Nutrient Budgets/Analysis – Woldwide 1 – Soil Survey

File Overview

Current

This scenario has been modelled on the current dairy farm (Woldwide 1) and the Horner Support Block as currently managed. The Horner Support Block is currently used for the spreading of wintering barn (and some small quantities of dairy) effluent from Woldwide 1 and the cut and carrying of grass silage for three wintering barns (including Woldwide 1). The dairy unit (Woldwide 1) currently occupies an effective area of approximately 204ha and is consented for 540 cows.

The current dairy farming area associated with Woldwide 2 that will become part of Woldwide 1 has not been modelled as part of the existing Woldwide 1 scenario. This land (including the associated nutrient losses) has already been allocated in the consent application to expand the land area associated with Woldwide 2. In order to gain a true reflection of the total nutrient losses from the proposed changes, the current losses from Woldwide 1 and Woldwide 2 will be compared to the proposed scenarios for both of these farms.

Fertiliser inputs for the file have been taken from the 2015/16 season application plan which reflects a typical farming year for the property.

Supplements taken off the cut and carry blocks are based on an average weight of 17T/DM/ha taken over four cuts. Silage feed to mature cows in the wintering barn and in paddocks are based on silage intakes of 700kg/DM/cow in winter and 513kg/DM/cow during the rest of the season. Additional supplements have also been utilised in the form of Palm Kernel Extract, Barley Grain and Molasses to supplement pasture and allow higher milks solids production per cow (491kg/MS/cow/yr).

Wintering barn slurry is generally applied to the Horner Block in three applications totalling between 1200m^3 and 1400m^3 depending on the season. Modelling has been undertaken on the maximum volume of 1400m^3.

To enable the utilisation of testing carried out on the nutrient content of the wintering barn effluent; effluent from the wintering barn has been entered as all exported with imported dairy effluent subsequently entered as a fertiliser on the support blocks. The nutrient content of the wintering barn effluent is derived from testing carried out by AgResearch in 2009 as part of their report on characterising dairy manures and slurries (used by Environment Southland). Subsequent testing has also been carried out Ravensdown, which has shown a slightly lower nutrient content.

Proposed

The proposed farming operation has an additional 54ha of land from Woldwide 2 added to the northern end of the current milking platform with a proposed increase of 260 cows (800 cows total).

The wintering barn will be increased in size to accommodate 620 cows with any additional cows wintered off the farm. Wintering barn effluent will continue to be spread on the Horner Support Block to support the cut and carry silage production for three wintering barns. With the additional effluent from the barn, imported fertiliser use will decrease on the Horner Block.

It is proposed to apply wintering barn effluent at 150kg/N/ha to minimise the amount of artificial fertiliser that needs to be applied. Even with all of Woldwide 1's wintering barn effluent being applied on the Horner Support Block (143kg/N/ha) this is insufficient to meet the nitrogen, phosphate and potassium requirements of the cut and carry operation (due to the lack of nutrient return via animal dung and urine while grazing).

Approximately 310-350 units of nitrogen per hectare are required to operate the cut and carry operation efficiently along with 73-80 units of phosphate per hectare.

On the main dairy platform Olsen P levels are proposed to be reduced from their current levels (40+) to 30. This is still within the range of a high producing dairy farm and more than adequate to sustain the levels of pasture production being proposed. The decrease in Olsen P levels also reduces the risk of phosphate being lost from the farming system.

Palm Kernel use in the dairy shed is proposed to increase slightly to supplement pasture eaten in paddocks and maintain high levels of production per cow with barley and molasses remaining the same on a per cow basis.

Nitrogen losses across Woldwide 1 & Woldwide 2 are outline in the following table and show a slight decrease in total nitrogen lost as a result of the farm changes. This is largely due to the removal of the wintering grazing from Woldwide 2 (SH96 Block), the effective cut and carries operations that are carried out on the Horner Block to support the wintering barn operations and the soil types on which the farms are located.

Total phosphate losses increase by 5.6% as a result if the changes to the farming enterprises, however this represents a total change of just 27kg across 572ha of land that makes up WW1 & WW2.

Current			
Nutrient	*Woldwide 1*	*Woldwide 2*	*Total*
Nitrogen (kg/yr)	3598	7564	**11162**
Phosphate (kg/yr)	141	189	**330**

Proposed			
Nutrient	*Woldwide 1*	*Woldwide 2*	*Total*
Nitrogen (kg/yr)	4350	6652	**11002**
Phosphate (kg/yr)	176	181	**357**

65% of the total phosphate loss is modelled as occurring from "other sources", which are farm scale losses from farm infrastructure, i.e. laneways, silage stacks, etc. A May 2015 report, prepared for Overseer by AgResearch, on the phosphorus loss sub-model was critical of the 'other sources' section of the P sub-model stating a review of these structures (lanes, pads, silage pits, etc) needs to be undertaken to identify whether these should actually be included in the model with a particular focus on lanes to determine whether the current loss factor is reasonable.

It would appear that most of the phosphate losses in “other sources” are being derived from lanes. Overseer automatically assumes 30% of phosphate deposited on a lane is lost, even if there is no surface water nearby.

