Irricon resource solutions

OVERSEER Nutrient Budget Review

For: Environment Southland – Kanadale Ltd

Prepared by: Nicky Watt, CNMA

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Introduction

1. Regarding the consent application for Kanadale Ltd, I have reviewed the following OVERSEER ® Nutrient Budget (OVERSEER) files:
   a) Current Milking Platform 19/20 (v1)
   b) Current Bastiaasen Block (v1)
   c) Current Murray block (v1)
   d) Proposed combined (v1)

2. Along with the files I have reviewed the following accompany report: "OverseerFM farm system modelling to support a consent for expanded dairy" prepared by Miranda Hunter, Roslin Consultancy Ltd, reviewed by Lee Baldwin, Baldwin Agri Solutions Ltd. 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 v6.4.3.

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 Kanadale 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 files submitted and stated in paragraph 1 of this report have 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 combination of the Dairy model, Basti model and Murray model along with the Proposed model had a total area of 461.5 ha with 370.8 ha effective. The combination of the Dairy model, Basti model and Murray model had a revised stocking rate of 26.73 RSU/ha for dairy cows on the effective dairy grazed pasture area. The Proposed model had a revised stocking rate of 24.26

RSU/ha for the effective dairy grazed pasture area or a 9.2 % decrease in RSU/ha for effective dairy grazed pasture area. The combination of the Dairy model, Basti model and Murray model had a total revised stocking rate of 24.09 RSU/ha for all animals on the effective grazed pasture area. The Proposed model had a total revised stocking rate of 23.17 RSU/ha for the effective grazed pasture area or a 3.8 % decrease in RSU/ha for effective grazed pasture area (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 474.4 kgMS/cow and 1241 kgMS/ha is respectively higher than the Southland Regional average of 414 kg MS/cow and higher than the Southland Regional average of 1,133 kgMS/ha. The Proposed model at 459.9 kgMS/cow and 1,036 kgMS/ha are respectively higher than the Southland Regional average of 414 kg MS/cow and lower than the Southland Regional average of 1,133kgMS/ha.

5. The dairy cow stocking rate for Dairy and Proposed models at 2.6 cows/ha and 2.3 cows/ha are both respectively lower than the Southland average for the 2019/2020 season of 2.71 cows/ha (Southland).

6. It is noted that the Dairy cows have been modelled as lactating cows and since there is a drying-off date in May the cows are pregnant but no longer lactating from this date through June and July until they have calved. As there is a mean calving date for August the model then assumes there is an average number of lactating cows (cows calved and now in milk) for August onwards.

Table 1: Summary of Production and stocking rate

	Dairy[1]	Basti[2]	Murray[3]	Combined*	Proposed[4]
Total Ha	352.8	50.5	58.2	461.5	461.5
Effective Area (ha)	277	43	50.8	370.8	370.8
Effective Pasture Area (ha)	264.5	41.1	39.2	344.8	333.8
KgMS	343850	-	-	343850	384000
MS kg/ha grazed	1241	-	-	1241	1036
MS kg MS/cow	474.4	-	-	474.4	459.9
Dairy Pasture area (ha)	277	-	-	277	333.8
Dairy RSU	7403	-	-	7402	8099
Dairy RSU/ha (dairy pasture area)	26.73	-	-	26.73	24.26
Total RSU	7486	634	812	8932	8592
Total RSU/ha	27.03	14.74	15.98	24.09	23.17
Lactation Length	266	-	-	266	266
Cows/ha (per ha grazed)	2.6	-	-	2.6	2.3
Cows October	720	-	-	720	800
Cows June	650	-	275	925	835
Cows July	725	-	275	1000	830
Replacements June	0	-	95	95	210
Replacements July	0	-	95	95	210
Replacement RSU	83	-	812	895	493
Beef RSU	-	48	812	860	-
Sheep RSU	-	586	-	586	-
N lost kg/ha/yr	43	14	43	39.8	39.0

