/ha applied in split applications from Sep to Apr *Note: No nitrogen fertiliser applied to the baleage grass paddocks in April prior to wintering on them*
Drainage	50% of the property is drained using mole and tile drainage	50% of the property is drained using mole and tile drainage	50% of the property is drained using mole and tile drainage
Effluent system	Holding pond – solids are separated Effluent is applied using a cobra rain gun at an application depth of 12-24mm Liquid effluent is applied to the "eff" blocks Solids are spread on the Non effluent blocks when conditions allow (usually December)	NA	Holding pond – solids are separated Effluent is applied using a cobra rain gun at an application depth of 12-24mm Liquid effluent is applied to the "eff" blocks Solids are spread on the Non effluent blocks when conditions allow (modelled as December)

Appendix 3: OverseerFM Data Outputs

Dairy Farm Current system

Farm nutrient budget

	Total loss (kg/yr)	Loss per ha (kg/yr)					
Nitrogen	11,315	62					
Phosphorus	455	2.5					
Nutrients added (kg/ha/yr)	**N**	**P**	**K**	**S**	**Ca**	**Mg**	**Na**
Fertiliser, lime and other	224	30	4	20	0	0	3
Irrigation	0	0	0	0	0	0	0
Supplements	81	16	51	10	18	10	7
Rain/clover fixation	78	0	2	5	3	6	27
Nutrients removed (kg/ha/yr)	**N**	**P**	**K**	**S**	**Ca**	**Mg**	**Na**
Leached from root zone	62	2.5	14	42	69	8	23
As product	92	16	22	5	21	2	6
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	102	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
Change in pools (kg/ha/yr)	**N**	**P**	**K**	**S**	**Ca**	**Mg**	**Na**
Organic pool	121	15	9	-14	2	1	1
Inorganic mineral	0	2	-25	0	-2	-3	-4
Inorganic soil pool	8	10	46	0	-70	8	10

Nitrogen summary

	Total loss (kg)	Loss per ha (kg/ha)	N in drainage (ppm)	Added (kg/ha)	Surplus (kg/ha)	Fertiliser (kg/ha)	Irrigation (kg/ha)	Effluent (kg/ha)
Eff, flat - makar, paro	90	45.2	10	267	257	239	0	28
Eff, flat - puke, apar	392	54.4	12	267	255	239	0	28
Eff, flat - ymai	137	42	9	267	247	239	0	28
Eff, rolling - makar, paro	97	46.2	10	267	257	239	0	28
Eff, rolling - puke, apar	4494	58.2	12	267	257	239	0	28
Non eff, flat - makar, paro	760	41.6	9	262	251	239	0	23
Non eff, flat - ymai	112	40	9	262	244	239	0	23
Non eff, rolling - makar	173	43.4	10	262	255	239	0	23
Non eff, rolling - puke, apar	2419	53.4	12	262	252	239	0	23
Non eff, rolling - makar, paro	21	42.2	9	262	253	239	0	23
Fodder beet	2130	178	32	135	190	135	0	0
Pond and wetland	6	3	-	0	0	0	0	0

Phosphorus summary

	Total loss (kg)	Loss per ha (kg/ha)	Fertiliser (kg/ha)	Irrigation (kg/ha)	Effluent (kg/ha)
Eff, flat - makar, paro	2	0.7	29	0	0
Eff, flat - puke, apar	6	0.8	30	0	0
Eff, flat - ymai	3	0.9	29	0	0
Eff, rolling - makar, paro	5	2.2	33	0	0
Eff, rolling - puke, apar	188	2.4	34	0	0
Non eff, flat - makar, paro	13	0.7	16	0	13
Non eff, flat - ymai	2	0.8	16	0	13
Non eff, rolling - makar	8	2.1	20	0	13
Non eff, rolling - puke, apar	105	2.3	21	0	13
Non eff, rolling - makar, paro	1	2.1	20	0	13
Fodder beet	29	2.4	77	0	0
Pond and wetland	0	0.1	0	0	0

Schrama Block Current System

Farm nutrient budget

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)				
Nitrogen	1,738	21				
Phosphorus	190	2.3				
NUTRIENTS ADDED (KG/HA/YR)	**N**	**P**	**K**	**S**	**CA**	**MG**	**NA**
Fertiliser, lime and other	23	25	4	15	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	74	0	2	5	3	6	27
NUTRIENTS REMOVED (KG/HA/YR)	**N**	**P**	**K**	**S**	**CA**	**MG**	**NA**
Leached from root zone	21	2.3	10	36	44	9	28
As product	11	1	0	2	2	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	38	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
CHANGE IN POOLS (KG/HA/YR)	**N**	**P**	**K**	**S**	**CA**	**MG**	**NA**
Organic pool	24	12	0	-18	0	0	0
Inorganic mineral	0	2	-21	0	-2	-3	-4
Inorganic soil pool	10	8	27	0	-39	1	3

Nitrogen summary

	Total loss (kg)	Loss per ha (kg/ha)	N in drainage (ppm)	Added (kg/ha)	Surplus (kg/ha)	Fertiliser (kg/ha)	Irrigation (kg/ha)	Effluent (kg/ha)
Rolling - makar	91	10.4	2	18	89	18	0	0
Rolling - puke, apar	809	12.2	3	18	87	18	0	0
Swedes	807	149	26	100	85	100	0	0

Phosphorus summary

	Total loss (kg)	Loss per ha (kg/ha)	Fertiliser (kg/ha)	Irrigation (kg/ha)	Effluent (kg/ha)
Rolling - makar	18	2.1	23	0	0
Rolling - puke, apar	151	2.3	23	0	0
Swedes	12	2.3	63	0	0

Proposed Dairy Farm System

Farm nutrient budget

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)					
Nitrogen	12,749	48					
Phosphorus	615	2.3					
NUTRIENTS ADDED (KG/HA/YR)	**N**	**P**	**K**	**S**	**CA**	**MG**	**NA**
Fertiliser, lime and other	158	29	27	22	0	0	2
Irrigation	0	0	0	0	0	0	0
Supplements	45	11	19	6	10	7	5
Rain/clover fixation	113	0	2	5	3	6	27
NUTRIENTS REMOVED (KG/HA/YR)	**N**	**P**	**K**	**S**	**CA**	**MG**	**NA**
Leached from root zone	48	2.3	14	42	59	8	23
As product	76	13	18	4	18	2	5
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	86	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
CHANGE IN POOLS (KG/HA/YR)	**N**	**P**	**K**	**S**	**CA**	**MG**	**NA**
Organic pool	102	15	8	-15	2	1	1
Inorganic mineral	0	2	-29	0	-2	-3	-4
Inorganic soil pool	6	8	42	0	-63	6	9

Nitrogen summary

	Total loss (kg)	Loss per ha (kg/ha)	N in drainage (ppm)	Added (kg/ha)	Surplus (kg/ha)	Fertiliser (kg/ha)	Irrigation (kg/ha)	Effluent (kg/ha)
Baleage grass - schrama, rolling puke apar	165	51.4	11	168	493	154	0	13
Baleage grass - schrama, rolling, makar	16	41.4	9	168	586	154	0	13
Baleage/grass - non eff, rolling, makar	8	41.4	9	168	482	154	0	13
Baleage/grass - eff, rolling, puke apar	220	54.8	11	168	485	136	0	32
Baleage/grass - non eff, rolling, puke apar	114	51.4	11	168	451	154	0	13
Eff, flat - makar, paro	66	33	7	186	200	154	0	32
Eff, flat - puke, apar	289	40.2	9	186	198	154	0	32
Eff, flat - ymai	102	31	7	186	188	154	0	32
Eff, rolling - makar, paro	72	34.6	7	186	197	154	0	32
Eff, rolling - puke, apar	3274	43	9	186	196	154	0	32
Non eff, flat - makar, paro	586	32	7	188	189	175	0	13
Non eff, flat - ymai	86	31	7	188	180	175	0	13
Non eff, rolling - makar	129	33	7	188	192	175	0	13
Non eff, rolling - puke, apar	1800	40.6	9	188	188	175	0	13
Non eff, rolling - makar, paro	18	35	8	188	209	175	0	13
Schrama, non eff, rolling - puke, apar	2589	40.6	9	188	188	175	0	13
Schramas, non eff, rolling makar	276	33	7	188	192	175	0	13
Fodder beet	2345	195	36	135	235	135	0	0
Pond and wetland	6	3	-	0	0	0	0	0

Phosphorus summary

	Total loss (kg)	Loss per ha (kg/ha)	Fertiliser (kg/ha)	Irrigation (kg/ha)	Effluent (kg/ha)
Baleage grass - schrama, rolling puke apar	6	1.9	0	0	8
Baleage grass - schrama, rolling, makar	0	1.7	0	0	8
Baleage/grass - non eff, rolling, makar	0	1.7	0	0	8
Baleage/grass - eff, rolling, puke apar	8	2	0	0	0
Baleage/grass - non eff, rolling, puke apar	5	1.9	0	0	8
Eff, flat - makar, paro	2	0.7	30	0	0
Eff, flat - puke, apar	5	0.7	31	0	0
Eff, flat - ymai	3	0.8	31	0	0
Eff, rolling - makar, paro	5	2	34	0	0
Eff, rolling - puke, apar	168	2.2	34	0	0
Non eff, flat - makar, paro	12	0.7	23	0	8
Non eff, flat - ymai	2	0.8	23	0	8
Non eff, rolling - makar	8	1.9	26	0	8
Non eff, rolling - puke, apar	96	2.1	27	0	8
Non eff, rolling - makar, paro	1	1.9	23	0	8
Schrama, non eff, rolling - puke, apar	136	2.1	27	0	8
Schramas, non eff, rolling makar	17	1.9	26	0	8
Fodder beet	29	2.4	77	0	0
Pond and wetland	0	0.1	0	0	0

Appendix 4: Beef and Lamb NZ Economic Survey Data

The Schrama Block Current farm nutrient budget has been completed using information from a recent Beef and Lamb NZ Economic Survey. This can be found at https://beeflambnz.com/sites/default/files/data/files/2019%20SSI.pdf

Appendix 5: David Moate Wetlands Report

Titipua Ltd Partners Wetland Ideas

No 1

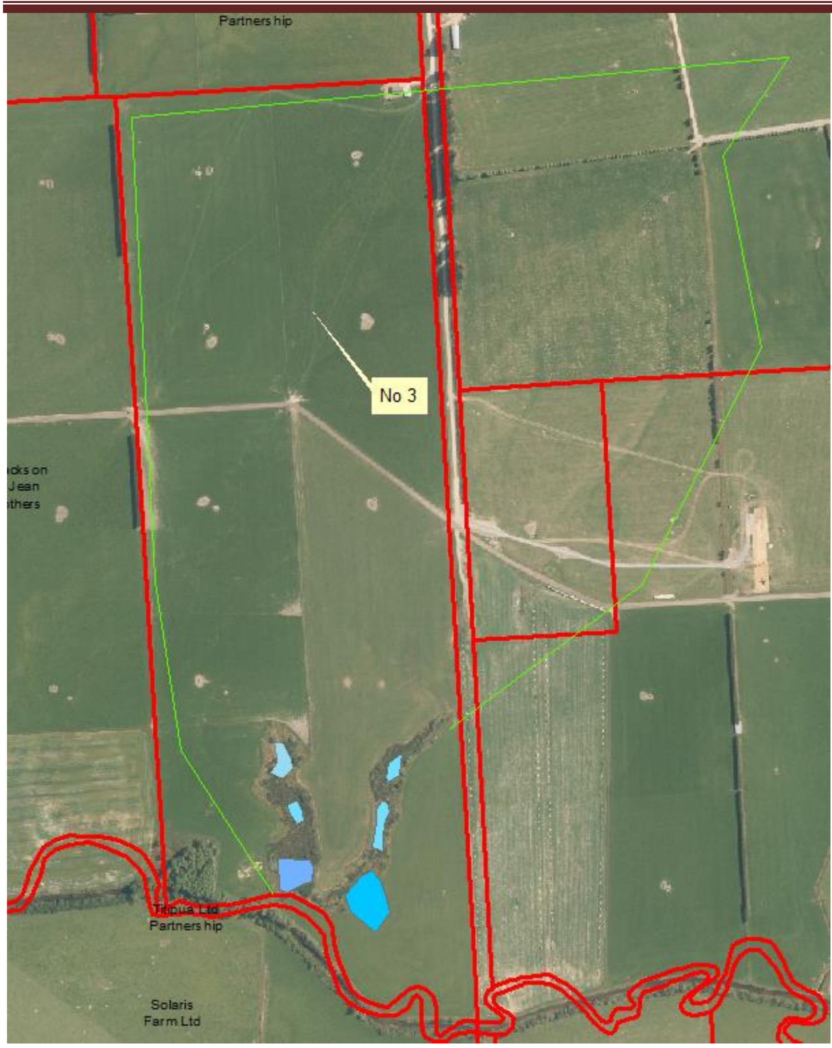
- 9 Ha catchment
- 900m2 wetland = 1 % of the catchment that will remove 50% of sediment, 25% of N, 25% P

No 2

- 10 Ha catchment
- 1000m2 wetland = 1% of catchment that will remove 50% of sediment, 25% of N, 25% P

Design Features

- First half 0.5m deep to improve tile outfalls, collected sediment and kill bacteria
- Second half 0.3m deep planted heavily with Carex secta
- Banks can be planted for in short plants for erosion control and aesthetics
- All 3 options do not require a resource consent



No 3

- 50 Ha
- 2.216 Ha wetland = 4.5% of the catchment that will remove 86% of sediment, 50% of N, 48% of P

Design Features

This existing area can be added too by creating more open water sections to store more water for longer allowing sunlight and wind to kill bacteria, sediment to be stored and N reduced. Open water areas created by bunds or digging out hollows. Make any overflows from earth not pipe and maybe lined with rock to prevent scouring in heavy rain events.

Main Creek

- Too risky trying to build anything in this waterway best to treat water before it gets there
- Permission required from ES catchment for nay planting
- Planting a row of Crow's nest or Tasman poplars or Moutere or Matsudana willow would benefit water quality and farm production and animal welfare
- For free Matsudana willow wands that only require a trim to length (1-1.2m) call Aaron Baird Otautau 021867522

Irricon
resource solutions

OVERSEER Nutrient Budget Review

For: Environment Southland – Titipua Ltd Partnership

Prepared by: Nicky Watt, CNMA

Date: 2nd June 2021

www.irricon.co.nz

Introduction

1. Regarding the consent application for Titipua Ltd Partnership, I have reviewed the following OVERSEER ® Nutrient Budget (OVERSEER) files:
   a) Current Dairy Platform FINAL
   b) Current Schrama block FINAL
   c) Proposed FINAL

2. Along with the file I have reviewed the following accompany reports: OverseerFM farm system modelling to support a consent application for expanded dairy. Report prepared for Titipua Ltd Partnership prepared by Mo Topham, AgriAce Consulting Limited and reviewed by Lee Baldwin, Baldwin Agri Solutions. I have completed a robustness check on the file for sensibility based on data available and checked to ensure the modelling aligns with the OVERSEER Best Practice Data Input Standards for v6.3.5.

3. It must be assumed that the information provided in the OVERSEER files that the current farming system as modelled is a viable farming system, using actual stock and fertiliser inputs. Therefore, the actual and proposed scenario is also assumed to be appropriate for the location and climate.

4. A 'sensibility test' has been undertaken on the Titipua Ltd nutrient budgets with the following five output screens from OVERSEER forming the basis of the determination of the robustness of the nutrient budget:
   a) Is the nutrient loss consistent with what you would expect for an operation of this type and soils in this location?
   b) Does the summary of inputs and outputs make sense? Especially clover fixation and change in block pools?
   c) Check the 'Other values' block reports for rainfall, drainage, and PAW.
   d) Select the Scenario reports other values and check the production and stocking rate.
   e) Select the pasture production in the scenario report and check pasture growth.

5. Answers to each of these five points will be provided further in this report and then a final determination of the robustness of the nutrient loss to water will be provided at the end of this report.

OVERSEER AUDIT

Appropriateness of the Overseer inputs

1. The Overseer FM file submitted and stated in paragraph 1 of this report has been reviewed for consistency between the files and appropriateness of the inputs regarding the farming systems and the Overseer Best Practice Data Input Standard (BPDIS).

2. I concur that there are no deviations from the BPDIS.

3. The Dairy model has 181.5 ha total area with 175 ha effective (163 ha in pasture and 12 ha in fodder beet rotated through 141.5 ha of rolling pasture blocks). The Schrama Model has 84.2 ha total area with 80.5 ha effective (75.1 ha in pasture and 5.4 ha in swedes rotated through all the pasture blocks). The Proposed model has 265.7 ha total area with 255.5 ha effective (243.5 ha in pasture and 12 ha in fodder beet rotated through 141.5 ha of rolling pasture blocks and 76.9 ha of Schrama blocks). The Dairy plus Schrama models have a revised stocking rate of 26.0 RSU/ha, compared to the Proposed model which has a RSU 27.2 RSU/ha or a 4.4% increase in RSU/ha (see Table 1 below).

4. Reviewing the NZ Dairy statistics for the 2019/2020 season, shows the average milk solids production on this property for the Dairy model at 411.7 kgMS/cow and 1301 kgMS/ha is respectively lower than the Southland Regional average of 418 kg MS/cow and higher than the Southland Regional average of 1133 kgMS/ha. The Proposed model at 410.3 kgMS/cow and 1045 kgMS/ha is respectively lower than the Southland Regional average of 418 kg MS/cow and lower than the Southland Regional average of 1133 kgMS/ha. The stocking rate for Dairy Model at 3.1 cows/ha is greater than the Southland average for the 2019/2020 season of 2.76 cows/ha (Invercargill). The stocking rate for Proposed Model at 2.5 cows/ha is less than the Southland average for the 2019/2020 season of 2.76 cows/ha (Invercargill).

