Irricon resource solutions

**OVERSEER Nutrient Budget Review**

For: Environment Southland – Titipua Ltd Partnership

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## 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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