Current Milking Platform 19/20 (v1) - Dairy[1]
Current Bastiaasen Block (v1) - Basti[2]
Current Murray block (v1) - Murray[3]
Proposed combined (v1) - Proposed[4]
*Combined is Dairy model, Basti model and Murray model added together

7. The combination of the Dairy model, Basti model and Murray model showed an area of 1.9 ha of swedes grazed in the winter 2020 by sheep and 24.1 ha of kale grazed in the winter by dairy cows. This is a total of 26 ha of winter feed grown and grazed by sheep/dairy cows. The Proposed model

had 27 ha of Kale grazed in the winter by dairy cows and 10 ha of Fodder crop also grazed by dairy cows grazed in winter. This is a total of 37 ha of winter crops grazed by dairy cows. This is a 29.7% increase in winter crop grown in the Proposed model (see Table 2 below). It was noted in the supplementary report that there was 39 ha of winter crop used in the Reference Period.

Table 2: Crop Details

	Dairy	Basti	Murray	Combined	Proposed
Fodder Beet Crop (ha)	-	-	-	-	10
Fodder Beet Yield (tDM/ha)	-	-	-	-	24
When grazed	-	-	-	-	June to Sept
Grazed By	-	-	-	-	Dairy Cows
Swedes Crop (ha)	-	1.9	-	1.9	-
Swedes Yield (tDM/ha)	-	12	-	12	-
When grazed	-	June to Sept	-	June to Sept	-
Grazed by	-	Sheep	-	Sheep	-
Kale (ha)	12.5	-	11.6	24.1	27
Kale Yield (tDM/ha)	12	-	12	12	12
When grazed/Harvested	June to Sept	-	June to Sept	June to Sept	June to Sept
Grazed by	Dairy cows	-	Dairy grazing	Dairy Grazing	Dairy grazing

8. The soil areas are with margin of error for all soils (see Table 3 below).

Table 3: Soil Details

	Dairy	Basti	Murray	Combined	Proposed
Heret_47a.1 (ha)	206.8	37.8	45.7	290.3	290.3
Wynd_9a.1 (ha)	48.9	-	5.1	54	54
Orati_3a.1 (ha)	21.3	-	-	21.3	21.3
Eure_22a.1 (ha)	-	5.2	-	5.2	5.2

9. Supplements are imported to meet cow demand (see Table 4 below). Pasture silage has been made where there was a surplus of pasture. The combination of the Dairy model, Basti model and Murray model had a pasture growth calculated at 15.08 tDM/ha and the Proposed model had a pasture growth of 14.80 tDM/ha for dairy pasture. This is a 1.9% decrease in pasture growth. The N used on all pasture blocks for the combination of the Dairy model, Basti model and Murray model was 196 kgN/ha for non-effluent and effluent areas compared to 186 kgN/ha for effluent and non-effluent areas in the Proposed model. This is a 5.1% decrease in N fertiliser used. There is expected to be 39.6% less supplement imported, and 77.9% more silage harvested in the Proposed model compared to the combination of the Dairy model, Basti model and Murray models (see Table 4 below).

Table 4: Supplements imported and Harvested

	Dairy	Basti	Murray	Combined	Proposed
Supplements Imported (tDM)	538	-	-	538	325
Supplements Imported Effective Area (tDM/ha)	1.94	-	-	1.45	0.88
Silage Harvested (tDM)	70	9	48	127	575
Silage Harvested Eff Pasture (tDM/ha)	0.26	0.22	1.22	0.37	1.72
Total Area (ha)	352.8	50.5	58.2	461.5	461.5
Effective Area (ha)	277	43	50.8	370.8	370.8
Effective Pasture Area (ha)	264.5	41.1	39.2	344.8	333.8
Dairy RSU	7403	-	-	7402	8099
Dairy RSU/ha (eff pasture area)	26.73	-	-	26.73	24.26
Total RSU	7486	634	812	8932	8592
Total RSU/ha	27.03	14.74	15.98	24.09	23.17
Cows/ha (per ha grazed)	2.6	-	-	2.6	2.3
N Fertiliser applied non -effluent area(kgN/ha)	222*	-	-	196	186
N Fertiliser applied effluent Area (kgN/ha)	222	-	-	196	186