5. *Table 1: Summary of Production and stocking rate*

	Dairy[1]	Schrama[2]	Dairy + Schrama	Proposed[3]
Total Ha	181.5	84.2	265.7	265.7
Effective Area (ha)	175	80.5	255.5	255.5
Effective Pasture Area (ha)	163	75.1	238.1	243.5
KgMS	212000	-	-	254400
MS kg/ha grazed	1301	-	-	1045
MS kg MS/cow	411.7	-	-	410.3
Total RSU	5459	1186	6645	6956
RSU/ha (effective area)	31.2	14.7	26.0	27.2
Dairy RSU	5301	-	5301	6485
Lactation Length	266	-		266
Cows/ha	3.1	-		2.5
Cows October	500	-		600
Cows June	315	-		480
Cows July	315	-		620
Replacement RSU	127	-	127	471
Replacement June	-	-		140
Beef RSU	31	-	31	-
Beef June	0	-		-
Sheep Nov	-	1773		-
Sheep RSU	-	1186	1186	-
N lost kg/ha/yr	62	21		48

[1]Current Dairy Platform FINAL
[2]Current Schrama block FINAL
[3]Proposed FINAL

6. There was 12 ha of fodder beet (crop rotation) in the Dairy Model, 5.4 ha swedes (crop rotation) in the Schrama model and 12 ha Fodder Beet (crop rotation) in the Proposed model (see Table 2 below)

Table 2: Crop Details

	Dairy	Schrama	Proposed
	Year 1	Reporting Year	-
Swedes (ha)	-	5.4	-
Swedes Yield (tDM/ha)	-	12	-
When Grazed	-	June to August	-
Grazed by	-	Sheep	-
Fodder Beet (ha)	12	-	12
Fodder Beet Yield (tDM/ha)	22	-	22
When Grazed	May to September	-	May to September
Grazed by	Dairy Cows	-	Dairy Cows

7. Supplements imported to meet cow demand (see Table 3 below). Pasture silage has been made where there was a surplus of pasture.

8. The Dairy + Schrama models had pasture growth calculated at 15.0 tDM/ha compared to 16.07 tDM/ha for the Proposed model (a 6.7 % increase in growth). The average N used during the Dairy + Schrama model was 119 kgN/ha onto non effluent pasture. The Proposed model is expected to drop the N applied to effluent area to 154 kgN/ha (a 35.6 % drop when compared to the dairy model) and 175 kgN/ha to the Non-Effluent area (a 32 % increase when compared to the Dairy model). There is expected to be 1.81 tDM/ha supplement imported and 1.78 tDM/ha silage harvested in the Proposed model compared to 2.57 tDM/ha supplement imported and 0.17 tDM/ha silage harvested in the Dairy + Schrama models (see Table 3 below).

Table 3: Supplements imported and Harvested

	Dairy	Schrama	Dairy + Schrama	Proposed
Supplements Imported (tDM)	613	-	613	440
Supplements Imported Effective Area (tDM/ha)	3.76	-	2.57	1.81
Silage Harvested (tDM)	41	-	41	433
Silage Harvested Pasture (tDM/ha)	0.25	-	0.17	1.78
Total Area (ha)	181.5	84.2	265.7	265.7
Effective Area (ha)	175	80.5	255.5	255.5
Effective Pasture Area (ha)	163	75.1	238.1	243.5
Peak Cows/ha	3.1	-	-	2.5
N Fertiliser applied non -effluent area(kgN/ha)	239	18	119	175
N Fertiliser applied effluent Area (kgN/ha)	239	-	239	154
Pasture Growth non-effluent area (tDM/ha)	16.76	-	-	16.07
Pasture Growth effluent area (tDM/ha)	16.76	-	-	16.07
Whole Farm Pasture Growth (tDM/ha/yr)	16.76	11.17	15.00	16.07

9. Relative productivity is 'No difference between blocks' and 'Same ratio as animal intake' for all models.

Overseer Outputs

The N lost to water for the Dairy + Schrama models was 49.1 kgN/ha compared to 48 kgN/ha for the Proposed model (2.2 % reduction in N loss). The P loss for the Dairy + Schrama models was 2.4 kgP/ha compared to 2.3 kgP/ha for the Proposed model which is a 4.2 % reduction in P loss (see Table 5 below). It is assumed that the information provided in this farming system is modelled as a viable farming system, using actual stock and fertiliser inputs.

Table 5: OVERSEER outputs

Overseer v6.3.4	Dairy	Schrama	Dairy + Schrama	Proposed
N lost to water kg/ha/yr	62	21	49.1	48
Total N lost kg/farm	11315	1738	13053	12749
P lost kg/ha/yr	2.5	2.3	2.4	2.3
Total P lost kg/farm	455	190	645	615
Other sources – N	483	30	513	589
Other sources – P	94	9	103	114

Change in block pools

10. The organic pool for N indicates the amount of N that is being either immobilized as seen by a 'positive' Organic pool N value or being mineralized as seen by a 'negative' Organic pool N value. N being immobilized is being used for increased biological activity and temporarily locked up. Once the microorganisms die the organic N in their cells is converted by mineralization and nitrification to plant available nitrate. It appears N is potentially being mineralized in all models (see Table 6 below).

11. The inorganic soil pool for P indicates the amount P that exceeds soil P maintenance as seen by a 'positive' inorganic soil P value or is less than the soil P maintenance requirements as seen by a 'negative' inorganic soil P value. Slightly above maintenance P was applied to all models (see Table 6a below).

Table 6: Change in block pool (N)

	Dairy	Schrama	Proposed
Organic Pool	121	24	102
Inorganic Mineral	0	0	0
Inorganic Soil Pool	8	10	6

Table 6a: Change in block pool (P)

	Dairy	Schrama	Proposed
Organic Pool	15	12	15
Inorganic Mineral	2	2	2
Inorganic Soil Pool	10	8	8

Rain/clover N Fixation

All plants, including forage crops, need relatively large amounts of nitrogen for growth and development. Biological nitrogen fixation is the term used for a process in which nitrogen gas (N2) from the atmosphere is incorporated into the tissue of certain plants. Only a select group of plants can obtain N this way, with the help of soil microorganisms. Among forage plants, the group of plants known as legumes (predominantly Clover in NZ pastures) are well known for being able to obtain N from air N2. The OVERSEER Technical Manual – Characteristics of Pasture, April 2015 indicates that biological N fixation is based on total pasture production and includes the fertiliser induced reduction in N fixation.

12. The Biological fixation for the Dairy and Schrama models is 76 and 72 respectively compared to the Proposed model at 111 (see table 7 below).

13. The average N added to the Dairy + Schrama models is 160 kgN/ha to whole farm compared to 158 kgN/ha for the Proposed model (a 1.3 % drop in N used).

14. The increase in biological fixation in the Proposed model can be explained by the decrease in N fertiliser applied and the decrease in supplements imported and increase in pasture harvested.

Table 7: Biological fixation

	Dairy	Schrama	Dairy + Schrama	Proposed
Biological Fixation	76	72		111
Average N applied to whole farm kg/ha/yr	224 (239 to non-effluent and effluent pasture)	23 (18 to pasture)	160 (119 to non-effluent pasture)	158 (136-154 to effluent and 175 to non-effluent pasture

Pasture Production

15. The average effluent N inputs for Dairy model was 28 kgN/ha from liquid effluent to 99.7 ha pasture. There was 23 kgN/ha from solids to 75.3 ha of Pasture (see table 8 below). The average effluent N inputs for Proposed model was 32 kgN/ha from liquid effluent to 99.7 ha pasture. There was 13 kgN/ha from solids to 159.8 ha of Pasture.

16. Fertiliser inputs of N, for dairy model, to effluent and non-effluent pasture was 239 kgN/ha. Fertiliser inputs of N, for Schrama model, to pasture was 18 kgN/ha. This equated to an average of 119 kgN/ha for the Dairy and Schrama models combined for non-effluent pasture. Fertiliser inputs of N, for Proposed model, to effluent area was mainly 154 kgN/ha and 175 kgN/ha to the non-effluent pasture.

17. Liquid effluent is applied on pasture block for Dairy and Proposed models was applied all year-round using a -12mm-24 mm' application depth. Solids effluent from pond is applied in December for Dairy and Proposed models.

Table 8: Pasture production and N inputs (fertiliser and effluent)

	Dairy	Schrama + Dairy	Proposed
Effluent Liquid Area (ha)	99.7		99.7
Effluent Solids Area (ha)	75.3		159.8
Pasture Growth (tDM/ha/yr)			
Effluent	16.76		16.07
Non-Effluent	16.76		16.07
Whole farm pasture average (tDM/ha/yr)	16.76	15.0	16.07
N Fertiliser inputs (kg/ha/yr)			
Effluent	239		154
Non-Effluent	239	119	175
N Effluent Inputs (kg/ha/yr)			
Effluent	28		32
Non-effluent (includes solids)	23		13
Total N Inputs (kgN/ha/yr)			
Effluent	267		188
Non-Effluent	262	119	168

18. The pasture production for all models has been modelled as varying based on topography, climate, and development status.

19. Fertiliser inputs of N are moderate to high (see Table 8).

20. It is assumed the Current Dairy and Current Schrama models represent the actual farm system with actual stock, crop area and fertiliser inputs, it is assumed that the pasture production is accurate and reasonable.

21. Long term pasture growth in Southland between 1979 and 2012 indicated that average pasture growth for newer pastures was 12.7T DM/ha/yr.

22. The pasture production for the Dairy + Schrama models was 15.0 kgDM/ha compared to 16.07 tDM/ha for the Proposed model which is respectively 15.3% and 21% higher than the Southland average.

23. Dairy + Schrama models: Allowing for the Overseer model assuming an average metabolisable energy (ME) value of 10.5 MJME/kgDM for pasture and South Island pastures have a ME value closer to 11 MJME/kgDM the models output of pasture growth would drop by 4.5%. Also, the Dairy and Schrama models have used actual data and have been rotating crops which means new pasture which can account for 15-20% improvement in pasture growth.

24. Proposed Model: What cannot be accounted for is the 6.7% increase in pasture harvest for the Proposed model when compared to the Dairy and Schrama models combined. The RSU for the Proposed model has increased, supplement imported has decreased and more silage is being made on farm with similar N fertiliser used per ha over the whole farm. Where will the extra growth come from?

25. The animal distribution is modelled as 'No difference between blocks' and 'Default Grazing Months'.

Mitigations Modelled

26. Reporting out lined the following: As described in the Nutrient Budget Report for Titipua Ltd prepared for Titipua Ltd by Mo Topham AgriAce Consulting Ltd, there are several mitigation measures indicated to mitigate N loss that have been included in the Proposed modelling. The below table details if the mitigation measures have been included in the proposed scenario and if they are accurately modelled.

Table 9: Mitigation option for proposed scenarios

A change in culling policy meaning culls leave the property earlier in the season	Yes, there was 1.5% culled Feb, 3% culled March and 0% culled in April in Dairy model versus 4.8% culled Feb, 5.2 % culled March and 5.5 % culled April in Proposed model
A reduction in imported feed	Yes, supplements imported have reduced from 2.57 tDM/ha in Dairy + Schrama models to 1.81 tDM/ha in the Proposed model.

Greater use of the calving pad in spring	No and yes. The percentage of animals on the calving pad has not changed, but with more cows in the Proposed model more cows will be on the calving pad
Reduction of nitrogen fertiliser use	Yes, however the reduction over the whole farm is only a 1.3% decrease (160 Dairy + Schrama compared to 158 kgN/ha for Proposed)
Larger area for spreading effluent solids	Ye, there is a 53% increase in area that receives solids in the Proposed model
Reducing Olsen P levels to 30	Yes, Olsen P levels have dropped from 34 to 30.

27. All mitigations have been modelled correctly.

28. It is important that these mitigation measures are measured and monitored as if they are not adhered to the N loss reductions proposed may not occur.

29. Some good management practices assumed in Overseer are maintain accurate and auditable records of annual farm inputs, outputs and management practices (Overseer output is only as good as the data entered); Fertiliser is being applied according to the Fertmark and Spreadmark Codes of Practice; Feed is stored to minimise leachate and soil damage; Compliant effluent systems as defined by DairyNZ; Stock exclusion from water ways; Irrigation efficiency greater than 80%; farm race and bridge/culvert nutrient runoff is directed to paddocks; grazing managed to minimise losses from critical source areas.

30. Overseer will account for bad practices such as nitrogen (N) applied that exceeds the plants' ability to absorb the excess N, application of N in the winter, high stocking rates, land left fallow between crops and irrigating high water application rates causing N drainage to name a few.

31. The Overseer modelling completed for Titipua Ltd does not have any of the 'Bad Practices' as suggested in paragraph 33 and it would be assumed the FEMP would cover any good management practices (not limited to) outlined in paragraph 32.

CONCLUDING COMMENTS

Determination of the robustness of the nutrient loss to water

32. The questions below were described at Paragraph five of this report. Whilst these have been answered throughput this report, this section summarizes the answer to each question to make an overall conclusion about the robustness of the nutrient budgets.

Is the N loss consistent with what you would expect for an operation of this type and soils in this location?

33. Based on my experience, the N loss estimates are reasonably consistent with an operation of this scale and soil types present.

Does the summary of inputs and outputs make sense? Especially clover fixation and change in block pools?

34. The Biological fixation at 76 to 111 is expected with the moderate amount of N fertiliser applied.

35. The average N added to the Dairy + Schrama models is 160 kgN/ha to whole farm compared to 158 kgN/ha for the Proposed model (a 1.3 % drop in N used).

36. It is not apparent from reviewing the Overseer technical manuals or the nutrient budgets if the pasture production and N fertiliser use accounts for all the biological fixation.

Check the 'Other values' block reports for rainfall, drainage, and PAW.

37. The rainfall and soil information have been entered based on protocols for the location and soil type selected.

Production and stocking rate

38. The Dairy plus Schrama models have a revised stocking rate of 26.0 RSU/ha, compared to the Proposed model which has a RSU 27.2 RSU/ha or a 4.4% increase in RSU/ha.

39. Based on my experience as well as reviewing NZ Dairy statistics for the 2019/2020 season, shows the average milk solids production for the Dairy model at 411.7 kgMS/cow and 1301 kgMS/ha are respectively lower than the Southland Regional average of 418 kg MS/cow and higher than the Southland Regional average of 1133 kgMS/ha. The Proposed model at 410.3 kgMS/cow and 1045 kgMS/ha is respectively lower than the Southland Regional average of 418 kg MS/cow and lower than the Southland Regional average of 1133 kgMS/ha.

40. The stocking rate for Dairy Model at 3.1 cows/ha is greater than the Southland average for the 2019/2020 season of 2.76 cows/ha (Invercargill). The stocking rate for Proposed Model at 2.5 cows/ha is less than the Southland average for the 2019/2020 season of 2.76 cows/ha (Invercargill).

41. It is assumed that the Dairy and Schrama models are based on actual year end information.

Select the pasture production in the scenario report and check pasture growth.

42. Long term pasture growth in Southland between 1979 and 2012 indicated that average pasture growth for newer pastures was 12.7T DM/ha/yr.

43. The pasture production for the Dairy + Schrama models was 15.0 kgDM/ha compared to 16.07 tDM/ha for the Proposed model which is respectively 15.3% and 21% higher than the Southland average.

44. Dairy + Schrama Models: Allowing for the Overseer model assuming an average metabolisable energy (ME) value of 10.5 MJME/kgDM for pasture and South Island pastures have a ME value closer to 11 MJME/kgDM the models output of pasture growth would drop by 4.5%. Also, the Dairy and Schrama models have used actual data and have been rotating crops which means new pasture which can account for 15-20% improvement in pasture growth.

45. Proposed Model: What cannot be accounted for is the 6.7% increase in pasture harvest for the Proposed model when compared to the Dairy and Schrama models combined. The RSU for the Proposed model has increased, supplement imported has decreased and more silage is being made on farm with similar N fertiliser used per ha over the whole farm. Where will the extra growth come from?

46. I have assumed an adequate level of robustness around the Dairy and Schrama Models of actual Overseer Modelling as it is based on an actual farming system, and with that, I have assumed actual stock and fertiliser inputs used.

47. The data input protocols have been followed with no deviations. This leads to a high level of robustness for the relevant input data for example, climate, soils, and pasture type.

    Based on the concerns raised regarding some of the inputs and outputs in the Proposed Overseer model, I consider that the robustness of the nutrient loss estimates for the Proposed model to be **medium,** this is due to the following:

    - Provide an explanation how the higher pasture growth for the Proposed model can be achieved (when compared to the Dairy + Schrama models).

    I consider the robustness of the nutrient loss estimates for the Dairy and Schrama models to be **high.**

References:

New Zealand Dairy Statistics 2019/2020. Produced by LIC and DairyNZ 2020. https://www.dairynz.co.nz/publications/dairy-industry/new-zealand-dairy-statistics-2019-20/

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https://www.dairynz.co.nz/media/5790163/average-pasture-growth-data-south-island-2018.pdf

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File Note: Titipua Ltd Partnership – Pasture Grown

June 2021

1.0 Supporting information to this report:

This file note is not a standalone report. It is intended to be read in conjunction with:

- The Overseer modelling report, dated 23rd March 2021 titled "Titipua Ltd Partnership – OverseerFM farm system modelling to support a consent application for expanded dairy". This report has been attached to this file note.

