
Consent Nutrient Budget Adjustments

Further Clarifications and P Mitigation Requests of Scenario Reports

Prepared by Mark Crawford

Senior Farm Environmental Advisor



Certified Nutrient Management Adviser

60877676 and 60876935

WORLDWIDE FOUR AND FIVE LIMITED

C/- A & JJ DE WOLDE

104 SHAWS TREES ROAD; RD 3 WINTON 9783

2/08/2019



Executive Summary

Landpro Senior Scientist/Planner Mike Freeman on behalf of Woldwide Four Limited and Woldwide Five Limited have requested additional nutrient loss mitigation to completed OVERSEER FM[®] Nutrient Budgets to model the farm systems and assess the nutrient loss changes in support of the current consent being sought.

The 349.3 ha and 262.6 ha farms are located at 805 Mayfield Road and 800 Bayswater Road, Heddon Bush, with Woldwide 4 including the 78.8 ha support block located at 477 Gladfield Rd, 19 km west north west from Winton Township, 40 km nor-north west from Invercargill city and 36 km from the south west coast (Orepuki). Both properties are dryland dairy farms, milking approximately 810 cows (consented numbers 850) and 680 cows (consented numbers 800 respectively; with Woldwide 5 modelled at 680 from current 540 average with the additional cows modelled allowed for the 44.3 ha of consented land yet converted.

Point 1 – Adjusted Barn Autumn Numbers and Supplementary feed plus re adjusted fertiliser with additional barn slurry.

For Woldwide Five: Average Nitrogen lost from the root zone from the farm system modelled using OVERSEER FM[®] Nutrient Budgets 6.3.1/2.6.2.0 is changed from **15,804 kg N/year** or **47 kg N/ha/year** to **14,873 kg N/year (5.9% decrease)** or **43 kg N/ha/year**.

For Woldwide Four: Average Nitrogen lost from the root zone from the farm system modelled using OVERSEER FM[®] Nutrient Budgets 6.3.1/2.6.2.0 is changed from **11,276 kg N/year** or **27 kg N/ha/year** to **9,550 kg N/year (15% decrease)** or **23 kg N/ha/year**.

For Woldwide Five: Average Phosphorus lost from the root zone from the farm system modelled using OVERSEER FM[®] Nutrient Budgets 6.3.1/2.6.2.0 is changed from **247 kg P/year** or **0.7 kg P/ha/year** to **244 kg N/year (1% reduction)** or **0.7 kg N/ha/year**.

For Woldwide Four: Average Phosphorus lost from the root zone from the farm system modelled using OVERSEER FM[®] Nutrient Budgets 6.3.1/2.6.2.0 is changed from **371 kg P/year** or **0.7 kg P/ha/year** to **366 kg N/year (1% reduction)** or **0.7 kg N/ha/year**.

Average Nitrogen loss reductions by and large reflect the additional wintering of cattle in doors, whilst the Phosphate losses reflect the adjustments made to fertiliser and barn slurry distribution.

Point 2 – P Loss Mitigation from Other Sources

For Woldwide Five, the average Phosphorus mitigated and therefore not lost from the root zone from the farm system modelled using OVERSEER FM[®] Nutrient Budgets 6.3.1/2.6.2.0 is calculated to be **12.7 kg P/year** and so the final P loss is recalculated to **231 kg/year (6% reduction)** or **0.7 kg P/ha/year**

This was not reported in the Overseer report.

For Woldwide Four, the average Phosphorus mitigated and therefore not lost from the root zone from the farm system modelled using OVERSEER FM[®] Nutrient Budgets 6.3.1/2.6.2.0 is calculated to be **28.8 kg P/year** and so the final P loss is recalculated to **337 kg/year (6% reduction)** or **0.8 kg P/ha/year**.

This was not reported in the Overseer report.

Actual data was used in compiling the Nutrient budgets, with adjustments made where sensibly required to align modelled outputs.

The key reductions are in line with amounts shown for Woldwide 1&2.

The barn calculations have been sent to OVERSEER FM for an explanation of why other source P loss appears not to be consistent with cows spending less time on the laneways.

The farms are entities, modelled as production units with their systems using actual averaged data for the inputs and this data is then extrapolated for the scenario budgets.

Overseer nutrient budgets Version 6.3.1/2.6.2.0 have been used to create the nutrient budgets presented in this report.

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Mark Crawford

Senior Farm Environmental Consultant

Dated: 4th August 2019

Point 1 – Adjusted Barn Autumn Numbers and Supplementary feed plus re adjusted fertiliser with additional barn slurry.