In terms of the phosphate sub-model in Overseer, this estimates phosphate loss from dairy farm systems via run-off to surface water. This is either surface flow, interflow or subsurface flow to second order streams. It estimates the concentration of dissolved phosphate in an overland flow event from Olsen P and the soils P retention or ASC ability. The instigation of run-off is derived from a hydrological model within Overseer and a weighting for slope.

Phosphorus losses can be further mitigated (beyond that modelled by Overseer) by detailing at a farm level how surface and subsurface run-off will be prevented from entering waterways (this can’t be modelled in Overseer as the model can’t look at individual farm surface water flow paths or critical source areas). In addition to this, the large losses from “other sources” can be mitigated in a similar manner. Overseer automatically assumes 30% of phosphorus deposited on farm lanes is lost, when in reality there needs to be a transport mechanism to get the phosphorus from the lane to a waterway, thus good lane management, especially around waterways will be a further mitigation above that able to be modelled in Overseer.

Current – 540 cows (Soil Survey Soils)

- Potential nitrogen loss to water of 17kg/ha (Fonterra Ward Mean = 33 kg/ha/yr based on 243 farms)
  Nitrogen leaching to water is nitrogen that leaves the soil root zone, it does not account for denitrification within the soil profile or the underlying aquifer. This may be significant in some physiographic zones.

- High Nitrogen Conversion Efficiency at 63%
  This is the percentage of nitrogen that is brought into the farming system from fertiliser, supplementary feed and clover fixation that is converted to products (milk and meat).The higher the percentage, the more efficient the farm is at using its nitrogen resources. Indicative range = 10-45%. ***This farm includes a moderate sized cut and carry block, which accounts for the nitrogen conversion efficiency sitting outside the normal range for a typical dairy farm.***

Woldwide 1 - Current (Soil Survey) Cain Duncai
Woldwide 1 Fonterra
Client reference:
Farm name: 32650-1516-F (2015-16)

Farm Nutrient Budget - Whole farm

	N	P	K	S	Ca	Mg	Na
	(kg/ha/yr)						
Nutrients added							
Fertiliser, lime & other	235	42	81	39	55	4	1
Rain/clover N fixation	77	0	2	4	3	6	25
Irrigation	0	0	0	0	0	0	0
Supplements imported	72	15	30	10	3	6	3
Nutrients removed							
As products	96	16	23	5	22	2	7
Exported effluent	49	8	43	5	11	4	2
As supplements	0	0	0	0	0	0	0
To atmospheric	117	0	0	0	0	0	0
To water	17	0.7	18	56	58	3	12
Change in internal pools							
Plant material	32	3	31	2	7	0	0
Organic pool	64	17	4	-16	0	1	0
Inorganic mineral	0	5	-18	0	-2	-3	-4
Inorganic soil pool	11	8	12	0	-36	10	11

- Phosphate applications generally well matched to soil test results with areas of high Olsen P receiving below maintenance phosphate applications (will reduce Olsen P overtime) and areas with lower Olsen P receiving capital applications.

- Paddock 8 has an Olsen P of 60ug/ml. Consider reducing P inputs to this area well below maintenance levels and re-test over the coming seasons.

- Overall Olsen P levels are high, even for a high producing dairy farm. These are proposed to be gradually reduced to 30. Maintaining Olsen P levels above 40 results in few productivity gains and disproportionally high costs and risk of P loss.

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SOIL ANALYSIS

Lab Number	Sample Name	Core Length (cm)	pH	Olsen Sol. P ug/mL	Calcium QTU	Magnesium QTU	Potassium QTU	Sodium QTU	Sulphate Sulphur ug/g	Ext.Org. Sulphur ug/g
1392390	36	7.5	6.2	30	11	30	11	7	10	8
1392391	13	7.5	5.9	43	12	34	11	9	9	16
1392392	30	7.5	5.9	37	12	25	6	6	15	13
1392393	23	7.5	6.0	48	13	41	9	10	5	13
1392394	19 Eff	7.5	6.4	42	17	50	20	8	8	18
1392395	8	7.5	6.3	60	18	61	14	12	9	19

- Nitrogen summary report shows slightly higher nitrogen losses on the Drummond soil blocks due to the nature of the soil. These soils are well drained making them more susceptible to nutrient leaching. The farms overall nitrogen leaching risk is low (17kg/ha) when compared to other dairy farms in the region (Ward 35 Lower Quartile = 22 kg/ha – 243 farms).

- Proportionally higher nitrogen losses are occurring on the areas where summer turnips are grazed due to the lack of plant uptake of urinary N when grazing (ground fallow once crop eaten).

- The strategic use of nitrogen (rather than simply following the cows) to fill specific feed gaps is encouraged as good practice both environmentally and economically.