2.0 Purpose of this report:

The Overseer Nutrient Budget Review, completed by Nicky Watt of Irricon raised points of clarification over the pasture grown estimates in the proposed nutrient budget scenario when compared to that estimated in the current dairy and Schrama block scenarios. This report seeks to explain the pasture grown figures to give council confidence that they are reasonable.

3.0 Modelled pasture grown results:

Table 1 below has been completed using information from the Overseer modelling report (section 1.1 and appendix 2 in that report). It shows the estimated pasture grown in each of the scenarios modelled – current dairy, Schrama block and the proposed dairy system.

Table 1. Estimated pasture grown figures in the current, Schrama and proposed system scenarios as per the Overseer report, dated 23rd March 2021.

	Current system	Schrama Block	Proposed system
Pasture grown (TDM/ha)	16.8	11.2	16.1
N Fertiliser applied (kgN/ha)	239	18	166 (average for pastoral area) *175 (non Effluent areas)* *154 (effluent areas)*

4.0 Overseer modelling process

Overseer calculates pasture grown from the data inputted using a back calculation and an assumed pasture quality. Overseer is not able to check the feasibility of these pasture production estimates and therefore the user must check them.

For the Titipua Ltd Partnership, input data was collected for the last three seasons and then averaged to reduce the impact of one seasons climatic conditions during the period.

As described in the Overseer modelling report, detailed input data for the Schrama block was not available due to the death of the previous owner. Therefore, a nutrient budget has been created using data from the Beef and Lamb NZ economic survey alongside information available from Google Earth and the purchaser. The property has been modelled in a conservative approach that resulted in a pasture grown estimate at the lower end of the expected range. It should be noted that if a conservative approach had not been taken it would have resulted in higher nutrient losses, and thus an easier threshold for the Titipua Ltd Partnership to reach.

The proposed dairy system model is the Titipua Ltd Partnerships preferred future farm system. The inputs for the proposed system were discussed with the client at length to ensure that a viable system was modelled.

The Schrama block, when compared to the current dairy platform, has the same soil types, drainage, topography, rainfall and temperature, and similar or better soil fertility.

In Southland there are significant differences between sheep and dairy grazing systems. Sheep farms tend to be set stocked for a significant part of the season and grazed to lower residuals. These practices influence growth rates, and result in lower growth rates than a dairy farming system. It is not relevant to make direct comparisons between sheep and dairy farming growth rates. It should be noted that Woodlands growth data is from a sheep farm, but as it uses “caged cuts” is not reflective of standard sheep grazing practices.

The Schrama block, given the same farm system, nitrogen use and pasture management, has the same potential to grow pasture as the current dairy farm. Therefore, the pasture grown estimate in the proposed scenario should be compared to the current dairy farm only (not the previous sheep grazing system).

4.0 Interpretation of Overseer pasture grown estimates:

Section 4.1.1 of the Overseer modelling report discusses that the pasture grown estimations in Overseer for Southland dairy farms are higher than expected. I have included this section below:

“It should be noted that the estimated pasture grown outputs from Overseer are higher than expected. Overseer uses a default value for ryegrass/white clover pasture quality irrespective of the land use and management. The default Overseer value in Southland ranges from 10.5 to 11.17 MJ ME/ kg DM depending on the month (reference: Characteristics of pasture, June 2018, D M Wheeler AgResearch Ltd). Pasture cuts from an Eastern Southland monitor farm show MEs of 11.5 to 12.2 (reference: Pasture growth and quality on Southland and Otago dairy farms, D. E. Dalley and T. Geddes, DairyNZ, NZ Grasslands Publication 2012).

The Overseer default values have been used throughout the entirety of this modelling as the Best Practice Data Input Standards state that “there needs to be a very good long-term average evidence of clover content, pasture utilisation, pasture N content and pasture quality to justify changes from the default OVERSEER values. This level of information would be rare.”

To ensure that comparisons are valid between the baseline and proposed the same method has been used to ensure that an “apples with apples” approach is taken.”

The Overseer Nutrient Budget Review completed by Irricon also noted that Overseer assumes a lower ME (metabolizable energy) than that found in the South Island. The lower ME assumed results in pasture grown estimates that are higher than expected.

Table 2 below shows the estimated pasture grown figures for the dairy scenarios at 10.8ME (as per the average of the Overseer assumed pasture quality) and at 11.85ME (as per the average of the pasture quality measured by Dalley and Geddes, 2012).

Table 2. Pasture grown estimates taken directly from Overseer compared to an updated pasture grown figure using pasture quality figures measured on Southland dairy farms.

	Current system	Schrama Block	Proposed system
Overseer Pasture grown estimate – 10.8 MJME/kgDM (TDM/ha)	16.8	11.2	16.1
Updated pasture grown estimate – 11.85MJME (TDM/ha)	15.3	NA	14.7

Therefore, the pasture production estimated by Overseer and corrected for Metabolisable Energy content is 15.3TDM/ha and 14.7TDM/ha on the current and proposed dairy system scenarios, respectively.

5.0 Expected pasture grown in Southland

Pasture production has been measured at the Woodlands Research Station on a fortnightly basis since 2000. The trial is operated in a nil nitrogen, optimal soil fertility system. The results of these measurements are publicly available, and I note that the Irricon report referenced a paper written about this trial which averaged pasture production from 2001 – 2012. Recent data released by the Woodlands Research Station including the years 2013 - 2021 showed that the average annual pasture production for this trial is now 13.0 TDM/ha (with no nitrogenous fertiliser input).

Pasture production in the current and proposed dairy farm scenarios is 2.3 and 1.7 TDM/ha higher respectively than the Woodlands Research Station average. This difference can be explained by nitrogen fertiliser pasture growth. As shown in Table 1, the current and proposed dairy farm scenarios included fertiliser nitrogen use of 239 and 166kgN/ha respectively. At a 10:1 response rate (10kgDM per 1kgN applied per ha), we would expect that the current and proposed would grow 2.39TDM/ha and 1.66TDM/ha more than the Woodlands Research Station. **This equates to an expected pasture grown of 15.39TDM/ha and 14.66TDM/ha on the current and proposed system respectively.**

5.0 Conclusions:

Due to differences in pasture management and its effect on pasture production, it is not justifiable to directly compare pasture grown figures rates for a sheep and dairy system. This comparison, by Irricon has led to incorrect conclusions regarding robustness of the modelling.

Pasture production is estimated by Overseer using a back calculation and an assumed pasture quality. Overseer overestimates pasture production on Southland dairy farms due to an under estimation of pasture quality. After correcting for this error, Overseer estimates pasture production on the current and proposed scenarios to be 15.3 and 14.7TDM/ha respectively.

The Woodlands Research Station has measured pasture production for the last 20yrs. The average annual pasture production on a Nil Nitrogen site is 13.0TDM. Considering the nitrogen applied to the current and proposed system, and a 10:1 response rate, we would expect pasture production on the Titipua Ltd Partnership property to be 15.39 and 14.66TDM/ha in the current and proposed systems respectively.

Given that the corrected Overseer pasture grown estimates are within 0.1TDM/ha of the Woodlands + nitrogen estimates, it can be concluded that the pasture grown is feasible and sensible.

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File Note: Titipua Ltd Partnership – Overseer version change

September 2021

1.0 Supporting information to this report:

This file note is not a standalone report. It is intended to be read in conjunction with:

- The Overseer modelling report, dated 23rd March 2021 titled "Titipua Ltd Partnership – OverseerFM farm system modelling to support a consent application for expanded dairy".
- The File Note, dated June 2021 titled "File Note: Titipua Ltd Partnership – Pasture grown"

These reports have been attached to this file note.

2.0 Purpose of this report:

Since the completion of the nutrient budgeting report, and the subsequent audit, there has a version change of Overseer. This has resulted in changes in the estimated losses of N and P. This file note seeks to update the nutrient loss figures so that Environment Southland have current loss estimates.

3.0 Overseer version change:

Periodically, Overseer releases a new version of the model. The version changes are generally a result of new science becoming available. The original report for Titpua Ltd Partnership was written using information calculated in Overseer version 6.3.5. On the 28th July 2021, after the consent application was lodged, Overseer released version 6.4.0. The update is as follows:

- *NIWA climate data - The climate data for OverseerFM has been updated to use NIWA data from 1991-2020.*
- *All climate data used in the model will be based on the location of the block. If the block does not have a location, the location of the farm will be used. Where farms do not have a location, the model will not run until a location is set. This ensures that each analysis is using the best representation of climate for their farm.*
  (taken from the Overseer website)

Upon further reading of the Overseer version 6.4.0 release notes, I also note that there has been a change to using monthly climate data rather than annual. This climate data update has affected the modelled rainfall, average temperature, and potential evapotranspiration (PET). This in turn affects modelled drainage volumes and biological activity (particularly volatilisation).

4.0 Previously modelled losses:

The tables below show the losses as calculated using Overseer version 6.3.5 and presented in the Overseer modelling report, dated 23rd March 2021.

Table 1. Estimated nitrogen and phosphorus losses from the current system using Overseer version 6.3.5

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	11,315	1,738	13,053
N Loss/ha (kgN/ha/yr)	62	21	49
Total Farm P Loss (kg)	455	190	645
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

Table 2. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.3.5

	Total current (same as above)	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	13,035	12,181 *(12,749 modelled plus 173 baleage grass wintering minus 741 wetlands calculated outside OverseerFM)*	6.7% decrease
N Loss/ha (kgN/ha/yr)	49	46	
Total Farm P Loss (kg)	645	572 *(615 modelled minus 43 wetlands calculated outside OverseerFM)*	11.3% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note.*

5.0 Updated modelled losses:

Following the version update to 6.4.0, I have reopened the relevant Overseer budgets. There have been no other changes made to the budgets. The tables below show the updated Overseer outputs. For ease of reading, changes have been shown in red.

Table 3. Estimated nitrogen and phosphorus losses from the current system using Overseer version 6.4.0

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	10,196	1,685	11,881
N Loss/ha (kgN/ha/yr)	56	20	45
Total Farm P Loss (kg)	456	191	647
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

Table 4. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.0

	Total current (same as above)	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11,881	11,088 *(11,656 modelled plus 173 baleage grass wintering minus 741 wetlands calculated outside OverseerFM)*	6.7% decrease
N Loss/ha (kgN/ha/yr)	45	42	
Total Farm P Loss (kg)	647	574 *(617 modelled minus 43 wetlands calculated outside OverseerFM)*	11.3% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note. These calculations have NOT been updated in light of the update in Overseer version.*

6.0 Updating the outside of Overseer calculations

The proposed system estimated losses included the use of calculations outside of Overseer. These calculations have been recalculated below utilising information from version 6.4.0.

6.1 Baleage grass wintering:

As explained in the March 2021 report *"OverseerFM is likely to underestimate nitrogen losses as OverseerFM is not able to adequately reflect the on-farm realities of this system. OverseerFM assumes that the pasture plants will regrow post grazing and take up urinary N from the wintering* *activity. However, due to the soil type and climate on the applicant's property, the plants are not viable following the winter grazing. As a result, the area is cultivated and regrassed in spring. I am unaware of any research that has quantified the impact of baleage grass wintering in terms of nitrate and phosphorus loss. I have therefore completed a desktop modelling exercise that attempts to estimate the nutrient losses from this system more accurately."*

In the March 2021 report, I explained that I had created an Overseer file that showed the baleage grass area as a very low yielding kale crop. This allowed me to add a defoliation and regrassing event to Overseer and ensured that overseer would assume no uptake of urinary N between grazing of the crop and the resowing of the pasture. Further details on how this was modelled can be found in the March 2021 report in section 4.2.1. I have rerun the same calculation and summarised the results below:

	Total nitrogen losses for the kale or baleage/grass area (10ha)	
	OverseerFM version 6.3.5 (taken from the March 2021 report)	OverseerFM version 6.4.0
Pasture baleage system	523	433
Kale system	696	877
Difference	173	444

Therefore, it is predicted that the losses from the grass baleage wintering system will be 444kgN higher than estimated in the OverseerFM Proposed scenario.

6.2 Installation of a wetland

As per the March 2021 report, Titipua Ltd Partnership have sought advice from David Moate of Environment Southland regarding the installations of wetlands. Following this advice, they have agreed to install a wetland on the property. Calculations outside of Overseer have been completed to quantify the expected reduction in nitrogen and phosphorus loss because of the wetland. The catchment of the wetland is 50ha, although only 38ha of this is on the Titipua ltd Partnership property.

The table below calculates the expected amount of nitrogen captured by the wetland. This has been updated following the Overseer version change. Updated figures are shown in red. The original figures are also shown for completeness.

Overseer block name	Area (ha)	OverseerFM estimated nitrogen leaching loss (kgN/ha) (updated in red)	Reduction in N leaching due to wetland (from David Moate's report) (%)	Total reduction (kgN) (Ha x kgN/ha x %) (updated in red)
Non-Eff, Rolling – Puke, Apar	32.2	40.6 36.2	50	653.66 582.82
Eff, Rolling – Puke, Apar	2.1	43.0 38.6	50	45.15 40.53
Non effective area (laneways and tracks) – the losses from this area are accounted for in "other sources" below.	3.7			
Total block Nitrogen loss mitigated	**38.0**			**698.81** **623.35**
Plus reduction in other sources losses	38/265.7	589 593	50	42.12 42.40
Total farm Nitrogen loss mitigated				**740.93** **665.75**

The table below calculates the expected amount of nitrogen captured by the wetland. This has been updated following the Overseer version change. Updated figures are shown in red. The original figures are also shown for completeness. As there has been no change in the estimated Phosphorus losses at a block and other sources level, there is no change to the total loss mitigated.

Overseer block name	Area (ha)	OverseerFM estimated P loss (kgP/ha)	Reduction in P loss due to wetland (from David Moate's report) (%)	Total reduction (kgP) (Ha x kgP/ha x %)
Non-Eff, Rolling – Puke, Apar	32.2	2.14 2.14	48	33.08
Eff, Rolling – Puke, Apar	2.1	2.20 2.20	48	2.22
Non effective area (laneways and tracks) – the losses from this area are accounted for in "other sources" below.	3.7			
Total block Phosphorus loss mitigated	**38.0**			**35.3**
Plus reduction in other sources losses	38/265.7	114 114	48	7.83
Total farm Phosphorus loss mitigated				**43.13**

Therefore, it is predicted that the wetland will reduce nutrient losses from the proposed dairy system by 666kgN and 43kgP.

6.3 Cumulative effects of mitigations calculated outside of Overseer

Calculations outside of Overseer have been completed to quantify the impact of the baleage grass wintering and the wetland installation. The updated loss estimates are shown in the table below. Differences, as compared to Table 2 of this report are shown in red.

Table 3. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.0

	Total current	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11,881	11,434 *(11,656 modelled plus 444 baleage grass wintering minus 666 wetlands calculated outside OverseerFM)*	3.8% decrease
N Loss/ha (kgN/ha/yr)	45	43	
Total Farm P Loss (kg)	647	574 *(617 modelled minus 43 wetlands calculated outside OverseerFM)*	11.3% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note. These calculations have NOT been updated in light of the update in Overseer version.*

7.0 Conclusions:

A version change of Overseer has resulted in changes in the estimated losses of Nitrogen and Phosphorus.

Table 4. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.0

	Total current (same as above)	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11,881	11,434 *(11,656 modelled plus 444 baleage grass wintering minus 666 wetlands calculated outside OverseerFM)*	3.8% decrease
N Loss/ha (kgN/ha/yr)	45	43	
Total Farm P Loss (kg)	647	574 *(617 modelled minus 43 wetlands calculated outside OverseerFM)*	11.3% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

3. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
4. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note. These calculations have NOT been updated in light of the update in Overseer version.*

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File Note: Titipua Ltd Partnership – Wetland mitigation calculations

October 2021

1.0 Supporting information to this report:

This file note utilises information collected from the following sources:

- Overseer modelling of the proposed dairy system
- The wetland ideas report written by David Moate – former ES Land Sustainability
- The resource "constructed wetlands to reduce contaminant loss from pastoral farms"

These reports have been attached to this file note in the appendices.

2.0 Background

Titipua Ltd Partnership have applied for a consent to expand their dairy farm located in Southland. One of the proposed mitigations is to install a wetland on the property. During the consenting process, the applicant compiled information and sought expertise to design a wetland. Initially, this involved inviting former Environment Southland Land Sustainability officer David Moate to the property. David suggested possible locations for three wetlands. David's report is attached to this report in the appendices. Two of the three wetlands were later disregarded due to their proximity to an ES managed waterway. The third wetland location was deemed by the applicants and David Moate to be a good opportunity to mitigate losses.

The location of this wetland within the boundaries is shown in Figure 1. Figure 2 shows the location and size of the recommended wetland (in blue) and the wetland catchment area (green line). The area that will become the wetland is currently a duck pond and waste area.

Report disclaimer: This file note is intended to be read alongside the reports listed in section 1.0 of this report. Details of how the properties are operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement and industry benchmarks.