Description of farm system scenario; Woldwide Four and Five:

The properties will be operated as a dryland dairy farms, calving 1032 and 960 cows and peak milking 1000 and 930 (540 & 500 kg LW) Friesian cows respectively. Milk production aimed for is at 535,000 and 570,000 kg MS/year (575 and 570 kg MS/cow peak). Cow numbers are shown in the table below.

Key changes to the original farm proposed farm systems are;

- Additional cows and R 2 Heifers are milked and wintered indoors. Numbers are highlighted in the table below;

Stock Number details and Barn Information (Woldwide Five): Table 1

	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	LW (kg)
Dairy cows		265	715	705	695	695	675	665	655	645	600	260	540
First calving heifers	30	220	247	240	235	235	235	225	225	225	195		500
Dairy grazers (milking cows)	715	450									0	455	540
Dairy grazers (Repl. In calf hfrs)	218	27									122* (248)	248	480 & 500
Bulls						20	20						700
Number in Barns	960	960								435	918	960	

* Overseer FM shows 248, however would have calculated the weighted average from 15th May, and so have also shown 122 as a weighted average

Stock Number details and Barn Information (Woldwide Four): Table 1(a)

	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	LW (kg)
Dairy cows		300	769	760	750	750	730	720	710	700	655	295	540
First calving heifers	30	235	260	255	250	250	250	240	240	230	210		500
Dairy grazers (milking cows)	769	469									0	474	540
Dairy grazers (repl. In calf heifers)	233	27									131* (263)	263	500
Bulls						20	20						700
Number in Barns	1032	1031								465	995	1032	

* Overseer FM shows 263, however would have calculated the weighted average from 15th May, and so have also shown 131 as a weighted average

- With added cows and more time in barns, supplements were adjusted, and pastoral productivity aligned more in line with the current farm systems productivity, with associated reductions in fertiliser N and P as well. This fertiliser reduction was not significant and merely aligned P and N inputs with the added effluent and barn slurry P and N inputs

Pasture and Supplementary Feed Comparison

The predominant pasture species on the dairy farms is ryegrass/white clover. Annual pasture production has been weighted by relative productivity as 1 between dairy blocks, and 0.8 for the lesser producing grazing blocks on the platform respectively:

Woldwide Four

Block	Relative productivity	Current System T DM/ha/year	Proposed Barn System T DM/ha/year	Final Proposed Barn System T DM/ha/year
Dairy pastoral areas	1.0	15.1	16.0	15.6
Brax_4a.1 Non Eff Other Grazing	0.8	12.1	12.8	12.5
Cut & carry block Gladfield RO	n/a	12.2	16.3	16.3
Increased supplement amount				+100 T DM grain cows +115 T DM silage to heifers
Whole Farm N and P		195 and 26	216 and 26 249 and 34 slurry incl.	205 and 25 244 and 35 slurry incl.

Woldwide Five

Block	Relative productivity	Current System T DM/ha/year	Proposed Barn System T DM/ha/year	Final Proposed Barn System T DM/ha/year
Dairy pastoral areas	1.0	15.3	15.7	15.7
Upukeroroa soils	0.8	12.2	12.5	12.5
Increased supplement amount				+105 T DM silage to heifers
Whole Farm N and P fertiliser including slurry		158 and 47	156 and 12 193 and 26 slurry incl.	161 and 6 219 and 26 slurry incl

It should be noted that this estimated pasture production is based on default South Island pasture ME values and may be different to actual ME values and utilisation values on this farm which in turn would influence estimated pasture production.

All other factors have remained the same.

Results

For Woldwide Five: Average Nitrogen lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is changed from **15,804 kg N/year** or **47 kg N/ha/year** to **14,873 kg N/year** or **43 kg N/ha/year**.

There is an overall decrease in the amount of N lost on a per hectare basis. This has been reported in the Overseer Report

For Woldwide Four: Average Nitrogen lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is changed from **11,276 kg N/year** or **27 kg N/ha/year** to **9,550 kg N/year** or **23 kg N/ha/year**.

There is an overall decrease in the amount of N lost on a per hectare basis.

For Woldwide Five: Average Phosphorus lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is changed from **247 kg P/year** or **0.7 kg P/ha/year** to **244 kg N/year** or **0.7 kg N/ha/year**.

There is an overall decrease in the amount of P lost on a per hectare basis.

For Woldwide Four: Average Phosphorus lost from the root zone from the farm system modelled using OVERSEER FM® Nutrient Budgets 6.3.1/2.6.2.0 is changed from **371 kg P/year** or **0.7 kg P/ha/year** to **366 kg N/year** or **0.7 kg N/ha/year**.

There is an overall decrease in the amount of P lost on a per hectare basis.

Point 2 Mitigate P losses from Other Sources

Description of farm system scenario

The request is to clarify from the provided Nutrient budgets for the Winter Barn final proposals, that further mitigations are able to reduce overall P losses. This was not an initial request of the modeller but is so now. The approach taken is in line with the approach from the Woldwide 1&2 proposals, the key difference here being that the farms are not already in winter barns.