Woldwide 1 - Current (Soil Survey) Cain Duncar
Woldwide 1 Fonterra
Client reference:
Farm name: 32650-1516-F (2015-16)

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Effluent (Drum_2a.1)	10	0.3	Low	Low	Medium
Turnips	1	0.2	n/a	n/a	n/a
Non-Effluent (Brax_4a.1) ##	14	0.5	Low	Medium	n/a
Non-Effluent (Drum_2a.1) ##	18	0.2	Low	Low	n/a
New Grass	1	0.2	Low	Low	n/a
Support Horner Blk (CC) Barn Eff (Br	13	0.3	n/a	n/a	n/a
Other farm sources	84				
Whole farm	141	0.7			

Has a fodder crop rotating though, results for pastoral block component only

Woldwide 1 - Current (Soil Survey) Cain Duncar

Woldwide 1 Fonterra

Client reference:

Farm name: 32650-1516-F (2015-16)

Block Nitrogen

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Effluent (Drum_2a.1)	722	23	6.2	310	317
Turnips	325	50	**11.5**	62	133
Non-Effluent (Brax_4a.1) ##	300	11	3.3	233	249
Non-Effluent (Drum_2a.1) ##	1456	17	4.6	230	249
New Grass	53	11	3.1	163	61
Support Horner Blk (CC) Barn Eff (Br	497	10	3.0	-6	334
Other farm sources	246				
Whole farm	3598	17			
Less N removed in wetlands	0				
Farm output	3598	17			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Has a fodder crop rotating though, results for pastoral block component only

Proposed – 800 cows (Soil Survey Soils)

- Increase in cow numbers from 540 to 800 over an additional 54ha.
- Inputs (fertiliser & imported feed) increased proportionally based on current per cow demands with some additional increases to in shed feed (PKE).
- Milk solids production increased to 392,000kg/yr from 270,050kg/yr.
- No crops produced.
- Reduction in Olsen P levels on dairy platform from 40+ to 30 with corresponding reduction in phosphate fertiliser to maintain Olsen P at 30.

Woldwide 1 - Proposed - 800cows — Cain Duncai

Woldwide 1 — Fonterra

Client reference:

Farm name: 32650-1516-F (2015-16)

Farm Nutrient Budget - Whole farm

	N	P	K	S	Ca	Mg	Na
	(kg/ha/yr)						
Nutrients added							
Fertiliser, lime & other	230	33	82	31	42	4	1
Rain/clover N fixation	88	0	2	4	3	6	25
Irrigation	0	0	0	0	0	0	0
Supplements imported	87	19	37	12	4	8	3
Nutrients removed							
As products	113	19	27	6	26	2	8
Exported effluent	63	9	57	6	15	5	3
As supplements	0	0	0	0	0	0	0
To atmospheric	128	0	0	0	0	0	0
To water	16	0.7	20	53	61	3	13
Change in internal pools							
Plant material	0	-1	5	-1	0	-2	-1
Organic pool	85	15	4	-17	0	1	0
Inorganic mineral	0	4	-19	0	-2	-3	-4
Inorganic soil pool	0	4	26	0	-51	11	11

- Nitrogen loss per hectare reduces from 17kg/ha to 16kg/ha with total nitrogen loading increasing from 3598 kg/ha to 4350kg/ha. This does not take into account the existing baseline losses from the land associated with Woldwide 2 that now forms part of Woldwide 1. Total nitrogen losses need to be compared across both Woldwide 1 and Woldwide 2 to obtain a full understanding of total nitrogen losses. This comparison is undertaken on page 2 of this document.

- Nitrogen Conversion Efficiency remains high at 62%

- Expansion of wintering barn results in the majority of cows being able to be wintered indoors, minimising the need for cows to be wintered on support land within the catchment.

- No increase in phosphate losses per hectare (0.7kg/ha) but total phosphate loading increases from 141 to 176kg/ha. This does not take into account the existing baseline losses from the land associated with Woldwide 2 that now forms part of Woldwide 1. Total phosphorus losses need to be compared across both Woldwide 1 and Woldwide 2 to obtain a full understanding of total phosphorus losses. This comparison is undertaken on page 2 of this document.

Woldwide 1 - Proposed - 800cows — Cain Duncar
Woldwide 1 — Fonterra
Client reference:
Farm name: 32650-1516-F (2015-16)

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Effluent (Drum_2a.1)	12	0.2	Low	Low	Medium
Non-Effluent (Brax_4a.1)	23	0.4	Low	Low	n/a
Non-Effluent (Drum_2a.1)	14	0.1	Low	Low	n/a
New Grass	2	0.4	Low	Low	n/a
Support Horner Blk (CC) Barn Eff (Br	12	0.3	n/a	n/a	n/a
Other farm sources	113				
Whole farm	176	0.7			

Woldwide 1 - Proposed - 800cows

Woldwide 1

Client reference:

Farm name: 32650-1516-F (2015-16)

Cain Duncar

Fonterra

Block Nitrogen

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Effluent (Drum_2a.1)	1184	24	6.3	294	301
Non-Effluent (Brax_4a.1)	749	12	3.5	228	249
Non-Effluent (Drum_2a.1)	1706	18	5.0	227	249
New Grass	39	8	2.4	127	30
Support Horner Blk (CC) Barn Eff (Br	323	7	1.9	16	312
Other farm sources	350				
Whole farm	4350	16			
Less N removed in wetlands	0				
Farm output	4350	16			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.