OVERSEER Nutrient Budget review

For: Environment Southland – Cashmere Bay Dairy (Proposed Mitigations)

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Introduction

1. Regarding the consent application for Cashmere Dairy, I have reviewed the following OVERSEER ® Nutrient Budget (OVERSEER) files:
   a) Cashmere Bay-Pro-posed scenario
   b) Cashmere Bay Dairy Limited -Pivots, Catch Crop (v1)

2. Along with the files I have reviewed the following accompany reports:
   - Brief report on the implications of additional nutrient loss mitigation for water quality, prepared by: Mike Freeman, Senior Scientist/Planner Landpro.

3. I have completed a robustness check on the files for sensibility based on data available and checked to ensure the modelling aligns with the OVERSEER Best Practice Data Input Standards for v6.3.0. There is a small increase in the total farm area and the productive block area when comparing the Proposed to the Catch crop model.

4. 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 proposed scenario and Catch Crop Scenario is also assumed to be appropriate for the location and climate.

5. A 'sensibility test' has been undertaken on the Cashmere Bay Dairy 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.

6. 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 two Overseer FM files (have compared both models in Overseer FM) 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 is no deviation from the BPDIS.

3. The models differ in the total farm area and productive block area. The Proposed model has a total area of 522.9 ha vs 526.1 ha in the Catch Crop model. The Proposed model has a productive block area of 510.5 ha vs 510.8 ha for the Catch Crop model. The peak stocking rate has increased from 2.0 cow/ha to 2.1 cows/ha but the Dairy Replacement revised stock units (RSU) have decreased from 1737 to 1638 when comparing the Proposed model to the Catch Crop model. This is due to the dairy replacements now being grazed on a greater area (over morel blocks on the farm?) and the dairy cows are grazed on a lower area (40 ha crop taken out of pasture blocks)

4. Reviewing the NZ Dairy statistics for the 2017/2018 season, shows the average milk solids production proposed on this property (470 kgMS/cow) is greater than the Southland regional average of 408 kg MS/cow. The stocking rate is lower than the Southland average for the 2017/2018 season of 2.64 cows/ha. The Catch Crop per cow production is the same as the Proposed per cow production but 6.8% higher in per hectare production which is due to less area modelled for dairy cows to graze on (40 ha less).

Table 1: Summary of Production and stocking rate

	Proposed[1]	**Catch Crop[2]**
Total Ha	522.9	526.1
Effective Area (ha)	510.5	510.8
Effective Pasture Area (ha)	510.5	470.8
KgMS	470000	470000
MS kg/ha grazed	920	998
MS kg MS/cow	470	470
Dairy RSU	10905	10916
Lactation Length	278	278
Cows/ha	2.0	2.1
Cows October	1010	1010
Cows June	810	810
Cows July	810	810
Replacement Support RSU	1737	1638
N lost kg/ha/yr	37	34

[1]Cashmere Bay-Pro-posed scenario -**Proposed**
[2]Cashmere Bay Dairy limited – Pivots, Catch Crops -**Catch Crop**

5. The crop area is the same between the 2 models, however the area of fodder crop has decreased to 14 ha and 20 ha is cropped with a catch crop in the Catch Crop model when compared to the Proposed model.

Table 2: Crop Details

	Proposed	**Catch Crop**
Dairy Fodder Ha	34 - FB rotates through all blocks	14 - FB rotates through all blocks*
Fodder Yield (tDM/ha)	26	26
Dairy Past-FB Ha	-	20
Dairy FB-Past Ha	-	20
Support Fodder Ha	4 - FB rotates through all blocks	4 – FB rotates through all blocks*

*Unsure if this is the case as Published reports do not show what blocks the fodder crops rotate through

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

Table 3: Supplements imported and Harvested

	Proposed	**Catch Crop**
Supplements Imported (tDM)	750	750
Supplements Imported (tDM/ha)	1.47	1.59
Total Area (ha)	522.9	526.1
Effective Pasture Area (ha)	510.5	470.9
Peak Cows/ha	2.0	2.1
N Fertiliser applied (kgN/ha)	156	152
Pasture Growth Dairy Irrigated and Effluent (TDM/ha)	17.68	17.46
Pasture Growth Dairy Dryland (TDM/ha)	13.26	13.10
Pasture Growth runoff Dryland (TDM/ha)	14.37	13.10
Silage Harvested to storage (tDM) -Dairy	350	283.3
Silage Harvested to Dairy (tDM) - Dairy	-	63.5
Silage Harvested to storage (tDM) - Support	63	66.6

7. The total supplement imported is the same and the supplements harvested is similar. The difference between the Proposed and Catch Crop Overseer models is the decrease in the area available in pasture (40 ha out as crop – 20 ha pasture to beet in Oct; 20 ha Beet to pasture in Jan with cover crop in between).