Key assumptions to the farm system results reported from the model are stated below.

Management details and Information: Proposed modelled P loss reductions Other Sources Woldwide Four: Table 2

Table 1.4 The fate of minerals ingested by a lactating dairy cow (ingesting 15.5 kg DM/day) (adapted from During 1984).

Element	Consumption Kg /week	Percentage in			
		Faeces	Urine	Milk	Retained
N	5.1	26	53	17	4
P	0.4	66	-	26	8
K	2.9	11	81	5	3
Mg	0.2	80	12	3	5
Ca	0.4	77	3	11	9
Na	0.4	30	56	8	6

All farm systems: Vegetated buffer strips For SS and P; Effectiveness is Moderate (34 to 66%) and cost is Moderate (108-200) to High (332-1393) see Smith 1989, Redding et al. 2008

Laneways	WW4		
Cow Numbers	1000	P loss	$(1000 * (299/7)) * 0.4 * 0.66$
Kg P eaten per week	0.4		$=11,276.6 * 0.04 * 0.3 = 135.3$
% excreted	66	P loss lanes	1.1 km
Lactation length	299	Total lanes	5.2 km
% time on lanes	4%	% of Total lanes	0.21
% P loss to water	30%	% effectiveness	34 to 66%
		P loss mitigated	$135.3 * 0.21 * 0.5$
			=14.2 kg P
Critical Source Areas (CSA)			
Number	4	P loss of Pastoral blocks	146
Area	2.5%	% effectiveness	34 to 66%
		P loss mitigated	$146 * 0.025 * 0.5$
			=1.825 kg P

A major component of P losses are losses from other sources which is from lanes, yards and stock camp areas.

The same information contained in the Phosphate Mitigation report by Cain Duncan the modeller for Woldwide 1 & 2 is used here;

An estimated 135 kg P/year is lost to lanes on Woldwide 4; the length of the laneway whereby trees are felled, and the lane way adjusted, and riparian planting and buffer zone installed is 1.1 km of the laneway system. This adds to 28 kg P/year lost to water and thus at a 50 % effectiveness for the mitigation as outlined in the table above, there is a reduction of 14.2 kg P/year.

In addition, it is been identified that there are 4 areas of Critical Source Areas (CSA) which would benefit from suggested riparian planting. Using the same figure of 2.5% of area as for Woldwide 1&2 and the P losses from Woldwide 4 of 73 kg P/year (of pastoral blocks totalled) a further reduction of 1.8 kg P/year can be made.

Management details and Information: Proposed modelled P loss reductions Other Sources Woldwide Five: Table 3

Waterway and riparian area	WW5		
Cow Numbers	930	P loss	$(930*(299/7)) * 0.4*0.66$
Kg P eaten per week	0.4		$=10487.2*0.04*0.3=136.3$
% excreted	66		=1.46 kg P/year
Lactation length	299	P loss for riparian buffer	$10+5 =15$
% time in paddocks	4%	% spent grazing on block	$42.8*8/(268.5*10+42.8*8)$
Area of platform block	268.5		$=0.1131$
Paddock area with water way	39.2	P loss mitigated	$15*0.1131=$
Paddock area with buffer zone	42.8		=1.7 kg P
		% effectiveness	67 to 100% (midpoint 85%)
			$(1.7+1.5) * 0.85=2.7$ kg P/year
Critical Source Areas (CSA)			
Number	4	P loss of Pastoral blocks	73
Area	2.5%	% effectiveness	34 to 66%
		P loss mitigated	$73*0.025*0.5$
			=0.91 kg P

Overseer is not able to account for the difference in P loss from Other sources when there is a winter barn used as a scenario option. It assumes the additional cows being milked and cattle wintered are still on the lanes and yards and the losses in these areas and subsequently the portion lost to waterways is not reduced. This was evidenced by the modelling of the same parameters with the final barn option and deleting the structures thus all animals grazed the pastoral blocks, with all supplements now fed on pasture, whilst all other inputs remained the same.

The N losses rose dramatically, thus showing that the Nitrogen sub model was accounting for the barn as a mitigation, however the P losses were very similar, with a very small increase, likely due to the grazing of all the dry stock on pasture.

The two results of this modelling are shown in the Table below;

Management details and Information: Modelled changes in P loss reductions No Barns or Winter Barns Woldwide Four & Five: Table 4

Losses	WW 4 N loss kg N	WW4 P loss kg P	WW5 N Loss kg.N	WW5 P loss kg P.
Barn	9550/year or 23/ha/yr.	366/yr. or 0.9/ha/yr.	14378/yr. or 43/ha/yr.	244/yr. or 0.7/ha/yr.
No Barn	13572/yr. or 33/ha/yr.	371/yr. or 0.9/ha/yr.	22070/yr. or 66/ha/yr.	245/yr. or .07/ha/yr.