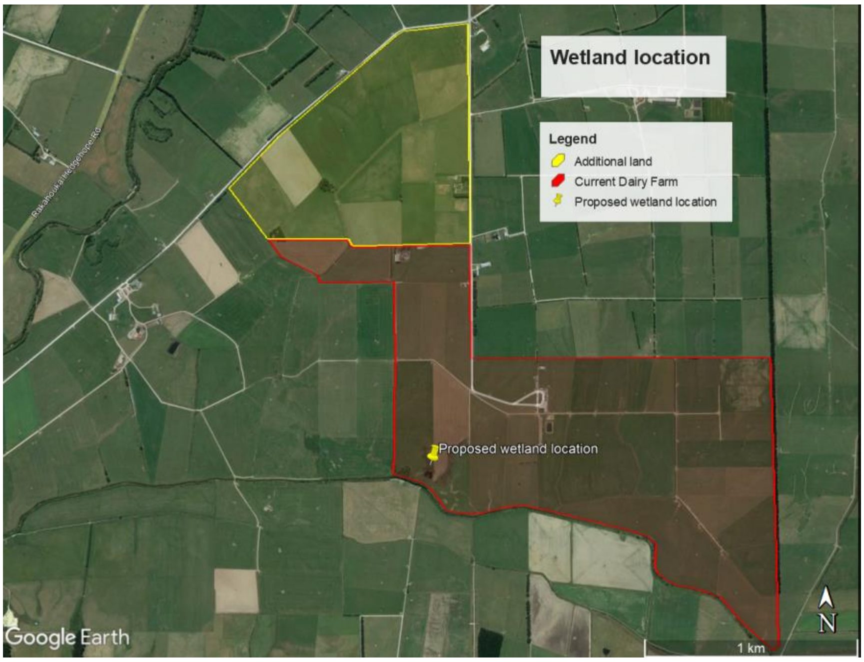


Figure 1. Farm boundaries and location of the proposed wetland.

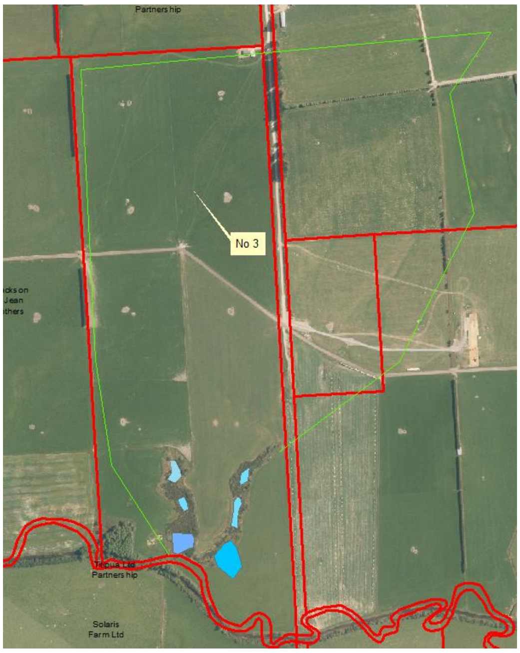


Figure 2. Schematic of the proposed wetland and catchment area - taken from David Moate's wetland ideas report.

David's report included information regarding the size of the wetland and the catchment, and the expected mitigation potential of the wetland. These were utilised in the original application to quantify the mitigation potential. Since then, it has become apparent that there were errors within this report regarding wetland catchment area and the mitigation efficiency of the wetland.

3.0 Purpose of this report:

This report seeks to update the calculations completed outside of Overseer considering the errors identified in the original calculations. This report will then be peer reviewed by a suitably qualified person to ensure the reductions calculated are feasible.

4.0 Proposed wetland location and design:

Farm location:	Hedgehope Block road, south of Hedgehope in Central Southland
Climate (Overseer):	Annual average temperature of 10.2-10.3°C
NIWA climate zone:	"Cool Zone" as defined by NIWA in the attached "Constructed Wetlands to Reduce Contaminant Loss from Pastoral Farms" resource.
Wetland location:	As per the pin on Figure 1
Wetland size:	2.2ha as per the blue areas shown in Figure 2
Catchment area:	44ha with 34ha of this within the Titipua Limited Partnership boundary. This is shown in Figure 3.
Wetland design:	As per the constructed wetland design recommendations in the attached "Constructed Wetlands to Reduce Contaminant Loss from Pastoral Farms" resource"

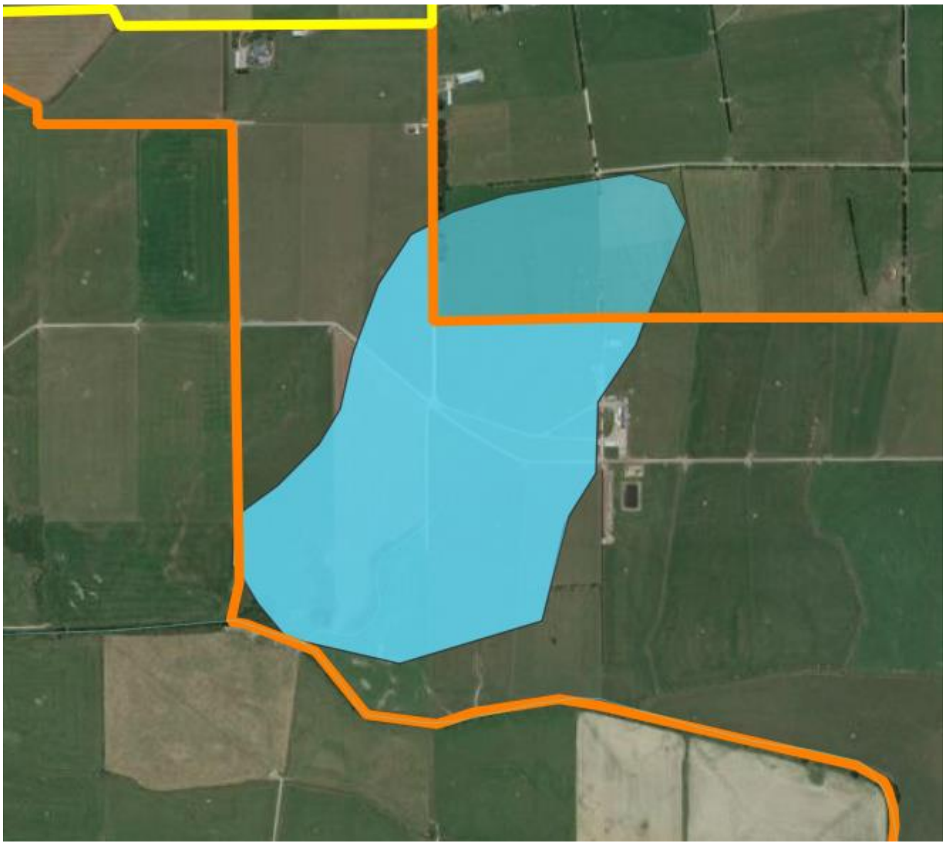


Figure 3. Catchment area of wetland. Orange line depict the property boundaries. Total wetland catchment area is 44ha with 34ha of this falling within the property boundary.

5.0 Estimated mitigation potential of the wetland

Calculations have been made outside of Overseer to estimate the mitigation potential of the wetland. These calculations utilise performance estimates from the resource "constructed wetlands to reduce contaminant loss from pastoral farms" shown below on the following page. The full report is given in the appendices of this report.

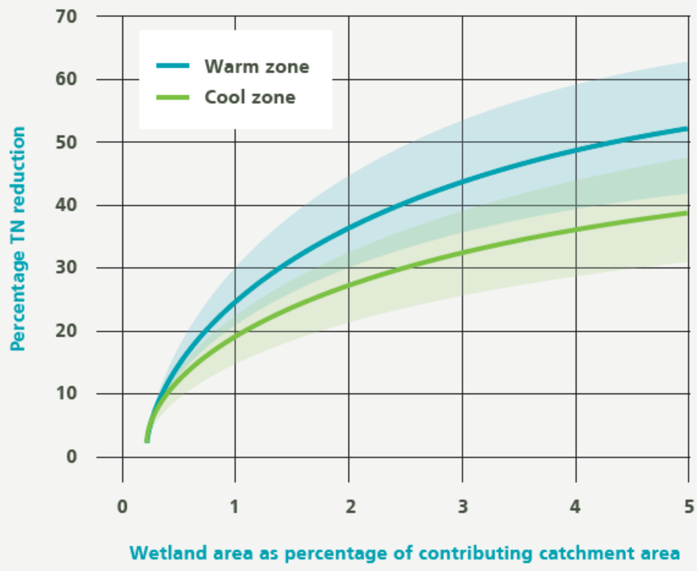


Figure 2: Long-term median annual Total Nitrogen (TN) reduction performance expectations. Performance is for appropriately constructed wetlands receiving surface run-off and drainage from pastoral farmland for warm (median annual temperature >12°C) and cool (median annual temperature 8-12°C) climatic zones in New Zealand and with catchment rainfall within NZ norms. Solid lines show expected medians for each zone; shaded areas show inter-annual and inter-site range of performance expected.

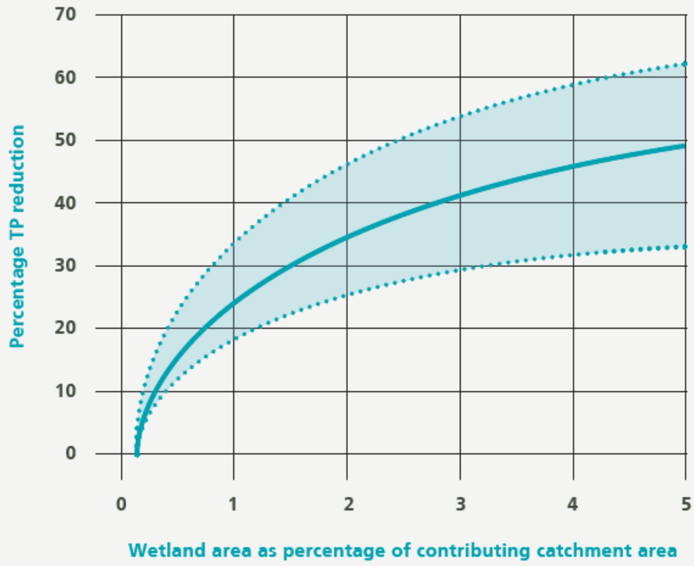


Figure 3: Long-term median annual Total Phosphorus (TP) reduction performance expectations. Performance is for appropriately constructed wetlands receiving surface run-off and drainage from pastoral farmland in New Zealand with catchment rainfall within NZ norms. Solid line shows expected median; shaded area shows inter-annual and inter-site range of performance expected. These predictions do not apply for constructed wetlands whose main source is subsurface drainage containing predominantly dissolved forms of phosphorus.

A wetland of 2.2ha in a catchment of 44ha is 5% of the contributing area.

Using the graphs above, at 5.0% of the catchment area, the proposed wetland is expected to mitigate the following losses:

- 38% reduction in total nitrogen lost with a range of 31-46%. This utilises the cool zone climate estimates which are for areas with a median average temperature of 8-12°C. Overseer estimates that the average temperature on the property is 10.2-10.3°C.
- 48% reduction in total Phosphorus with a range of 33-60%

6.0 Calculations outside of Overseer

Overseer has been utilised to estimate the per hectare losses from the catchment without a wetland present. These loss estimates are taken from the nitrogen summary, farm details report, and block details report. The proposed wetland captures water from two productive blocks within overseer as well as some non-effective area. The catchment area within the Titipua Limited Partnership property is 34ha. The calculations below do not account for the mitigation of losses that have originated on the neighbouring property.

Using the midpoint of the estimates given above, the table below has been created to calculate the amount of nitrogen expected to be mitigated by the wetland.

Table 1. Estimated nitrogen mitigation because of the wetland installation

Overseer block name	Area of block captured by wetland (ha)	OverseerFM estimated nitrogen leaching loss (version 6.4.1) (kgN/ha)	Reduction in N leaching due to wetland (estimated from wetland resource) (%)	Total reduction (Ha x kgN/ha x %) (kgN)
Non-Eff, Rolling – Puke, Apar	21.4	39.4	38	320.4
Eff, Rolling – Puke, Apar	9.1	36.0	38	124.5
Non effective area (laneways and tracks) – the losses from this area are accounted for in “other sources” below.	3.5			
Total block Nitrogen loss mitigated	**34.0**			**444.9**
Plus reduction in other sources losses	34/265.7	637	38	31.0
Total farm Nitrogen loss mitigated				**475.9**

Using the midpoint of the mitigation estimates given above, the table below has been created to calculate the amount of phosphorus expected to be mitigated by the wetland.

Table 2. Estimated phosphorus mitigation because of the wetland installation

Overseer block name	Area (ha)	OverseerFM estimated P loss (kgP/ha)	Reduction in P loss due to wetland (estimated from wetland resource) (%)	Total reduction (kgP) (Ha x kgP/ha x %)
Non-Eff, Rolling – Puke, Apar	21.4	2.14	48	22.0
Eff, Rolling – Puke, Apar	9.1	2.20	48	9.6
Non effective area (laneways and tracks) – the losses from this area are accounted for in “other sources” below.	3.5			
Total block Phosphorus loss mitigated	**34.0**			**31.6**
Plus reduction in other sources losses	34/265.7	115	48	7.1
Total farm Phosphorus loss mitigated				**38.7**

6.0 Conclusion

It is expected that the wetland will mitigate 38% of the nitrogen and 48% of the phosphorus losses from the catchment area. 34ha of the 44ha captured by the wetland are situated on the Titipua Ltd Partnership property. The wetland is expected to reduce nutrient loss from this 34ha by 476kgN and 39kgP.

Appendices

Appendix 1: David Moate – wetland ideas

Titipua Ltd Partners Wetland Ideas

No 1

- 9 Ha catchment
- 900m2 wetland = 1 % of the catchment that will remove 50% of sediment, 25% of N, 25% P

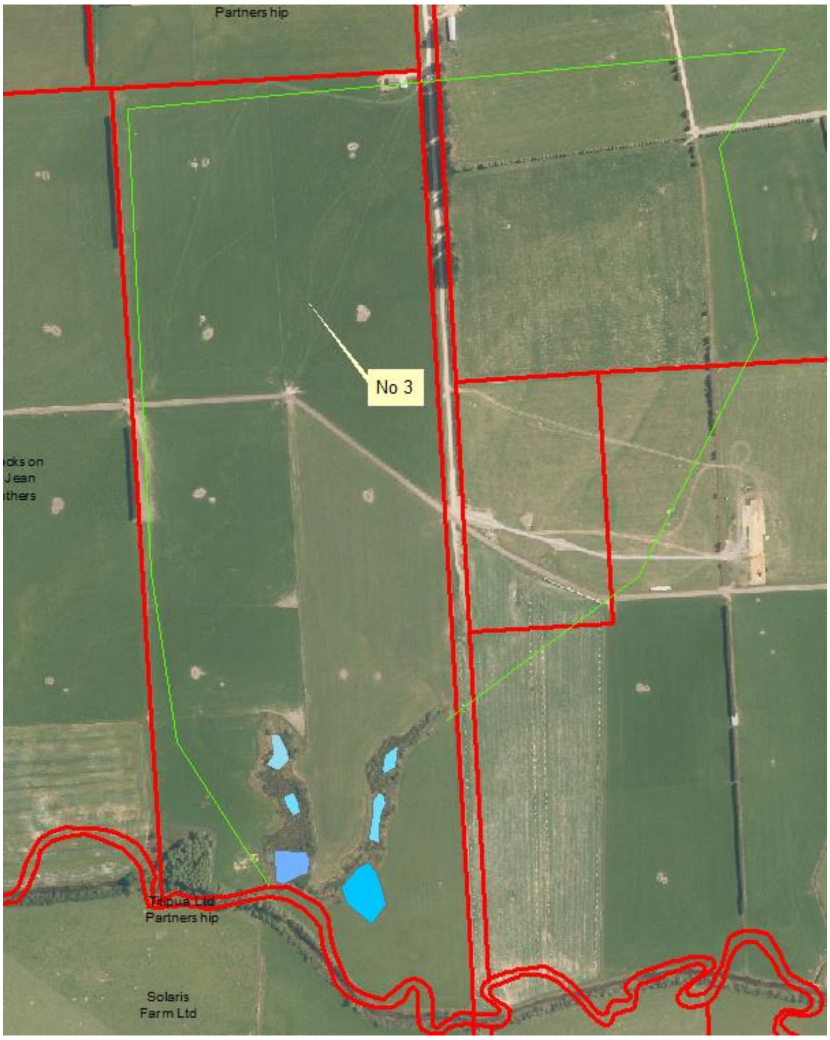
No 2

- 10 Ha catchment
- 1000m2 wetland = 1% of catchment that will remove 50% of sediment, 25% of N, 25% P

Design Features

- First half 0.5m deep to improve tile outfalls, collected sediment and kill bacteria
- Second half 0.3m deep planted heavily with Carex secta
- Banks can be planted in short plants for erosion control and aesthetics

- All 3 options do not require a resource consent



No 3

- 50 Ha
- 2.216 Ha wetland = 4.5% of the catchment that will remove 86% of sediment, 50% of N, 48% of P

Design Features

This existing area can be added too by creating more open water sections to store more water for longer allowing sunlight and wind to kill bacteria, sediment to be stored and N reduced. Open water areas created by bunds or digging out hollows. Make any overflows from earth not pipe and maybe lined with rock to prevent scouring in heavy rain events.