Table 4: Irrigation use comparison

	Proposed	**Catch Crop**
Area under Pivot (ha)	28.9	103
Area under Rotorainer (ha)	157.5	0
Total Area Irrigated	186.4	103
Total N Loss Under Pivot (kgN)	756	3225
Total N Loss under Rotorainer (kgN)	5933	0
N Loss under pivot (kgN/ha)	26.2	31.3
N Loss under rotorainer (kgN/ha)	37.7	0
N Loss under irrigation (kgN/ha)	**35.9**	**31.3**

8. The 'Brief Report' produced by Mike Freeman indicated that the irrigation area for the Catch crop was 143 ha but there is only 103 ha of area irrigated as the 40 ha of crop area is not being irrigated. The addition of the pivot only irrigation to the Catch Crop model does show a 12.8% drop in N loss versus the pivots and rotorainers in the Proposed model.

9. The N lost to water for the Catch Crop model has shown an 8.1% drop in the N loss when compared to the Proposed model (see Table 5 below). The P loss has dropped by 6.3% in the Catch Crop model when compared to the Proposed model. It must be assumed that the information provided in the current information was modelled as viable farming system, using actual stock and fertiliser inputs. Therefore, the future scenarios are also assumed to be appropriate for the location and climate.

Overseer Outputs

Table 5: OVERSEER outputs

Overseer v6.3.0	**Proposed**	**Catch Crop**
N lost to water kg/ha/yr	37	34
Total N lost kg/farm	19584	17874
P lost kg/ha/yr	0.6	0.6
Total P lost kg/farm	316	296
Other sources – N	430	452
Other sources – P	184	181

Change in block pools

10. Overall there is no significant difference in the change in block pool values between Catch Crop and the Proposed model for both N and P.

11. It appears N is potentially being immobilized. This is observed with a positive value in the Organic pool for N. This value remains reasonably constant between the 2 models.

12. Slightly above maintenance P is being applied to both models by the respective slight increase in Inorganic Soil Pool levels.

Table 6: Change in block pool (N)

	Proposed	**Catch Crop**
Organic Pool	81	84
Inorganic Material	0	0
Inorganic Soil Pool	5	3

Table 7: Change in block pool (P)

	Proposed	**Catch Crop**
Organic Pool	12	12
Inorganic Material	2	2
Inorganic Soil Pool	6	12

Rain/clover N Fixation

13. The Biological fixation for the Catch Crop model shows a decrease compared to the Proposed model (see table 8 below).

14. Average N added to the Catch Crop model shows a 2% increase when compared to the Proposed model.

15. The 21.5% decrease in biological fixation in part due to the small increase in average N applied per hectare and slightly larger farm area in the Catch Crop model. It is unclear if this an acceptable variance and within the limitations of the model.

Table 8: Biological fixation

	Proposed	Catch Crop
Biological Fixation	93	73
Average N applied to whole farm kg/ha/yr	149	152

Pasture Production

16. The effluent N inputs have increased from the Proposed to the Catch Crop model due to the decrease in area effluent is to be applied (see table 9 below).

17. Fertiliser inputs of N to the effluent blocks are slightly 4.5% higher in the Catch Crop model and the same in the non-effluent blocks when compared to the Proposed model.

18. Pond solids are applied mainly to the effluent area in almost all the models. Liquid effluent is only applied to the effluent block in all models using a low application method.

19. Long term pasture growth in Southland between 1979 and 2012 indicated that average pasture growth for newer pastures was 12.7T DM/ha/yr. Average growth data for Tapanui, from Dairy NZ data sheets, showed 10.2 tDM/ha excluding N applications on dryland (adding 267 kgN/ha of nitrogen at a 10:1 response will give pasture growth of 12.9 tDM/ha). The Proposed and Catch Crop models pasture production is higher than the pasture growth expectations for dryland and irrigated pastures in the area.