Management details and Information: Proposed modelled P loss reductions Winter Barns Woldwide Four & Five: Table 5

Barn Calculation WW 5			
Cow Numbers	930	P loss	$(930*(299/7)) * 0.4 * 0.66$
Kg P eaten per week	0.4		$=10487.2 * 0.04 * 0.3 = 125.8$
% excreted	66	Total Grazing days	$930 * 299 = 278,070$
Lactation length	299	Grazing days April May & Aug	$92 * 930 = 85560$
% time in laneways	4%	% spent grazing in barn	$(85560 / 278070) * 14 / 24$
% loss to waterways	30%		$= 0.18$
P loss for month April	$125.9 / 12 = 10.49$	P loss mitigated	$(31.47 * 0.18) + 7.9$
P loss for month May	10.49		= 13.51 kg P
P loss for month August	10.49	% effectiveness	34 to 66% (high effect 60%)
P loss for month June/July	$10.49 * 2 / (3/8)$		(13.51) * 0.6 = 8.1 kg P/year
	$= 7.9$		
Total P mitigation			
CSA	0.9	Barn	8.1
Waterway and		Dry Cattle	1.0
Buffer Riparian area	2.7	Total P mitigated	= 12.7 kg P/year

Barn Calculation WW 4			
Cow Numbers	1000	P loss	$(930*(299/7)) * 0.4 * 0.66$
Kg P eaten per week	0.4		$= 11276.6 * 0.04 * 0.3 = 135.3$
% excreted	66	Total Grazing days	$1000 * 299 = 299,000$
Lactation length	299	Grazing days April May & Aug	$92 * 1000 = 92000$
% time in laneways	4%	% spent grazing in barn	$(92000 / 299000) * 14 / 24$
% loss to waterways	30%		$= 0.18$
P loss for month April	$135.3 / 12 = 11.28$	P loss mitigated	$(33.84 * 0.18) + 8.5$
P loss for month May	11.28		= 14.6 kg P
P loss for month August	11.28	% effectiveness	34 to 66% (high effect 60%)
P loss for month June/July	$11.28 * 2 / (3/8)$		(14.6) * 0.6 = 8.8 kg P/year
	$= 8.5$		
Total P mitigation			
CSA	1.8	Barn	8.8
		Dry Cattle	4
Laneways	14.2	Total P mitigated	= 28.8 kg P/year

Explanation of calculations

The amount of P deposited on laneways and assumed to be lost to water is as before.

The amount deposited in a month from this figure is a function of number of grazing days, with the assumption that the grazing days are similar between months. Thus the % of time on lanes over April and May and August is 31% and given 14 hours of the 24 hours is in the barn then the amount deposited on lanes is 18% of the monthly P loss which is the total (135.3 kg P/year for WW4) divided by 12 months. For June and July, there is 3 weeks which they are milking, the rest of the time they are dry cattle, so the figure for June and July is twice the monthly figure but 3/8ths of that figure is not lost to laneways.

The effectiveness of barns is between 34 to 66 % and it was decided that these barns are highly effective and the figure of 60 % is used.

Finally, the difference between the P loss between the barn and no barn examples seemingly showed the effect of the dry cattle grazing on pastoral blocks when effectively they do not see the pastoral blocks until calved. For Woldwide Four this figure was 4 kg difference and for Woldwide Five the figure was only 1, due to lower numbers. It is assumed that this is a probable amount that is not lost to water as well, given the model still assumes that the dry cattle are somehow required to be assigned to pastoral blocks when in fact they are in barns for the full 24 hours.

Results

For Woldwide Four, the average Phosphorus mitigated and therefore not lost from the root zone from the farm system modelled using OVERSEER FM[®] Nutrient Budgets 6.3.1/2.6.2.0 is calculated to be **28.8 kg P/year** and so the final P loss is recalculated to **337 kg/year** or **0.8 kg P/ha/year**.

This was not reported in the Overseer report.

For Woldwide Five, the average Phosphorus mitigated and therefore not lost from the root zone from the farm system modelled using OVERSEER FM[®] Nutrient Budgets 6.3.1/2.6.2.0 is calculated to be **12.7 kg P/year** and so the final P loss is recalculated to **231 kg/year** or **0.7 kg P/ha/year**

Average Phosphorus lost from the root zone from the farm system modelled using OVERSEER[®] Nutrient Budgets 6.3.0 is calculated to be **237 kg P/year** or **0.7 kg P/ha/year**.

This was not reported in the Overseer report.