Main Creek

- Too risky trying to build anything in this waterway best to treat water before it gets there
- Permission required from ES catchment for nay planting
- Planting a row of Crow's nest or Tasman poplars or Moutere or Matsudana willow would benefit water quality and farm production and animal welfare
- For free Matsudana willow wands that only require a trim to length (1-1.2m) call Aaron Baird Otautau 021867522

Appendix 2: Constructed wetlands to reduce contaminant loss from pastoral farms

This is available at the following website:
https://niwa.co.nz/sites/niwa.co.nz/files/Summary%20of%20Constructed%20Wetland%20Guidelines%202020%20v2.pdf

Appendix 3: Overseer 6.4.1 outputs

Overseer estimates the per hectare losses from each block on the property. It also estimates losses from "other sources" which are losses that are expected to occur outside of the productive area (ie the ineffective area).

The table below shows the summary table of losses from Overseer for the proposed dairy farm scenario. The blocks that have areas captured by the wetland are highlighted:

Name	Area (ha)	N loss	N loss/ha	N surplus/ha	P loss	P loss/ha
Baleage grass - Schrama, rolling Puke Apar	3.2	106	33.2	426	6	1.9
Baleage grass - Schrama, rolling, Makar	0.4	10	24.2	539	0	1.7
Baleage/Grass - Non Eff, rolling, Makar	0.2	5	23.8	435	0	1.7
Baleage/grass - Eff, rolling, Puke Apar	4	149	37.2	430	8	2
Baleage/grass - Non Eff, Rolling, Puke Apar	2.2	73	33.2	464	5	2
Eff, Flat - Makar, Paro	2	52	26.4	195	2	0.7
Eff, Flat - Puke, Apar	7.2	243	33.8	181	6	0.8
Eff, Flat - Ymai	3.3	85	26	188	3	0.8
Eff, Rolling - Makar, Paro	2.3	63	29	195	5	2.1
Eff, Rolling - Puke, Apar	80.9	2,782	36	181	173	2.2
Non Eff, Flat - Makar, Paro	18.2	510	28	238	12	0.7
Non Eff, Flat - Ymai	2.8	80	29	238	2	0.8
Non Eff, Rolling - Makar	4.1	119	30.4	248	8	2
Non Eff, Rolling - Puke, Apar	47.3	1,772	39.4	231	97	2.14
Non eff, Rolling - Makar, Paro	0.5	15	29.4	238	1	2
Schrama, Non Eff, Rolling - Puke, Apar	68	2,132	32.6	180	141	2.1
Schramas, Non Eff, Rolling Makar	8.9	207	24.4	178	17	2
Fodder beet	10	2,028	203	168	24	2.4
Pond and Wetland	1.9	6	3	0	0	0.1
Other sources	-	637	-	-	115	-

LANDPRO
Make the most of your land

Project Memorandum

4 December 2021

Landpro Reference: 20544
Council Reference: APP-20211092

To: Matilda Ballinger

From: Andrea Richardson

Subject: Titipua Ltd Partnership - Review of Wetland Mitigation

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1. Technical Review Details

Review Scope	Technical review of the wetland mitigation calculations for estimated total nitrogen and total phosphorus mitigation in the document "Titipua Ltd Partnership – Wetland mitigation calculations (October 2021) by AgriAce Consulting Limited.
Applicant	Titipua Limited Partnership
Physical Address	354 Hedgehope Block Road, Hedgehope, Southland
Reference Documents	- AgriAce Consulting Limited. (2021). *File Note: Titipua Ltd Partnership – Wetland mitigation calculations.* - Resource Consent Application to Environment Southland – Prepared for Titipua Limited Partnership (10 May 2021) - NIWA. (2021). *Technical guidelines for constructed wetland treatment of pastoral farm run-off* (NIWA Client Report 20200208.120200208.1HN). - NIWA (n.d.) *Constructed wetland guidelines*. https://niwa.co.nz/freshwater-and-estuaries/management-tools/restoration-tools/constructed-wetland-guidelines
Date of Site Visit	No site visit undertaken for this technical review
Limitations	The review is limited to the wetland mitigation calculations described in the AgriAce Consulting Limited document. The review does not extend to the appropriateness or accuracy of the Overseer modelling.

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2. Location of wetland

The NIWA 2021 Report[1] states that the highest contaminant reductions will generally be achieved by targeting areas of elevated contaminant discharge and by maximising the proportion of discharge able to be captured. Constructed wetlands are often best located in natural swales, depressions and gullies that provide the dominant pathways for water flow (and associated contaminant loads). These areas also provide suitable landforms to contain the wetland with minimal excavation and earthmoving.

The general location of the proposed wetland complex is shown in Figure 1 of the AgriAce Report. Figure 2 of the Report shows that the wetlands will be constructed within two main depressions, each with three connected wetlands (a total of six within the wetland complex). The contributing catchment area to this constructed wetland complex is shown in Figure 3 of the Report.

Aerial photos show that the proposed wetland area is within two existing vegetated depressions downslope of natural swales. The wetland area is within 200 m of Titipua Stream, approximately 20m at its closest point at the southern end, and any surface water runoff would flow towards Titipua Stream. As the proposed wetland complex is at the base of ephemeral watercourses (the natural swales), I consider the location is suitable to intercept run-off and drainage flows in the pastoral catchment and discharge any surface flows into the stream.

The Tiaki Farm Environment Plan (attached to the Consent Application) recommends that Titipua Limited Partnership develop a subsurface tile drainage map. I recommend that the applicant considers diverting the discharges from these drains into the constructed wetland (where appropriate) to expand the contributing wetland catchment area.

3. Size of wetland

Generally, contaminant reduction efficacy increases as constructed wetland area increases, but subject to gradually diminishing returns. Wetlands intercepting agricultural runoff and drainage flows need to be between 1% and 5% of their contributing catchment to significantly reduce contaminant loads. The wetland sizes proposed refer to the actual wetted area under normal flows. They do not include the additional areas required for embankments or marginal plantings. Wetlands smaller than this will provide insufficient residence time to enable contaminant reduction and, unless they have a high flow bypass, will be frequently overwhelmed by stormflows.[1]

The AgriAce Report estimates the contributing catchment area to this wetland complex is 44 ha, of which 34 ha is within the Titipua Ltd Partnership property. The extent of the estimated wetland catchment is shown in Figure 3 the Report. I consider that the outline of the estimated catchment area is appropriate based on aerial photos and contour maps.

[1] NIWA. (2021). *Technical guidelines for constructed wetland treatment of pastoral farm run-off*

For a total contributing catchment area of approximately 44 ha, the recommended (NIWA, 2021) size of the wetted area of the constructed wetland equates to 0.44 to 2.2 ha (i.e., 1-5% of the catchment). Accordingly, the proposed wetland size of 2.2 ha is appropriate, noting that the actual wetted area of the constructed wetland complex under normal flows may be slightly smaller but still within the NIWA wetland sizing recommendations.

4. Predicted wetland contaminant reduction

The NIWA 2021 Report states that the performance of constructed wetlands depends to a large extent on the retention time of water within the wetland. This is influenced by the size of the wetland relative to its inflow, and how uniform the flow is as it passes through the wetland. The evenness or efficiency of flow distribution through the wetland is primarily determined by its internal design and distribution of emergent vegetation. In general, to maximise nutrient reduction it is important to maintain the majority of the wetland in shallow planted zones for microbial/plant induced attenuation. Deeper zones target sediment removal and promote an even flow distribution. Nutrient reduction processes are also affected by temperature, so performance will vary seasonally and for different climatic regions.

Sections 4 and 5 of the AgriAce Report specifies the percentage total nitrogen and total phosphorus reductions for a wetland area that is 5.0% of the contributing catchment area. I note that these percentage reduction figures are based on the assumption that the actual wetted area of the constructed wetland under normal flows will be 2.2 ha, and that areas taken up by any associated bunds, embankments and riparian plantings are additional.

I agree with the figures provided in the AgriAce Report for the expected long-term performance estimates for reduction of total nitrogen by a well-constructed and maintained wetland, being 38% reduction in total nitrogen lost with a range of 31-46%. Based on the NIWA 2021 Report, the figures for 'cool zones' are relevant to the subject site. However, it is reasonable to expect that the impacts of climate change in Southland[2] may result in the performance estimates for 'warm zones' (median annual air temperatures above 12 degrees Celsius) being more relevant in future years. Nitrogen reduction rates generally increase as temperature increases, meaning that the percentage nitrogen losses achieved by the proposed wetland complex may increase over time.

I also agree with the expected percentage total phosphorus reduction figures for an appropriately constructed wetland stated in the AgriAce Report, being 48% reduction in total Phosphorus with a range of 33-60%. The performance predictions for total phosphorus do not apply for constructed wetlands whose main source is sub-surface drainage containing predominantly dissolved forms of phosphorus, or where soils comprise ≥35% clay. The sub-surface drain locations have not been

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[2] Ministry for the Environment (2018, 31 May). *Climate change projections for the Southland region*. https://environment.govt.nz/facts-and-science/climate-change/impacts-of-climate-change-per-region/projections-southland-region/#temperature

provided with the documentation, so I assume that the main source of runoff is from the ephemeral waterway.

Kind Regards

Andrea Richardson

Position: Landpro Senior Planner

Relevant qualifications: Bachelor of Engineering (Honours, Civil)

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File Note: Titipua Ltd Partnership – Additional mitigation strategies

October 2021

1.0 Supporting information to this report:

This file note is not a standalone report. It is intended to be read in conjunction with:

- The Overseer modelling report dated 23rd March 2021 titled "Titipua Ltd Partnership – OverseerFM farm system modelling to support a consent application for expanded dairy".
- The File Note, dated June 2021 titled "File Note: Titipua Ltd Partnership – Pasture grown"
- The File Note, dated September 2021 titled "File Note: Titipua Ltd Partnership – Overseer version change"
- Titipua Ltd Partnership – Wetland mitigation calculations (Oct 2021)
- Landpro Project Memorandum written by Andrea Richardson (Nov 2021)

These reports have been attached to this file note.

2.0 Purpose of this report:

The applicant (Titipua Ltd Partnership) has instructed further modelling be undertaken following a decision to install a 200cow herd home on the property. Updates to the calculations outside of Overseer have also been completed to ensure continuity of the application and to address concerns raised by the consenting officers in the notification report.

3.0 Previously modelled losses as per file note dated September 2021:

In the most recent file note, dated September 2021, the nutrient losses were quantified under Overseer version 6.4.0. These were shown in Tables 3 and 4 of that report, and are repeated below:

Table 1. Estimated nitrogen and phosphorus losses from the current system using Overseer version 6.4.0 as per file note dated September 2021

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	10,196	1,685	11,881
N Loss/ha (kgN/ha/yr)	56	20	45
Total Farm P Loss (kg)	456	191	647
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

Table 2. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.0 as per file note dated September 2021

	Total current	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11,881	11,434 *(11,656 modelled plus 444 baleage grass wintering minus 666 wetlands calculated outside OverseerFM)*	3.8% decrease
N Loss/ha (kgN/ha/yr)	45	43	
Total Farm P Loss (kg)	647	574 *(617 modelled minus 43 wetlands calculated outside OverseerFM)*	11.3% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note.*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note.*

Since then, there has been another Overseer version change to 6.4.1. This version update introduces changes to some crops and added several new crop type options. These changes have not had any effect on the losses estimated from the Titipua Ltd Partnership models as this property does not have any of the relevant crop types.

4.0 Updated modelling to include a herd home

Titipua Ltd Partnership have recently decided to install a herd home. This herd home will be able to winter 200cows and will also be used in the shoulders of the season as a feed pad. The Titipua Ltd Partnership group expect that this herd home will allow for better pasture management and supplementary feed utilisation in wet conditions. It will also enable the management team to manage a greater proportion of the cow effluent. The herd home will be built in early 2022 and will be utilised from winter 2022 onwards.

The inclusion of the herd home requires addition modelling to be completed. The changes to the system are explained in detail below.

4.1 Overseer modelling input restriction

Overseer has a data entry restriction for off paddock structures. Overseer allows only one of each structure type to be entered into the model. The structure types and a brief description are given below:

- Wintering pad/shelter

A wintering pad or animal shelter is a specially constructed area where animals are withheld from pasture for extended periods and supplementary feeds are brought to them.

- Feed pad
  A feed pad is a hard surface area (usually concrete) normally sited adjacent to the farm dairy where stock can be held for some time, either prior to or after milking, and provided with supplementary feed.
- Stand off pad
  A stand-off or loafing pad is a specially built area where stock can be withheld from grazing during wet periods to minimise damage to pasture. There is no provision for stock feeding while the animals are on the pad.

In the modelling completed to date, the calving pad has been modelled as an Uncovered "Wintering pad". However, with the inclusion of the Herd Home in the proposed system, it is recommended to remodel the calving pad as a "Feed pad" (in both the current and proposed systems) and model the herd home as a Covered "Wintering Pad".

The table below shows the input data used in the modelling of the calving pad to date. Changes in red have been made to the models to allow for the addition of the Herd Home in the proposed system:

Table 3. Details of changes made to the current and proposed calving pad inputs to allow for the herd home to be modelled in the proposed system.

Calving Pad	**Current System**	**Proposed system**
	Uncovered calving pad Feed pad Carbon rich surface (bark) Concrete base Lined Management: All animals on for24hrs/day 12hrs/day Aug – 19% of animals (98 cows) 38% of animals (196 cows) Sep – 12% of animals (61 cows) 24% of animals (122 cows) Oct – 2% of animals (10 cows) 4% of animals (20 cows) Effluent: Liquid effluent added to farm effluent system Solids are spread on the non effluent blocks in December	Uncovered calving pad Feed pad Carbon rich surface (bark) Concrete base Lined Management: All animals on for24hrs/day 12hrs/day Aug – 19% of animals (118 cows) 38% of animals (236 cows) Sep – 12% of animals (73 cows) 24% of animals (146 cows) Oct – 2% of animals (12 cows) 4% of animals (24 cows) Effluent: Liquid effluent added to farm effluent system Solids are spread on the non effluent blocks in December

Please note, Overseer does not allow cows to be on a feed pad for 24hrs/day. Therefore, the number of cows on the structure has been doubled and the hours per cow has been halved to ensure that the total hours spent on the structure are the same

4.2 Additional changes to the proposed system

The addition of a herd home will cause downstream changes to how the system is operated in future. A table detailing all of the data inputs has been given in the appendices. Below is a list of inputs that have changed as a result of the inclusion of the herd home:

- Remodel "calving pad" as a "feed pad" as per the explanation above

- Add in a Covered wintering structure
- Reduce Fodder beet planted from 12ha to 10ha.
- Increase imported feed of PKE and DDG
- Harvest less baleage (54TDM less) but more silage (323TDM)
- Updated maintenance fertiliser requirements

4.3 Modelling results

The table below shows the modelling results. Where a value has been changed compared to tables 1 and 2 of this report, this has been shown in red. Please note that the adjustments outside of Overseer have not been updated.

Table 4. Estimated nitrogen and phosphorus losses from the current system using Overseer version 6.4.1

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	10,349	1,685	12,034
N Loss/ha (kgN/ha/yr)	57	20	45
Total Farm P Loss (kg)	458	191	649
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

Table 5. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.1

	Total current	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	12,034	10853 *(11,075 modelled plus 444 baleage grass wintering minus 666 wetlands calculated outside OverseerFM)*	9.8% decrease
N Loss/ha (kgN/ha/yr)	45	41	
Total Farm P Loss (kg)	649	580 *(623 modelled minus 43 wetlands calculated outside OverseerFM)*	10.6% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note.*

5.0 Updating the outside of Overseer calculations

The proposed system estimated losses included the use of calculations outside of Overseer. These calculations have been recalculated below utilising information from Overseer version 6.4.1.

6.1 Baleage grass wintering:

As explained in the March 2021 report *“OverseerFM is likely to underestimate nitrogen losses as OverseerFM is not able to adequately reflect the on-farm realities of this system. OverseerFM assumes that the pasture plants will regrow post grazing and take up urinary N from the wintering activity. However, due to the soil type and climate on the applicant’s property, the plants are not viable following the winter grazing. As a result, the area is cultivated and regrassed in spring. I am unaware of any research that has quantified the impact of baleage grass wintering in terms of nitrate and phosphorus loss. I have therefore completed a desktop modelling exercise that attempts to estimate the nutrient losses from this system more accurately.”*

In the March 2021 report, I explained that I had created an Overseer file that showed the baleage grass area as a very low yielding kale crop. This allowed me to add a defoliation and regrassing event to Overseer and ensured that overseer would assume no uptake of urinary N between grazing of the crop and the resowing of the pasture. Further details on how this was modelled can be found in the March 2021 report in section 4.2.1. I have undertaken the same modelling process and rerun the same calculation following the inclusion of the herd home. The results are summarised in the tables below:

Table 6. Total nitrogen losses for the kale or baleage/grass area (10ha)

	OverseerFM version 6.4.1 (No herdhome) *Taken from file note Sept 2021*	OverseerFM version 6.4.1 (Including a herdhome)
Pasture baleage system	433	343
Kale system	877	924
Difference	444kgN higher loss in the Kale system	581kgN higher loss in the Kale system

Feedback from Environment Southland in the recommending report noted that they would have liked to see an adjustment for phosphorus as well as nitrogen in the loss calculations. This had been omitted as the losses under kale were estimated to be lower than under the baleage grass system and therefore a conservative approach was taken. However, for completeness, the calculation is shown below. The same methodology has been utilised for Phosphorus as described above and in previous reports for Nitrogen.

Table 7. Total phosphorus losses for the kale or baleage/grass area (10ha)

	OverseerFM version 6.4.1 (No herdhome)	OverseerFM version 6.4.1 (Including a herdhome)
Pasture baleage system	19	19
Kale system	14	14
Difference	5kgP lower loss in the Kale system	5kgP lower loss in the Kale system

Therefore, it is predicted that the losses from the grass baleage wintering system will be 581kgN higher and 5kg P lower than estimated in the OverseerFM Proposed scenario.