N Fertiliser on support pasture area (kgN/ha)	-	72	148	-	-
Pasture Growth support area (tDM/ha)	-	11.44	13.52	-	-
Pasture Growth dairy area (tDM/ha)	15.88	-	-	15.08	14.80

*This exceeds the 190 kgN/ha N cap

Overseer Outputs

10. The N lost to water for the combination of the Dairy model, Basti model and Murray model was 39.6 kgN/ha/yr (18288 kgN/annum) compared to 39.4 kgN/ha/yr (18182 kgN/annum) for the Proposed model which is an 0.5% reduction in the total N loss. The P lost for the combination of the Dairy model, Basti model and Murray models showed was 0.66 kgP/ha/yr (303 kgP/annum) compared to 0.61 kgP/ha/yr (283 kgP/annum) for the Proposed model which is a 6.6% reduction in total 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 v6.4.3	Dairy	Basti	Murray	Combined	Proposed
N lost to water kg/ha/yr	43	14	43	39.6	39.4
Total N lost kg/farm	15069	729	2490	18288	18182
P lost kg/ha/yr	0.8	0.3	0.3	0.66	0.61
Total P lost kg/farm	269	15	19	303	283
Other sources – N	662	27	31	720	76
Other sources – P	143	5	6	154	152

Change in block pools

11. 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 immobilized in all models (see Table 6 below).

12. 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. Above maintenance P was applied to the combination of the Dairy model, Basti model and Murray model and slightly above maintenance was applied to the Proposed model (see Table 6a below).

Table 6: Change in block pool (N)

	Dairy (358.8 ha)	Basti (50.5 ha)	Murray (58.2 ha)	Combined (461.5 ha)	Proposed (461.5 ha)
Organic Pool	97	21	42	83	70
Inorganic Mineral	0	0	0	0	0
Inorganic Soil Pool	4	6	19	6	9

Table 6a: Change in block pool (P)

	Dairy	Basti	Murray	Combined	Proposed
Organic Pool	13	10	8	12	11
Inorganic Mineral	2	3	4	2	3
Inorganic Soil Pool	29	2	14	24	5

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.

13. The Biological fixation for the combination of the Dairy model, Basti model and Murray model showed is 49 compared to the Proposed model at 52. This is a 5.8% increase (see table 7 below).

14. The N added to pasture for the combination of the Dairy model, Basti model and Murray model was 196 kgN/ha compared to 186 kgN/ha for the Proposed model (a 5.1 % drop in N used).

15. The increase in biological fixation in the Proposed model can largely be explained by the 5.1% decrease in N fertiliser applied.

Table 7: Biological fixation

	Dairy (358.8 ha)	Basti (50.5 ha)	Murray (58.2 ha)	Combined (461.5 ha)	Proposed (461.5 ha)
Biological Fixation (kg/ha/yr)	46	77	40	49	52
Average N applied to whole farm kg/ha/yr	171 (222 to effluent and non-effluent pasture)	5 (72 to pasture)	114 (148 to pasture)	148 (196 to non-effluent and effluent pasture)	139 (186 to non-effluent and effluent pasture)

Pasture Production

16. The average effluent N inputs for the combination of the Dairy model, Basti model and Murray models was 77 kgN/ha from liquid and solid effluent to 90 ha of pasture (see table 8 below). The average effluent N inputs for Proposed model was 82 kgN/ha from liquid and solid effluent to 901 ha of pasture.

17. Fertiliser inputs of N, for the combination of the Dairy model, Basti model and Murray model, to effluent and non-effluent pasture was 222 kgN/ha (see Table 8 below). The fertiliser inputs of N to pasture onto effluent and non-effluent area was 186 kgN/ha pasture in the Proposed model (see Table 8 below).