20. The animal distribution is modelled the same in both scenarios.

Table 9: Pasture production and N inputs (fertiliser and effluent)

	Proposed	Catch Crop
Effluent Area (ha)*	170	137
Pasture Growth (tDM/ha/yr)		
Effluent	17.6	17.5/13.1 (irrigated/Non Irrigated)
Non-Effluent	13.58	17.5/13.1
N Fertiliser inputs (kg/ha/yr)		
Effluent	156	155
Non-Effluent	222	222
N Effluent Inputs (kg/ha/yr)		
Effluent	59	71
Non-effluent (includes solids)	0	0
Total N Inputs (kgN/ha/yr)		
Effluent	216	226
Non-Effluent	222	222

**Effluent area is area that receives liquid effluent*

Mitigations Modelled

21. As described in Brief Report supplied by Landpro, there are several mitigation measures to mitigate N loss that have been included in the Catch Crop model. 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

Farm system strategies	Included in Catch Crop OVERSEER scenario
Large Rotorainer replaced with 2 new centre pivots	Yes. The pivot has replaced the rotorainer
Small rotorainer removed completely reducing irrigation area from 186 ha to 143 ha	Yes and No, the small rotorainer has been removed. The area irrigated is shown to be 103 ha as there is 40 ha of crop area not irrigated (is this to be the case going forward? Will the pivots have VRI to not irrigate the crop areas or will they be blocked so they will not be irrigated so only ever irrigating 103 ha?)
Of the 34 ha of crop sown into fodder beet 20 ha will have a catch crop	Yes. There is 20 ha of fodder beet area planted with a catch crop.

22. Most of the mitigation measures are robust, however the area around irrigating the crops, or not, would need addressing.

23. 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.

CONCLUDING COMMENTS

Determination of the robustness of the nutrient loss to water

24. 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?

25. 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?

26. There is no significant difference in the change in block pool values between the 2 models presented for both N and P.

27. There is a 21.5% decrease in biological fixation in the Catch Crop model and a small increase in applied N when compared to the Proposed model. Clover and pasture inputs are the same across both scenarios.

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

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

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

Production and stocking rate

30. Based on my experience as well as reviewing NZ Dairy statistics for the 2017/2018 season the stocking rate is lower than the Southland Region average in the 2017/2018 season. The milk production per cow is higher than the Southland Region average in the 2017/2018 season

31. The milk solids production per cow is expected to be 470 kg MS/cow/year which is higher than the Southland regional average of 408kg MS/cow. The target of 470 kgMS/cow is the same for both models.

32. The stocking rate at 2.0 cows/ha for the Proposed and 2.1 cows/ha for Catch Crop model is lower than the Southland average for the 2017/2018 season of 2.64 cows/ha.

33. It is assumed that since the Proposed and Catch Crop models are based actual scenarios that are based on year end information that represent viable production and stocking rate.

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

34. A detailed explanation of the pasture production has been outlined in the above sections.

35. The pasture production has dropped slightly between the Proposed and Catch Crop models. This is as a result of the slight increase in effective farm area.

36. Average growth data for Tapanui, from Dairy NZ data sheets, showed a pasture growth of 12.9 tDM/ha (including N application). The pasture production on this property, for dryland and irrigated land, is much higher than average growth for the area.

37. I have assumed an adequate level of robustness around the actual Overseer Modelling as it is based on an actual farming system, and with that, I have assumed realistic stock and fertiliser inputs were used for the 2 models.

38. The area irrigated is 103 ha versus 143 ha reported as per the 'Brief Report' produced by Mike Freeman. It appears the 40 ha of crop is under this irrigated area but not irrigated. If the crops are never to be irrigated and will always be under the pivots and only 103 ha will ever be irrigated, then the model is robust. If the intention is to irrigate the full 143 ha, then this needs to be shown in the model as will otherwise underestimate the N loss.

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

40. Based on the concerns raised regarding some of the inputs and outputs in the Overseer models, I consider that the robustness of the nutrient loss estimates for the Proposed scenario are **high**, but the robustness of the Catch Crop model is **medium** due to the variance in farm area and the full area not being irrigated.

41. The area of concern In the Catch Crop model is: The difference in the farm area and the 40 ha of area not irrigated under pivot and resulting increase in N loss if it is.

42. It is vital that the proposed changes to the future farm system are effectively measured and monitored as if these are not adhered to then the reductions in N loss proposed may not occur.

References:

New Zealand Dairy Statistics 2017/2018. Produced by LIC and DairyNZ 2018.
https://www.dairynz.co.nz/media/5790451/nz-dairy-statistics-2017-18.pdf
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Smith. L. C. 2012. Proceedings of the New Zealand Grassland Association 74: 147-152 (2012) *Long Term pasture growth patterns for Southland New Zealand: 1978-2012*. www.grassland.org.nz/publications/nzgrassland_publication_2284.pdf

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