6.2 Installation of a wetland

As per the file note "Titipua Ltd Partnership – Wetland mitigation calculations (Oct 2021)" and the subsequent peer review by Andrea Richardson of Landpro (both attached as Appendices), the proposed wetland is expected to mitigate the loss of 476kg N and 39kg P per annum.

6.3 Cumulative effects of mitigations calculated outside of Overseer

Calculations outside of Overseer have been completed to quantify the impact of the baleage grass wintering and the wetland installation. The updated loss estimates are shown in the table below. Differences, as compared to Table 5 of this report are shown in red.

Table 8. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.1

	Total current	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	12,034	11,180 *(11,075 modelled plus 581 baleage grass wintering minus 476 wetlands calculated outside OverseerFM)*	7.1% decrease
N Loss/ha (kgN/ha/yr)	45	42	
Total Farm P Loss (kg)	649	579 *(623 modelled minus 5 baleage grass wintering minus 39 wetlands calculated outside OverseerFM)*	10.8% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note. Updates to these calculations are explained within this report.*

7.0 Conclusions:

The further modelling requested by the applicant has resulted in changes in the estimated losses of Nitrogen and Phosphorus.

Table 9. Estimated nitrogen and phosphorus losses from the current system using Overseer version 6.4.1

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	10349	1,685	12,034
N Loss/ha (kgN/ha/yr)	57	20	45
Total Farm P Loss (kg)	458	191	649
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

Table 10. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.1

	Total current	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	12,034	11,180 *(11,075 modelled plus 581 baleage grass wintering minus 476 wetlands calculated outside OverseerFM)*	7.1% decrease
N Loss/ha (kgN/ha/yr)	45	42	
Total Farm P Loss (kg)	649	579 *(623 modelled minus 5 baleage grass wintering minus 39 wetlands calculated outside OverseerFM)*	10.8% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note. Updates to these calculations are explained within this report.*

Appendix 1: Detailed Nutrient Budget Assumptions

A detailed description of modelling inputs is shown below for the budgets included in Oct 2021 File note modelling.

Changes from the file note (dated September 2021) are shown in red. Original modelling inputs are shown in black

<table>
<tr><th>Description</th><th>Current Dairy Farm</th><th>Current Schrama's Block</th><th>Proposed Dairy platform</th></tr>
<tr><td>Area</td><td>Total: 181.5ha (as per LINZ website)
Productive farm area: 175.0ha</td><td>Total: 84.2ha (excluding the 3ha lifestyle block)
Productive farm area: 80.5ha</td><td>Total: 265.7ha
Productive farm area: 255.5ha</td></tr>
<tr><td>Dairy cows (note: cow numbers refer to those on farm on the last day of the month)</td><td>Production: 212,000kgMS (424kgMS/cow at peak)

Mean calving date: 25 Aug
Dry off date: 28 May

<table>
<tr><td>Month</td><td>Dairy Herd – Friesian
Default LWT used</td></tr>
<tr><td>Jul</td><td>315</td></tr>
<tr><td>Aug</td><td>515</td></tr>
<tr><td>Sep</td><td>508</td></tr>
<tr><td>Oct</td><td>500</td></tr>
<tr><td>Nov</td><td>500</td></tr>
<tr><td>Dec</td><td>500</td></tr>
<tr><td>Jan</td><td>500</td></tr>
<tr><td>Feb</td><td>500</td></tr>
<tr><td>Mar</td><td>485</td></tr>
<tr><td>Apr</td><td>485</td></tr>
<tr><td>May</td><td>440</td></tr>
<tr><td>Jun</td><td>315</td></tr>
</table>

Breeding bulls: 8 Jerseys, Dec and Jan</td><td>NA</td><td>Production: 254,400kgMS (424kgMS/cow at peak)

Mean calving date: 25 Aug
Dry off date: 28 May

<table>
<tr><td>Month</td><td>Dairy Herd - Friesian
Default LWT used</td></tr>
<tr><td>Jul</td><td>620</td></tr>
<tr><td>Aug</td><td>620</td></tr>
<tr><td>Sep</td><td>610</td></tr>
<tr><td>Oct</td><td>600</td></tr>
<tr><td>Nov</td><td>600</td></tr>
<tr><td>Dec</td><td>600</td></tr>
<tr><td>Jan</td><td>600</td></tr>
<tr><td>Feb</td><td>580</td></tr>
<tr><td>Mar</td><td>550</td></tr>
<tr><td>Apr</td><td>520</td></tr>
<tr><td>May</td><td>490</td></tr>
<tr><td>Jun</td><td>480</td></tr>
</table>

Breeding bulls: 9 Jerseys Dec and Jan

Note: earlier culling in proposed system</td></tr>
</table>

<table>
<tr><th>Description</th><th>Current Dairy Farm</th><th>Current Schrama’s Block</th><th>Proposed Dairy platform</th></tr>
<tr><td>Beef calves and replacements</td><td>Calves are reared on farm until early January. The dairy replacements are then grazed at a third-party grazier until their return as in calf heifers in late July (18 months later). The beef type calves are sold.

<table>
<tr><th></th><th>Dairy Calves
Breed: Friesian
Age: 1month</th><th>Beef Calves
Breed: Beef type</th></tr>
<tr><td>Jul</td><td></td><td></td></tr>
<tr><td>Aug</td><td>78</td><td>15</td></tr>
<tr><td>Sep</td><td>130</td><td>30</td></tr>
<tr><td>Oct</td><td>130</td><td>30</td></tr>
<tr><td>Nov</td><td>130</td><td>30</td></tr>
<tr><td>Dec</td><td>130</td><td>30</td></tr>
</table></td><td>NA</td><td>Calves are reared on farm and remain on farm until May 1st. The dairy replacements are then grazed at a third-party grazier until their return as in calf heifers in May (12 months later).

<table>
<tr><th></th><th>Dairy Calves
Breed: Friesian
Age: 1month</th><th>In calf heifers
Breed: Friesian
Age: 22months</th></tr>
<tr><td>Jul</td><td></td><td></td></tr>
<tr><td>Aug</td><td>9694 (mistake in original report)</td><td></td></tr>
<tr><td>Sep</td><td>156</td><td></td></tr>
<tr><td>Oct</td><td>156</td><td></td></tr>
<tr><td>Nov</td><td>156</td><td></td></tr>
<tr><td>Dec</td><td>156</td><td></td></tr>
<tr><td>Jan</td><td>156</td><td></td></tr>
<tr><td>Feb</td><td>156</td><td></td></tr>
<tr><td>Mar</td><td>156</td><td></td></tr>
<tr><td>Apr</td><td>156</td><td></td></tr>
<tr><td>May</td><td></td><td>140</td></tr>
<tr><td>Jun</td><td></td><td>140</td></tr>
</table>
Note: Change in young stock policy and removal of beef stock reared.</td></tr>
<tr><td>Sheep</td><td>NA</td><td>Modelled as an average “class 7, S.I. Finishing Otago/Southland” property using benchmarking data from Beef and Lamb NZ. The report is attached to this document.

Lambing percentage: 137%

Breed: Coopworth</td><td>NA</td></tr>
</table>

<table>
<tr><th>Description</th><th>Current Dairy Farm</th><th>Current Schrama's Block</th><th>Proposed Dairy platform</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th></th><th>Ewes</th><th>Hoggets</th><th>Rams</th><th>Lambs</th></tr>
<tr><td>Jul</td><td>577</td><td>218</td><td>16</td><td></td></tr>
<tr><td>Aug</td><td>577</td><td>218</td><td>16</td><td></td></tr>
<tr><td>Sep</td><td>562</td><td>208</td><td>16</td><td></td></tr>
<tr><td>Oct</td><td>562</td><td>208</td><td>16</td><td></td></tr>
<tr><td>Nov</td><td>547</td><td>208</td><td>16</td><td>1002</td></tr>
<tr><td>Dec</td><td>547</td><td>208</td><td>16</td><td>868</td></tr>
<tr><td>Jan</td><td>532</td><td>208</td><td>16</td><td>738</td></tr>
<tr><td>Feb</td><td>532</td><td>208</td><td>16</td><td>608</td></tr>
<tr><td>Mar</td><td>521</td><td>208</td><td>16</td><td>478</td></tr>
<tr><td>Apr</td><td>521</td><td>208</td><td>16</td><td>348</td></tr>
<tr><td>May</td><td>379</td><td>198</td><td>16</td><td>218</td></tr>
<tr><td>Jun</td><td>379</td><td>198</td><td>16</td><td>218</td></tr>
</table>

Greasy wool: 4650kg</td><td></td></tr>
<tr><td>In shed feeding</td><td>100% of herd fed inshed Aug – May</td><td>NA</td><td>100% of herd fed inshed Aug – May</td></tr>
<tr><td>Structures</td><td>Current System
Uncovered calving pad Feed pad
Carbon rich surface (bark) Concrete base
Lined

Management:
All animals on for24hrs/day 12hrs/day
Aug – 19% of animals (98 cows)
38% of animals (196 cows)
Sep – 12% of animals (61 cows)
24% of animals (122 cows)
Oct – 2% of animals (10 cows)
4% of animals (20 cows)

Effluent:
Liquid effluent added to farm effluent system</td><td>NA</td><td>Calving Pad
Uncovered calving pad Feed pad
Carbon rich surface (bark) Concrete base
Lined

Management:
All animals on for24hrs/day 12hrs/day
Aug – 19% of animals (118 cows)
38% of animals (236 cows)
Sep – 12% of animals (73 cows)
24% of animals (146 cows)
Oct – 2% of animals (12 cows)
4% of animals (24 cows)

Effluent:
Liquid effluent added to farm effluent system</td></tr>
</table>

Description	Current Dairy Farm	Current Schrama's Block	Proposed Dairy platform
	Solids are spread on the non effluent blocks in December		Solids are spread on the non effluent blocks in December **Herd Home** Covered wintering shelter No lining material Management: Utilised in the shoulders of the season to feed supplements to milking cows and utilised as a wintering facility through June and July May – 100% (490) animals, 2hrs/day, June – 42% (200) animals, 24hrs/day July – 32% (200) animals, 24hrs/day August – 50% (310) animals, 2hrs/day September – 50% (305) animals, 2hrs/day
Animal distribution	No difference between blocks	No difference between blocks	No difference between blocks
Crop management	Fodder Beet 12ha planted 22TDM/ha yield Rotating through the "rolling" pasture blocks Planted in Nov – conventional cultivation 200kg/ha Cropzeal Boron boost at sowing 500kg/ha Fodder beet base at sowing 120kg/ha sustaiN applied in Jan Grazed in May and Sep for 2hr, and wintered on in June, Jul, Aug 24hrs/day. Sown into permanent pasture in October	Swedes 5.4ha planted (average as seen on Google earth) 12TDM/ha yield Rotating through the pasture blocks Planted in Dec – Conventional cultivation 325kg/ha Cropzeal boron boost at sowing 70kg/ha MOP at sowing 100kg/ha N-rich Urea in February Grazed in Jun, Jul, Aug (24hrs/day) Sown into permanent pasture in November	All cows are wintered on farm, on either Fodder Beet or a Baleage/Grass system or in the herd home as described above Fodder Beet 12ha planted 10ha planted 22TDM/ha yield Rotating through the "rolling" pasture blocks Planted in Nov – conventional cultivation 200kg/ha Cropzeal Boron boost at sowing 500kg/ha Fodder Beet Base mix at sowing 120kg/ha of SustaiN applied in Jan Grazed in May and Sep for 2hr, and wintered on in June, Jul, Aug 24hrs/day. Sown into permanent pasture in October

Description	Current Dairy Farm	Current Schrama's Block	Proposed Dairy platform
			10ha Baleage/Grass wintering This area rotates around the "rolling" pasture blocks. 205TDM baleage is fed out in paddock throughout the winter. The paddocks are then regrassed following the winter *Note: OverseerFM is not able to effectively model a Southland Baleage Grass wintering system. This block has therefore been modelled as a pastoral block and an adjustment to expected losses has been calculated outside of OverseerFM*
Imported Supplements	Silage – 150tDM fed in paddock and on feed pad Hay – 13TDM fed on feed pad PKE – 200TDM fed in shed DDG – 130TDM fed in shed Baleage – 120TDM fed on the crop	None	PKE – 265TDM 290TDM fed in shed DDG – 175TDM 195TDM fed in shed
Exported supplements	None	None	None
Harvested supplements	Hay – 17TDM fed on the pad Baleage – 24TDM fed on the crop	None	Hay – 36TDM fed on the feed pad Baleage – 144TDM 90TDM fed on the Fodder beet Baleage – 205TDM fed on the baleage grass wintering paddocks Silage – 48TDM fed on the pad and 323TDM fed in the herd home
Soil Fertility	Soil tests were completed in July 2019 Olsen P of 34 QT K of 7 QT Ca of 9 QT Mg of 17	Soil tests were completed in November 2019 Olsen P of 34 QT K of 9 QT Ca of 9 QT Mg of 17	Soil fertility would be targeted at agronomic optimum Olsen P of 30 QT K of 7 QT Ca of 9

Description	Current Dairy Farm	Current Schrama's Block	Proposed Dairy platform
	QT Na of 6 SO_4 of 13	QT Na of 9 SO_4 of 13	QT Mg of 17 QT Na of 6 SO_4 of 13
Fertiliser	Fertiliser applied to maintenance level. Total P applied – 5,380kg Total K applied – 814kg Total S applied – 3,642kg	Fertiliser applied to maintenance level. Total P applied – 2,070kg Total K applied – 357kg Total S applied – 1,2750kg	Fertiliser applied to maintenance level. Total P applied – 7,728kg 7108kg Total K applied – 7,222kg 6066kg Total S applied – 5,855kg 5280kg
Pastoral Nitrogen Fertiliser	239kgN/ha was applied to the pasture area in split application between Sep and Apr	Taken from fertiliser purchase records 18kg/ha N applied in March	Non Effluent paddocks – 175kgN/ha applied in split applications from Sep – Apr Effluent paddocks – 154kgN/ha applied in split applications from Sep to Apr *Note: No nitrogen fertiliser applied to the baleage grass paddocks in April prior to wintering on them*
Drainage	50% of the property is drained using mole and tile drainage	50% of the property is drained using mole and tile drainage	50% of the property is drained using mole and tile drainage
Effluent system	Holding pond – solids are separated Effluent is applied using a cobra rain gun at an application depth of 12-24mm Liquid effluent is applied to the "eff" blocks Solids are spread on the Non effluent blocks when conditions allow (usually December)	NA	Holding pond – solids are separated Effluent is applied using a cobra rain gun at an application depth of 12-24mm Liquid effluent is applied to the "eff" blocks Solids are spread on the Non effluent blocks when conditions allow (modelled as December)

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File Note: Titipua Ltd Partnership – Updating OverseerFM outputs to version 6.4.2

March 2022

1.0 Supporting information to this report:

This file note is not a standalone report. It is intended to be read in conjunction with:

- The Overseer modelling report dated 23rd March 2021 titled "Titipua Ltd Partnership – OverseerFM farm system modelling to support a consent application for expanded dairy".
- The File Note, dated June 2021 titled "File Note: Titipua Ltd Partnership – Pasture grown"
- The File Note, dated September 2021 titled "File Note: Titipua Ltd Partnership – Overseer version change"
- Titipua Ltd Partnership – Wetland mitigation calculations (Oct 2021)
- Landpro Project Memorandum written by Andrea Richardson (Nov 2021)
- The File Note, dated October 2021 titled "File Note: Titipua Ltd Partnership – Additional mitigation strategies"

These reports have been attached to this file note.

2.0 Purpose of this report:

Since the File note dated October 2021 titled "File Note: Titipua Ltd Partnership – Additional mitigation strategies" was written, there has been a new version of OverseerFM released – 6.4.2. Environment Southland have requested that the OverseerFM models for the Titipua Limited Partnership be rerun under the new version, and the results be presented. The calculations outside of Overseer have also been updated to ensure continuity of the application.

3.0 Previously modelled losses as per file note dated October 2021:

In the most recent file note, dated October 2021, the nutrient losses were quantified under Overseer version 6.4.1. These were shown in Tables 9 and 10 of that report, and are repeated below:

Table 1. Estimated nitrogen and phosphorus losses from the current system using Overseer version 6.4.1 (as per file note dated October 2021)

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	10349	1,685	12,034
N Loss/ha (kgN/ha/yr)	57	20	45
Total Farm P Loss (kg)	458	191	649
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

Report disclaimer: This file note is intended to be read alongside the reports listed in section 1.0 of this report. Details of how the properties are operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement and industry benchmarks.

Table 2. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer (as per file note dated October 2021). This modelling utilises Overseer version 6.4.1

	Total current	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	12,034	11,180 *(11,075 modelled plus 581 baleage grass wintering minus 476 wetlands calculated outside OverseerFM)*	7.1% decrease
N Loss/ha (kgN/ha/yr)	45	42	
Total Farm P Loss (kg)	649	579 *(623 modelled minus 5 baleage grass wintering minus 39 wetlands calculated outside OverseerFM)*	10.8% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in the file note dated October 2021 and in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note. Updates to these calculations are explained within this report.*

4.0 Updated modelling under Overseer version 6.4.2

A new version of Overseer (6.4.2) was released on the 20th December 2021. The Overseer website noted that the "OverseerFM model release 6.4.2 addresses defects in model implementation identified by feedback from our users." Of the defects identified, there were two that affected the modelling completed for this application. These defects are both related to how Overseer distributes supplements throughout the season and the downstream impact of this on estimated losses.