18. Liquid effluent is applied onto the dairy pasture blocks for the combination of the Dairy model, Basti model and Murray model and also to the Proposed model, during the lactation period and while the winter barn was being used August and September, using a <12 mm application method. Solids effluent from pond was applied in December to effluent blocks for all models.

19.

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

	Dairy/Basti/Murray	Proposed
Effluent Liquid Area (ha)	90	90
Effluent Solids Area (ha)	90	90
Pasture Growth (tDM/ha/yr)		
Effluent	15.08	14.80
Non-Effluent	15.08	14.80
N Fertiliser inputs (kg/ha/yr)		
Effluent	222	186
Non-Effluent	222	186

N Effluent Inputs (kg/ha/yr)		
Effluent	77	82
Non-effluent (includes solids)	0	0
Total N Inputs (kgN/ha/yr)		
Effluent	299	269
Non-Effluent	222	186

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

21. Fertiliser inputs of N are high for the combination of the Dairy model, Basti model and Murray models and for the Proposed Model (see Tables 7 and 8).

22. It is assumed the combination of the Dairy model, Basti model and Murray model represent the actual farm system with actual stock, crop area and fertiliser inputs, it is assumed that the pasture production is accurate and reasonable.

23. Long term pasture growth in Southland between 1979 and 2012 indicated that average pasture growth for newer pastures was 12.7T DM/ha/yr. Growth rates for Tapanui were 10.2 tDM/ha for the 2019/2020 season allowing for 60 kgN/ha.

24. The dairy pasture production for the combination of the Dairy model, Basti model and Murray model was 15.08 tDM/ha compared to 14.80 tDM/ha for the Proposed model which is respectively 15.8% and 14.2% higher than the Southland average. The dairy pasture production for the combination of the Dairy model, Basti model and Murray model was 15.08 tDM/ha compared to 14.80 tDM/ha for the Proposed model which is respectively 32.4% and 31.1% higher than the Tapanui area average (see Tables 4 and 8 above).

25. The combination of the Dairy model, Basti model and Murray model: 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 combination of the Dairy model, Basti model and Murray models had used actual data and is assumed that pasture renewal has occurred, and new pasture can account for a 15-20% improvement in pasture growth. Also 3-4 tDM/ha would come from the high N fertiliser applied (136 kgN/ha X 12 kgDM/kgN applied). This more than accounts for the high pasture growth.

26. Proposed model: The drop in pasture growth can be accounted for in the 5.1% drop in N fertiliser applied and 3.8% decrease in RSU/ha of pasture grazed by all animals.

27. The animal distribution is modelled as ‘No difference between blocks’ and ‘Same as ratio of total animal intake ’.

Mitigations Modelled

28. Reporting out lined the following: As described in the Nutrient Budget Report for Kanadale Ltd prepared Miranda Hunter (page 7 of the ‘OverseerFM farm system modelling to support a consent application for expanded dairy), there are several mitigation measures indicated to mitigate N/P 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 scenario

Decrease in total RSU and dairy cow stocking rate	Yes, there was 3.8 % decrease in RSU/ha for effective grazed pasture area and a 11.5% decrease in dairy cow stocking rate in the Proposed model.
Decrease in N applied	Yes, N fertiliser applied to pasture for the combination of the Dairy model, Basti model and Murray model was 196 kgN/ha compared to 186 kgN/ha for the Proposed model (a 5.1 % drop in N used).
Maintenance P applied	Yes, well above maintenance P was applied to the combination of the Dairy model, Basti model and Murray models and slightly above maintenance was applied to the Proposed model.
Decrease in imported feed	Yes, there is expected to be 39.6% less supplement imported, and 77.9% more silage harvested in the Proposed model compared to the combination of the Dairy model, Basti model and Murray model.

29. All mitigations identified in the OverseerFM report have been modelled correctly.

30. 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.