The Titipua Limited Partnership Overseer files have been rerun under Overseer version 6.4.2 with the outputs shown below. Outputs shown in red show a change to those given in Tables 1 and 2. *Note: calculations outside of Overseer have NOT been updated in these tables.*

A full description of the farm system is given within the file note, written October 2021, titled "File Note: Titipua Ltd Partnership – Additional mitigation strategies". No changes have been made to this.

Table 3. Estimated nitrogen and phosphorus losses from the current system using Overseer version 6.4.2

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	10151	1,658	11809
N Loss/ha (kgN/ha/yr)	56	20	44
Total Farm P Loss (kg)	458	191	649
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

Table 4. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.2. Please note: The calculations outside of Overseer have NOT been updated in this table.

	Total current	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11809	10,752 *(10,647 modelled plus 581 baleage grass wintering minus 476 wetlands calculated outside OverseerFM)*	9.0% decrease
N Loss/ha (kgN/ha/yr)	44	40	
Total Farm P Loss (kg)	649	579 *(623 modelled minus 5 baleage grass wintering minus 39 wetlands calculated outside OverseerFM)*	10.8% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in the file note dated October 2021 and in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note. Updates to these calculations are explained within this report.*

5.0 Updating the outside of Overseer calculations

The proposed system estimated losses included the use of calculations outside of Overseer. These calculations have been recalculated below utilising information from Overseer version 6.4.2.

6.1 Baleage grass wintering:

As explained in the March 2021 report *"OverseerFM is likely to underestimate nitrogen losses as OverseerFM is not able to adequately reflect the on-farm realities of this system. OverseerFM assumes that the pasture plants will regrow post grazing and take up urinary N from the wintering activity. However, due to the soil type and climate on the applicant's property, the plants are not* *viable following the winter grazing. As a result, the area is cultivated and regrassed in spring. I am unaware of any research that has quantified the impact of baleage grass wintering in terms of nitrate and phosphorus loss. I have therefore completed a desktop modelling exercise that attempts to estimate the nutrient losses from this system more accurately."*

In the March 2021 report, I explained that I had created an Overseer file that showed the baleage grass area as a very low yielding kale crop. This allowed me to add a defoliation and regrassing event to Overseer and ensured that overseer would assume no uptake of urinary N between grazing of the crop and the resowing of the pasture. Further details on how this was modelled can be found in the March 2021 report in section 4.2.1.

I have rerun the same calculation following the update of Overseer to Version 6.4.2. The results are summarised in the table below. Again, where applicable, changes in losses as compared to version 6.4.1 are shown in red while the previous presented figures are shown in black.

Table 5. Total nitrogen and phosphorus losses for the kale or baleage/grass area (10ha)

	Nitrogen losses (kg N) (version 6.4.1 in black) (version 6.4.2 in red)	Phosphorus losses (version 6.4.1 in black) (No changes for version 6.4.2)
Pasture baleage system	343 566	19
Kale system	924 1169	14
Difference	603 kgN higher loss in the Kale system (581 in version 6.4.1)	5kgP lower loss in the Kale system

Therefore, it is predicted that the losses from the grass baleage wintering system will be 603 kgN higher and 5kg P lower than estimated in the OverseerFM Proposed scenario.

6.2 Installation of a wetland:

Calculations on the potential mitigation efficiency of a constructed wetland were given in the file note "Titipua Ltd Partnership – Wetland mitigation calculations (Oct 2021)". These calculations were completed based on block N and P losses estimated in Overseer version 6.4.1. For a complete description of the assumptions and background information please refer to the earlier file note.

The tables below have been copied and updated from the previous file note "Titipua Ltd Partnership – Wetland mitigation calculations (Oct 2021)". I have rerun the same calculations following the update of Overseer to Version 6.4.2. Again, where applicable, changes in losses as compared to version 6.4.1 are shown in red while the previous presented figures are shown in black.

Table 6. Estimated nitrogen mitigation because of the wetland installation (Overseer version 6.4.2 – copied and updated from file note "Titipua Ltd Partnership – Wetland mitigation calculations (Oct 2021)".

Overseer block name	Area of block captured by wetland (ha)	OverseerFM estimated nitrogen leaching loss (version 6.4.1) (version 6.4.2 in red) (kgN/ha)	Reduction in N leaching due to wetland (estimated from wetland resource) (%)	Total reduction (Ha x kgN/ha x %) (kgN) (version 6.4.1) (version 6.4.2 in red)
Non-Eff, Rolling – Puke, Apar	21.4	39.4 38	38	320.4 309.0
Eff, Rolling – Puke, Apar	9.1	36.0 35	38	124.5 121.0
Non effective area (laneways and tracks) – the losses from this area are accounted for in "other sources" below.	3.5			
Total block Nitrogen loss mitigated	**34.0**			**444.9** **430.0**
Plus reduction in other sources losses	34/265.7	637 627	38	31.0 30.5
Total farm Nitrogen loss mitigated				**475.9** **460.5**

Table 7. Estimated phosphorus mitigation because of the wetland installation (Overseer version 6.4.2 – copied and updated from file note "Titipua Ltd Partnership – Wetland mitigation calculations (Oct 2021)". NOTE: no changes in P loss estimated by Overseer version 6.4.2 when compared to version 6.4.1 and therefore no changes to the P loss mitigation calculation below.

Overseer block name	Area (ha)	OverseerFM estimated P loss (version 6.4.1) (version 6.4.2 in red) (kgP/ha)	Reduction in P loss due to wetland (estimated from wetland resource) (%)	Total reduction (kgP) (Ha x kgP/ha x %) (version 6.4.1) (version 6.4.2 in red)
Non-Eff, Rolling – Puke, Apar	21.4	2.14	48	22.0
Eff, Rolling – Puke, Apar	9.1	2.20	48	9.6
Non effective area (laneways and tracks) – the losses from this area are accounted for in "other sources" below.	3.5			
Total block Phosphorus loss mitigated	**34.0**			**31.6**
Plus reduction in other sources losses	34/265.7	115	48	7.1
Total farm Phosphorus loss mitigated				**38.7**

Therefore, it is predicted that the losses from the wetland will reduce losses from the catchment area by 461kg N (previously 476kgN) and 39kgP per annum.

6.3 Cumulative effects of mitigations calculated outside of Overseer

Calculations outside of Overseer have been completed to quantify the impact of the baleage grass wintering and the wetland installation. The updated loss estimates are shown in the table below. Differences, as compared to Table 4 of this report are shown in red.

Table 1. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.1

	Total current	**Proposed**	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11809	10,789 *(10,647 modelled plus 603 baleage grass wintering minus 461 wetlands calculated outside OverseerFM)*	8.6% decrease
N Loss/ha (kgN/ha/yr)	44	41	
Total Farm P Loss (kg)	649	579 *(623 modelled minus 5 baleage grass wintering minus 39 wetlands calculated outside OverseerFM)*	10.8% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in the file note dated October 2021 and in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note. Updates to these calculations are explained within this report.*

7.0 Conclusions:

The further modelling requested by the applicant has resulted in changes in the estimated losses of Nitrogen and Phosphorus.

Table 2. Estimated nitrogen and phosphorus losses from the current system using Overseer version 6.4.2

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	10151	1,658	11809
N Loss/ha (kgN/ha/yr)	56	20	44
Total Farm P Loss (kg)	458	191	649
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

Table 3. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.2

	Total current	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11809	10,789 *(10,647 modelled plus 603 baleage grass wintering minus 461 wetlands calculated outside OverseerFM)*	8.6% decrease
N Loss/ha (kgN/ha/yr)	44	41	
Total Farm P Loss (kg)	649	579 *(623 modelled minus 5 baleage grass wintering minus 39 wetlands calculated outside OverseerFM)*	10.8% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
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Note:

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2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in the file note dated October 2021 and in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note. Updates to these calculations are explained within this report.*

File Note: Titipua Ltd Partnership – Peer Reviewed Technical Wetland Update

March 2022

Prepared by:

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Reviewed by:

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1.0 Background

Titipua Limited Partnership have made an application to Environment Southland to expand their dairy platform onto a neighbouring piece of land. As part of the application, it was proposed that a duck pond on the original dairy platform be improved to create a wetland. At that time advice was sought from the Environment Southland Land Sustainability staff regarding the sizing of the wetland, construction and calculating it potential mitigation efficacy.

Following the lodgement of the consent, the Environment Southland consents staff wrote a recommending report. The report raised concerns regarding the calculations used to estimate the mitigation potential of the wetland and the lack of detail around how the wetland would be designed and constructed. Subsequently, a submission from Forest and Bird also raised concerns about the proposed wetland. These concerns were similar to those raised by Environment Southland but also included concern about how long it would take for the wetland to become fully effective, and how the wetland would deal with large pulse rain events.

To address these concerns, the author has undergone further research into the ability of wetlands to mitigate nitrogen and phosphorus losses. This file note has been peer reviewed by Chris Tanner of NIWA, who is one of the leading researchers of wetlands within the New Zealand scientific community. Chris is the lead author of the NIWA/DairyNZ "Wetland Practitioner Guide" which is referred to extensively in this file note, and the lead author of the "NIWA – Technical guidelines for constructed wetland treatment of pastoral farm run-off" which is referred to in previous reports and file notes. For Chris' bio please refer to the appendices.

2.0 Purpose of this report:

This file note seeks to address the concerns raised throughout the consent application process, in particular:

- Provide detail on the proposed design of the wetland complex
- Give a proposed construction and planting timeline for the wetland and associated sediment traps
- Provide confidence around the expected effectiveness of the wetland as it develops

Report disclaimer: This file note is intended to be read alongside the reports listed in section 1.0 of this report. Details of how the properties are operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement and industry benchmarks.

- Quantify the expected mitigation potential of the wetland in terms of Nitrogen and Phosphorus losses

3.0 Wetland design

The wetland location and catchment are:

Wetland location:	As per the pin on Figure 1, at or about NZTM2000 1257230E 4869143N
Wetland size:	Estimated at 2.2ha as per the blue areas shown in Figure 2
Catchment area:	44ha with 34ha of this within the Titipua Limited Partnership boundary (Figure 3).

Proportion of catchment area in wetland: 5%

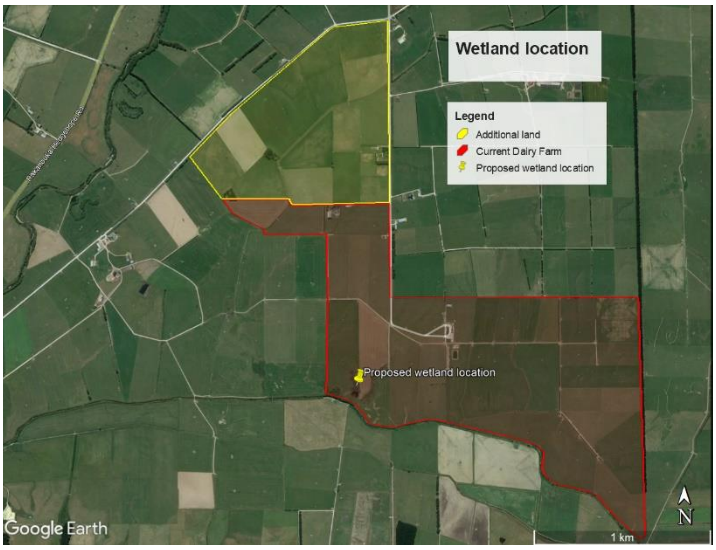

Figure 1. Farm boundaries and location of the proposed wetland.

Figure 2. Schematic of the proposed wetland area (blue), the key tile drains that will be intercepted (white lines) and the catchment boundary (green). The farm boundary is shown by the red line. The total wetland catchment area is 44ha with 34ha of this falling within the property boundary.

The wetland would be designed and constructed utilising the guidelines within the Wetland Practitioners Guide (Tanner *et al,* 2022) in section 5. This resource states that the three components (or zones) of a constructed wetland are a sedimentation zone, a deep water inlet zone, and a shallow vegetated wetland zone. The resource then goes on to show an example of an integrated sediment pond and inlet zone (shown below):

Figure 3. Schematic design of an integrated sediment pond and inlet zone style wetland (taken from Tanner et al., 2022)

In the case of the Titipua Limited Partnership proposed wetland complex, it is intended that there would be a series of six interlinking planted wetland zones – three in the base of each of the two swales that form the catchment for the wetland (shown as the blue areas in Figure 2). This will require some re-fencing to ensure that stock are excluded from the proposed wetland area. Two sediment traps would be created – one in each swale upstream of the first wetland zone.

The wetland area will be vegetated with native emergent plants based on recommendations in the NIWA/DairyNZ Practitioners Guide and advice from Te Ao Marama Inc. This will ensure that the plantings are appropriate for the location and climate found within the wetland.

4.0 Wetland construction timeline

The creation of the wetland complex will require digger work and extensive planting. To ensure that the best result is achieved in terms of plant survival, it is proposed that the wetland complex is constructed when ground conditions allow in summer 2022-23. Planting of the riparian zones would occur in autumn 2023 with planting in the wetland in spring 2024. This will allow for plant orders to be made and fulfilled, and for a digger to operate on site without causing unnecessary pasture and soil damage.

5.0 Expected effectiveness of the wetland during development

Concern was raised by Forest and Bird in their submission that the wetland will take time to be constructed and to establish plants, and that during this time, the wetland would not be mitigating nitrogen and phosphorus losses to it's full potential.

There is very limited scientific research relating to the actual wetland performance during the development stage. However, there was one study that measured nutrient removal performance at three intensively grazed dairy pasture sites across New Zealand for periods of 3-5years within 6-8 months of construction (*Tanner and Sukias, 2011).* One of the wetlands included in the study was sited at Bog Burn, near Winton, Southland. The Bog Burn site was in an area of predominantly tile/mole drained Pukemutu soils and occupied 0.66% of the catchment area. The climate at Bog Burn was described as a “cool southern South Island climate with low intensity rainfall.” The wetland was constructed and planted, left to establish for 12 months and then monitored for a further 4 years from 2003 – 2007.

The wetland reduced nitrate-N loads by 24-59% and TN loads by 28-42%. The trial concluded that “seasonal and year to year performance at each site varied markedly, largely dependent on climatic patterns affecting drainage flows and hence loading regimes.” The paper noted that reductions in Nitrate-N and Phosphorus losses were less dependent on maturation stage than seasonal conditions.

Advice has been sought from Dr Chris Tanner on expected mitigation potential of the wetland in the maturation period. He has advised that, if the wetland follows the guidelines, and the plantings within the wetland establish well, then the wetland should be 70-80% effective after the first growing season, achieving full performance after 1-2 years.

6.0 Expected mitigation potential of the wetland

The expected nitrogen and phosphorus mitigation potential of the wetland has been taken from the *Wetland Practitioner Guide* (Tanner *et al*, 2022).

6.1 Nitrogen

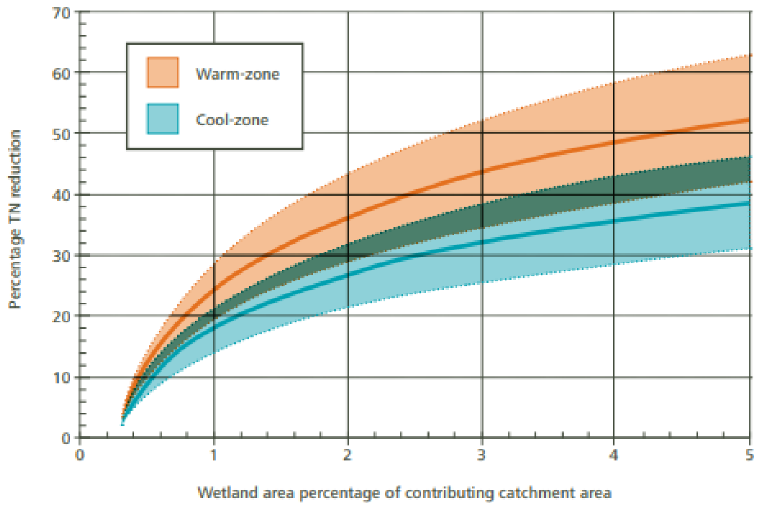

Figure 5. Long-term median annual total nitrogen (TN) reduction performance expectations. Performance is for appropriately constructed wetlands receiving surface run-off and drainage from pastoral farmland for warm (average annual temperature >12°C) and cool (average annual temperature 8-12°C) climatic zones in New Zealand and with catchment rainfall within NZ norms. Solid lines show expected medians for each zone; shaded areas show inter-annual and inter-site range of performance expected.

Figure 4. Wetland efficacy for nitrogen reductions depending on size of wetland as a percentage of the catchment area. Taken from Tanner et al, 2022.

Figure 5 shows the expected efficacy of the wetland for mitigating losses of nitrogen. OverseerFM estimates that the average temperature of the applicant’s property is 10.2 -10.3°C. This means that the farm is in a cool-zone (see blue area on Figure 5). The proposed wetland will be 5% of the catchment area (2.2ha of a 44ha catchment).