31. 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.

32. 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.

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

CONCLUDING COMMENTS

Determination of the robustness of the nutrient loss to water

34. 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?

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

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

36. The Biological fixation for the combination of the Dairy model, Basti model and Murray model showed is 49 compared to the Proposed model at 52. This is a 5.8% increase.

37. The N added to pasture for the combination of the Dairy model, Basti model and Murray model was 196 kgN/ha compared to 186 kgN/ha for the Proposed model (a 5.1 % drop in N used).

38. The increase in biological fixation in the Proposed model can largely be explained by the 5.1% decrease in N fertiliser applied.

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

39. The rainfall and soil information have been entered based on protocols for the location and soil type selected. The combination of the Dairy model, Basti model and Murray model soil areas are within acceptable marginal differences when compared to the Proposed model soils.

Production and stocking rate

40. Reviewing the NZ Dairy statistics for the 2019/2020 season, shows the average milk solids production on this property for the Dairy model at 474.4 kgMS/cow and 1241 kgMS/ha is respectively higher than the Southland Regional average of 414 kg MS/cow and higher than the Southland Regional average of 1,133 kgMS/ha. The Proposed model at 459.9 kgMS/cow and 1,036 kgMS/ha are respectively higher than the Southland Regional average of 414 kg MS/cow and lower than the Southland Regional average of 1,133kgMS/ha.

41. The dairy cow stocking rate for Dairy and Proposed models at 2.6 cows/ha and 2.3 cows/ha are both respectively lower than the Southland average for the 2019/2020 season of 2.71 cows/ha (Southland).

42. It is assumed that the Dairy model, Basti model and Murray model were based on actual year end information.

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

43. Long term pasture growth in Southland between 1979 and 2012 indicated that average pasture growth for newer pastures was 12.7T DM/ha/yr. Growth rates for Tapanui were 10.2 tDM/ha for the 2019/2020 season allowing for 60 kgN/ha.

44. The dairy pasture production for the combination of the Dairy model, Basti model and Murray model was 15.08 tDM/ha compared to 14.80 tDM/ha for the Proposed model which is respectively 15.8% and 14.2% higher than the Southland average. The dairy pasture production for the combination of the Dairy model, Basti model and Murray model was 15.08 tDM/ha

compared to 14.80 tDM/ha for the Proposed model which is respectively 32.4% and 31.1% higher than the Tapanui area average (see Tables 4 and 8 above).

45. The combination of the Dairy model, Basti model and Murray model: 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 combination of the Dairy model, Basti model and Murray models had used actual data and is assumed that pasture renewal has occurred, and new pasture can account for a 15-20% improvement in pasture growth. Also 3-4 tDM/ha would come from the high N fertiliser applied (136 kgN/ha X 12 kgDM/kgN applied). This more than accounts for the high pasture growth.

46. Proposed model: The drop in pasture growth can be accounted for in the 5.1% drop in N fertiliser applied and 3.8% decrease in RSU/ha of pasture grazed by all animals.

47. The animal distribution is modelled as 'No difference between blocks' and 'Same as ratio of total animal intake '.

48. I have assumed an adequate level of robustness around the Dairy model, Basti model and Murray model of actual Overseer Modelling as they are based on actual farming systems, and with that, I have assumed actual stock and fertiliser inputs used.

    The data input protocols have been followed with some deviations. This leads to a **high** level of robustness for the relevant input data for example, climate, soils, and pasture type. Based on this, I consider that the robustness of the nutrient loss estimates for the Proposed model to be **high.**

    Note: The Current Milking platform 19 20 (Dairy model) does have N fertiliser applied at 222 kg/ha which is greater than the 190 kgN/ha N Cap.

References:

https://www.dairynz.co.nz/publications/dairy-industry/new-zealand-dairy-statistics-2020-21/

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https://www.dairynz.co.nz/media/5793235/average-pasture-growth-data-south-island-2020-v1.pdf