Therefore, it is expected that the wetland will mitigate the losses of nitrogen from the catchment by approximately 31 – 46%, or 38% in median conditions. **A reduction in nitrogen losses, as predicted by OverseerFM, from the catchment area of 38% is deemed reasonable.**

6.2 Phosphorus

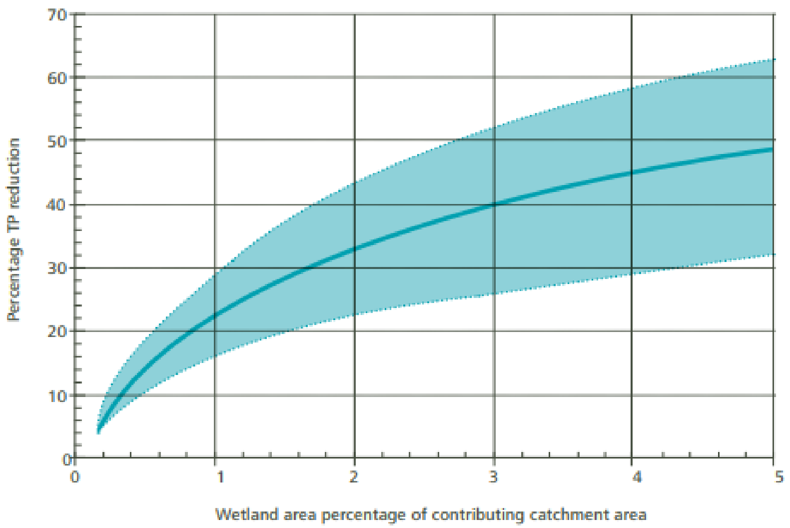

Figure 6. Long-term median annual total phosphorus (TP) reduction performance expectations. Performance is for appropriately constructed wetlands receiving surface run-off and drainage from pastoral farmland in New Zealand with catchment rainfall within 800-1600 mm/year. Solid line shows expected median; shaded area shows inter-annual and inter-site range of performance expected. These predictions do not apply for constructed wetlands whose main source of flow is subsurface drainage containing predominantly dissolved forms of phosphorus.

Figure 5. Wetland efficacy for phosphorus reductions depending on size of wetland as a percentage of the catchment area. Taken from Tanner et al, 2022.

Figure 6 shows the expected efficacy of the wetland for mitigating losses of phosphorus. The applicant's proposed wetland will be 5% of the catchment area (2.2ha of a 44ha catchment). Therefore, it is expected that the wetland will mitigate 33-60% of the phosphorus losses from the catchment, or 48% in median conditions.

However, it should be noted that the predictions "do not apply for constructed wetlands whose main source of flow is subsurface drainage containing predominantly dissolved forms of phosphorus". This exclusion became apparent only when the author was researching wetland efficacy during establishment. Further research has since been undertaken to ascertain the actual potential efficacy of a wetland in a catchment that is predominantly drained through a tile and mole drainage system.

A trial conducted at Tussock Creek, Southland (approx. 12km west of the applicants' property) studied the losses of N and P from a well-drained, intensive dairy farm system over a three year period (Monaghan *et al*, 2016). In comparison to the applicants' property, the trial farm had the same predominant soil type, higher Olsen P (40 vs 30), similar rainfall and perhaps a slightly flatter contour. The trial measured total P lost from the plots, and the form of the phosphorus losses. It found that even in a heavily tile drained environment, 32% of the phosphorus lost was in the form of particulate P. This particulate P is likely to settle and/or be filtered out through the use of a wetland as it is predominantly bound to sediment and will be captured in the deep sediment pond and within the shallow vegetated zones at the upper end of the wetland.

Therefore, it is expected that the wetland will mitigate losses of phosphorus by 48% for the 32% of losses that are from particulate phosphorus, or **15% of total phosphorus losses from the catchment as estimated by OverseerFM.**

7.0 Conclusions

Assuming the wetland is constructed following the guidelines of the "Wetland Practitioner Guide"(Tanner *et al,* 2022), the wetland proposed on the applicant's property is predicted to mitigate losses of nitrogen by 38% and mitigate the loss of total P by 15%. It is expected that the wetland will be 70-80% efficient after one growing season assuming plants are able to get well established.

Appendix – Dr Chris Tanner Biography (taken from the NIWA website)

Dr Chris Tanner – Principal Scientist - Aquatic Pollution, NIWA

Based in Hamilton

Qualifications:

B.Sc., M.Sc. (Hons), Ph.D.

Biography:

Chris is an aquatic ecologist with a MSc (Hons) and PhD from the University of Waikato. He is a Principal Scientists in the Aquatic Pollution Group. He previously led NIWAs Aquatic Rehabilitation and Protection Programme and co-led the Innovative Resilient Land and Water Use Theme of the Our Land and Water National Science Challenge. He has over 35 years of research and consultancy experience on the ecology and functioning of natural and constructed wetlands, and application of a wide range of ecotechnologies for treatment of urban, industrial and agricultural wastewaters and diffuse pollution. He has consulted widely with engineers, industry and government on the design, assessment and management of treatment systems, authored over 90 research publications and book chapters, led demonstration projects on farms, in small communities, towns, papakainga and marae in New Zealand and villages in Fiji, and translated his research into guidelines to promote improved practice and practical uptake.

References:

Monaghan RM, Smith LC, Muirhead RW (2016) Pathways of contaminant transfers to water from artificially-drained soils under intensive grazing by dairy cows. *Agriculture, Ecosystems & Environment* **220**, 76–88.

Tanner CC, Sukias JP. Multiyear nutrient removal performance of three constructed wetlands intercepting tile drain flows from grazed pastures. *Journal of Environmental Quality*. 2011 Mar-Apr;40(2):620-33.

Tanner, C.C; Sukias, J; Depree, C; Goeller, B; Wright-Stow, A Woodward, KB; Kalaugher, E; Burger, D (2022) Wetland Practitioners Guide: Wetland Design and Performance Estimates. DairyNZ/NIWA, Hamilton, New Zealand.

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File Note: Titipua Ltd Partnership – Updating OverseerFM outputs considering updated wetland efficacy expectations

24 March 2022

1.0 Supporting information to this report:

This file note is not a standalone report. It is intended to be read in conjunction with:

- The Overseer modelling report dated 23rd March 2021 titled "Titipua Ltd Partnership – OverseerFM farm system modelling to support a consent application for expanded dairy".
- The File Note, dated June 2021 titled "File Note: Titipua Ltd Partnership – Pasture grown"
- The File Note, dated September 2021 titled "File Note: Titipua Ltd Partnership – Overseer version change"
- Titipua Ltd Partnership – Wetland mitigation calculations (Oct 2021)
- Landpro Project Memorandum written by Andrea Richardson (Nov 2021)
- The File Note, dated October 2021 titled "File Note: Titipua Ltd Partnership – Additional mitigation strategies"
- The File Note, dated March 2022 titled "File Note: Titipua Ltd Partnership – Updating OverseerFM outputs to version 6.4.2"
- The File Note, dated March 2022 titled "File Note: Titipua Ltd Partnership – Peer Reviewed Technical Wetland Update"

These reports have been attached to this file note.

2.0 Purpose of this report:

During the preparation of evidence for the hearing and seeking advice from a leading NZ expert in wetlands it was identified that the Titipua wetland calculations required refining. This file note refines the original wetland calculations.

3.0 Previously modelled losses as per file note dated March 2022:

In the most recent file note, dated March 2022, the nutrient losses were quantified under Overseer version 6.4.2 and additional calculations were completed outside of Overseer to account for the Baleage grass system and the construction of a wetland. These were shown in section 7.0 of that report, and are repeated below:

Report disclaimer: This file note is intended to be read alongside the reports listed in section 1.0 of this report. Details of how the properties are operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement and industry benchmarks.

Table 1. Estimated nitrogen and phosphorus losses from the current system using Overseer version 6.4.2

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	10151	1,658	11809
N Loss/ha (kgN/ha/yr)	56	20	44
Total Farm P Loss (kg)	458	191	649
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

Table 2. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.2

	Total current	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11809	10,789 *(10,647 modelled plus 603 baleage grass wintering minus 461 wetlands calculated outside OverseerFM)*	8.6% decrease
N Loss/ha (kgN/ha/yr)	44	41	
Total Farm P Loss (kg)	649	579 *(623 modelled minus 5 baleage grass wintering minus 39 wetlands calculated outside OverseerFM)*	10.8% decrease
P loss/ha (kgP/ha/yr)	2.4	2.2	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in the file note dated October 2021 and in section 4.2. of the "Overseer modelling report, dated 23rd March 2021" attached to this file note. Updates to these calculations are explained within this report.*

4.0 Wetland calculation refinement required

Recently, while preparing the File Note, dated March 2022, titled "File Note: Titipua Ltd Partnership – Peer Reviewed Technical Wetland Update" it came to the attention of the author that the calculations completed outside of Overseer to quantify the mitigation potential of the wetland should consider the different forms of phosphorus. The original method of calculation used was consistent with the calculation method utilised by the Environment Southland Sustainability Team.

In the previous file note, dated March 2022, titled "File Note: Titipua Ltd Partnership – Updating OverseerFM outputs to version 6.4.2", and in file notes prior to that, the potential efficacy of the wetland had been estimated by using the median percentage reduction in total phosphorus (taken from the graph in Figure 1 below). This methodology is explained in detail in the file note dated

October 2021, titled "File Note: Titipua Ltd Partnership – Additional mitigation strategies". However, it has since become apparent that the estimates of phosphorus reduction "do not apply for constructed wetlands whose main source of flow is subsurface drainage containing predominantly dissolved forms of phosphorus" (taken from Tanner *et al*, 2022).

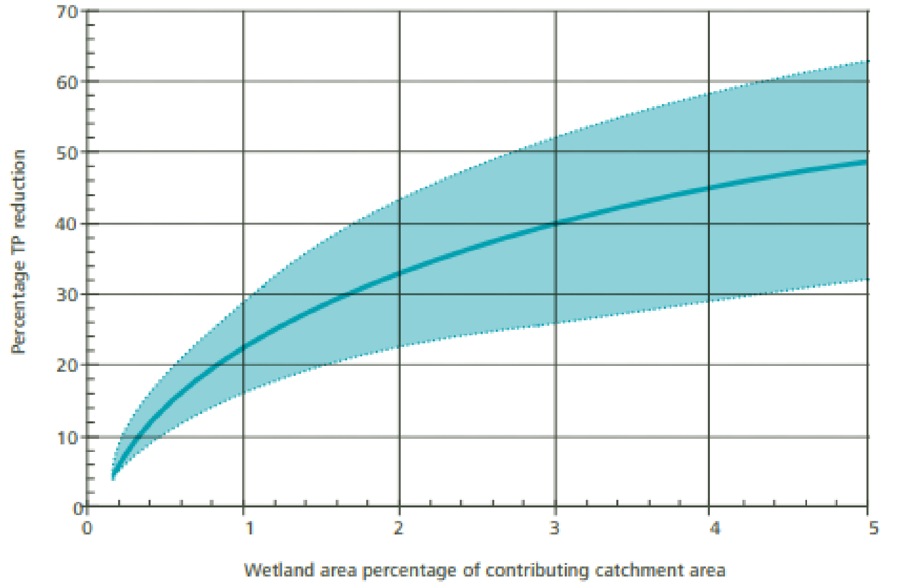

Figure 6. Long-term median annual total phosphorus (TP) reduction performance expectations. Performance is for appropriately constructed wetlands receiving surface run-off and drainage from pastoral farmland in New Zealand with catchment rainfall within 800-1600 mm/year. Solid line shows expected median; shaded area shows inter-annual and inter-site range of performance expected. These predictions do not apply for constructed wetlands whose main source of flow is subsurface drainage containing predominantly dissolved forms of phosphorus.

Figure 1. Phosphorus mitigation potential of a constructed wetland, highlighting the exclusion relating to flows from subsurface drainage that contain predominantly dissolved phosphorus. Taken from the Wetland Practitioner Guide, Tanner et al, 2022)

The File Note, written March 2022, titled "File Note: Titipua Ltd Partnership – Peer Reviewed Technical Wetland Update" seeks to update the wetland calculations. That file note has since been peer reviewed by Chris Tanner – Principal scientist of Aquatic Pollution at NIWA and lead author of the NIWA/DairyNZ Wetland Practitioner Guide. The file note concluded that "*assuming the wetland is constructed following the guidelines of the "Wetland Practitioner Guide"(Tanner et al, 2022), the wetland proposed on the applicant's property is predicted to mitigate losses of nitrogen by 38% and mitigate the loss of total P by 15%. It is expected that the wetland will be 70-80% efficient after one growing season assuming plants are able to get well established*."

5.0 Updated wetland calculations

The tables below have been copied and updated from the previous file note, dated March 2022, titled "File Note: Titipua Ltd Partnership – Updating OverseerFM outputs to version 6.4.2" I have rerun the same calculations correcting for the different forms of phosphorus loss. Again, where applicable, calculation changes as compared to the previous file note are shown in red while the previously presented figures are shown in black.

Table 3. Estimated nitrogen mitigation because of the wetland installation (Overseer version 6.4.2 – copied from file note "Titipua Ltd Partnership – Updating OverseerFM outputs to version 6.4.2", March 2022).

Overseer block name	Area of block captured by wetland (ha)	OverseerFM estimated nitrogen leaching loss (kgN/ha)	Reduction in N leaching due to wetland (estimated from peer reviewed technical wetland update) (%)	Total reduction (Ha x kgN/ha x %) (kgN)
Non-Eff, Rolling – Puke, Apar	21.4	38	38	309.0
Eff, Rolling – Puke, Apar	9.1	35	38	121.0
Non effective area (laneways and tracks) – the losses from this area are accounted for in "other sources" below.	3.5			
Total block Nitrogen loss mitigated	**34.0**			**430.0**
Plus reduction in other sources losses	34/265.7 = 12.8% of farm	627 x 12.8% = 80	38	30.5
Total farm Nitrogen loss mitigated				**460.5**

Table 4. Estimated phosphorus mitigation because of the wetland installation (Overseer version 6.4.2 – copied and updated from file note "Titipua Ltd Partnership – Updating OverseerFM outputs to version 6.4.2, March 2022)".

Overseer block name	Area (ha)	OverseerFM estimated P loss (kgP/ha)	Reduction in P loss due to wetland (estimated from peer reviewed technical wetland update) (%)	Total reduction (kgP) (Ha x kgP/ha x %)
Non-Eff, Rolling – Puke, Apar	21.4	2.14	48 15	22.0 6.9
Eff, Rolling – Puke, Apar	9.1	2.20	48 15	9.6 3.0
Non effective area (laneways and tracks) – the losses from this area are accounted for in "other sources" below.	3.5			
Total block Phosphorus loss mitigated	**34.0**			**31.6**
Plus reduction in other sources losses	34/265.7 = 12.8% of farm	115 x 12.8% = 14.7	48 15	7.1 2.2
Total farm Phosphorus loss mitigated				**38.7** **12.1**

Therefore, it is predicted that the losses from the wetland will reduce losses from the catchment area by 461kg N and 12kgP per annum.

6.0 Effect of corrected wetland calculation on estimated losses from the farm system

A correction has been made to the calculation outside of Overseer to quantify the mitigation potential of the proposed wetland. The updated loss estimates impact the estimated losses from the proposed farm system. Updated farm nitrogen and phosphorus loss estimates are shown in tables 5 and 6 below. Differences, as compared to Tables 1 and 2 of this report are shown in red.

Table 5. Estimated nitrogen and phosphorus losses from the current system using Overseer version 6.4.2

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	10151	1,658	11809
N Loss/ha (kgN/ha/yr)	56	20	44
Total Farm P Loss (kg)	458	191	649
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

Table 6. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.2

	Total current	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11809	10,789 *(10,647 modelled plus 603 baleage grass wintering minus 461 wetlands calculated outside OverseerFM)*	8.6% decrease
N Loss/ha (kgN/ha/yr)	44	41	
Total Farm P Loss (kg)	649	606 *(623 modelled minus 5 baleage grass wintering minus 12 wetlands calculated outside OverseerFM)*	6.6% decrease
P loss/ha (kgP/ha/yr)	2.4	2.3	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in previous file notes. Updates to these calculations are explained within this report.*

7.0 Conclusions:

The correction made to the wetland mitigation calculation outside of Overseer has resulted in changes in the estimated losses of Nitrogen and Phosphorus.

Table 7. Estimated nitrogen and phosphorus losses from the current system using Overseer version 6.4.2

	Current Dairy Platform	Schrama's block	Total current
Area (ha)	181.5	84.2	265.7
Total Farm N Loss (kg)	10151	1,658	11809
N Loss/ha (kgN/ha/yr)	56	20	44
Total Farm P Loss (kg)	458	191	649
P loss/ha (kgP/ha/yr)	2.5	2.3	2.4
Pasture Grown (tDM/ha)	16.8	11.2	

Table 8. Estimated nitrogen and phosphorus losses from the current and proposed systems including calculations outside of Overseer. This modelling utilises Overseer version 6.4.2

	Total current	Proposed	
Area (ha)	265.7	265.7	
Total Farm N Loss (kg)	11809	10,789 *(10,647 modelled plus 603 baleage grass wintering minus 461 wetlands calculated outside OverseerFM)*	8.6% decrease
N Loss/ha (kgN/ha/yr)	44	41	
Total Farm P Loss (kg)	649	606 *(623 modelled minus 5 baleage grass wintering minus 12 wetlands calculated outside OverseerFM)*	6.6% decrease
P loss/ha (kgP/ha/yr)	2.4	2.3	
Pasture Grown (tDM/ha)		16.1	

Note:

1. *Estimated pasture grown figures are higher than expected. This is discussed in section 4.1.1 of the "Overseer modelling report, dated 23rd March 2021" attached to this file note*
2. *Calculations outside of OverseerFM have been required in the proposed system modelling. These are explained in full in previous file notes. Updates to these calculations are explained within this report.*