File Note

Client Adams

Date 19th November 2018

File Note Background

An application for expanded dairying has been lodged by Mike and Cindy Adams. As part a section 92 request Environment Southland has raised some questions regarding a modelled increase in phosphorus (P) loss between the current and proposed scenarios.

The Overseer™ modelling predicts the following:

Total P loss to increase between the current and proposed scenarios by	19 kg P / year
Total P loss to increase due to off-site effects by	28 kg P / year
Potential total increase of	**47 kg P / year**

Further information can be found with regard to the Overseer™ and phosphorus loss in the following paper: Review of the phosphorus loss submodel in OVERSEER™, September 2016.

The Overseer™ leaching model has a significant amount of validation, whereas the P loss model is primarily based on calibration.

Further information can be found in the following report: Wheeler and Shepherd 2013, OVERSEER® : Answers to commonly asked questions.

Phosphorus Loss – From Lanes

Overseer™ has a range of base assumptions built into it. One of these is the loss of phosphorus from laneways. It is assumed that 30% of dung deposited on laneways will be lost to water. Phosphorus is a key component of dung and therefore this is a significant assumption. This loss is included in the "other sources" of the phosphorus report.

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	Percentage in			
	Kg /week	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

Source: MASSEY UNIVERSITY SUSTAINABLE NUTRIENT MANAGEMENT , Introductory Notes and Mastery Test

From the above table a cow being fed 15.5 kg DM / cow / day consumes 0.4 kg phosphorus per week, 66% of this is in faeces. For a cow with a 270 day lactation (assumed not walking

on lanes outside of lactation) this will be 10.2 kg of phosphorus per cow per year that will be in faeces.

If on a farm, the cows spend conservatively on average 1 hour per day walking to and from the shed, therefore 4% (1 hour as a percentage of 24 hours) of faeces will be deposited on lanes. Overseer™ assumes that 30% of faeces deposited on lanes will be lost from the farm to water.

Therefore Overseer™ is estimating that approximately 141 kg phosphorus per year will be lost from the farm (this takes no account of any farm specific features or mitigations) to water.

((10.2 kg P / cow / yr x 1150 cows) x 4%) x 30% = 141 kg P / year

To compare fairly between the current and proposed scenarios (assuming that the loss from lanes is already mitigated in the current milking platform), if the same calculations are rerun for the increase in cow numbers (that is 250 cows), phosphorus loss is calculated as follows:

((10.2 kg P / cow / yr x 250 cows) x 4%) x 30% = 31 kg P / year

Assuming the siting of lanes, vegetated buffer zones and lane management reduces the estimation by 38% (the very conservative lower range of the data summarised in figure 1 below), it would be expected that 12 kg P (31x 38%) would be mitigated.

The above calculations do not take into account that in practice that the current dairy support block has a laneway next a waterway (which will not be modelled in the Overseer™ current support block file). This lane will currently be incurring loss of phosphorus and will be decommissioned in the proposal.

Phosphorus Critical Source Areas

One of the key changes from the current to the proposed scenarios is the change from the dairy support block (which is intensively winter grazed) to including this block as part of the milking platform.

Overseer™ estimates the loss from the current 99.6 ha support block will be 175 kg phosphorus per year (1.8 kg P / ha / year). Due to a high portion of this block being wintered on with a multiple cropping regime (which will impact on soil structure) and that the block comprises of pallic soils it is highly likely that P loss is underestimated in Overseer™. It is difficult to quantify this – so no estimation has been made (note measured losses at the Telford site (pallic soils on sloping ground) showed a P loss of 6.9 kg P / ha / year).

Reference: Reducing surface runoff from grazed winter forage crop paddocks by strategic grazing management /www.dairynz.co.nz/media/5787285/reducing_surface_runoff.pdf

It is proposed the support block becomes part of the milking platform and cropping will reduce significantly. However, the change of land use offers the opportunity to manage the critical source areas on this 99.6 ha (it is assumed the majority of critical source areas have already managed on the current milking platform). We have not taken into account the further management of critical source areas on the current sheep breeding block.

Management of critical source areas and vegetated buffers have been shown to reduce phosphorus loss by 38 to 58% (refer figure 1 below). The actual mitigation achieved will depend on catchment area, size and vegetation of buffer zone.

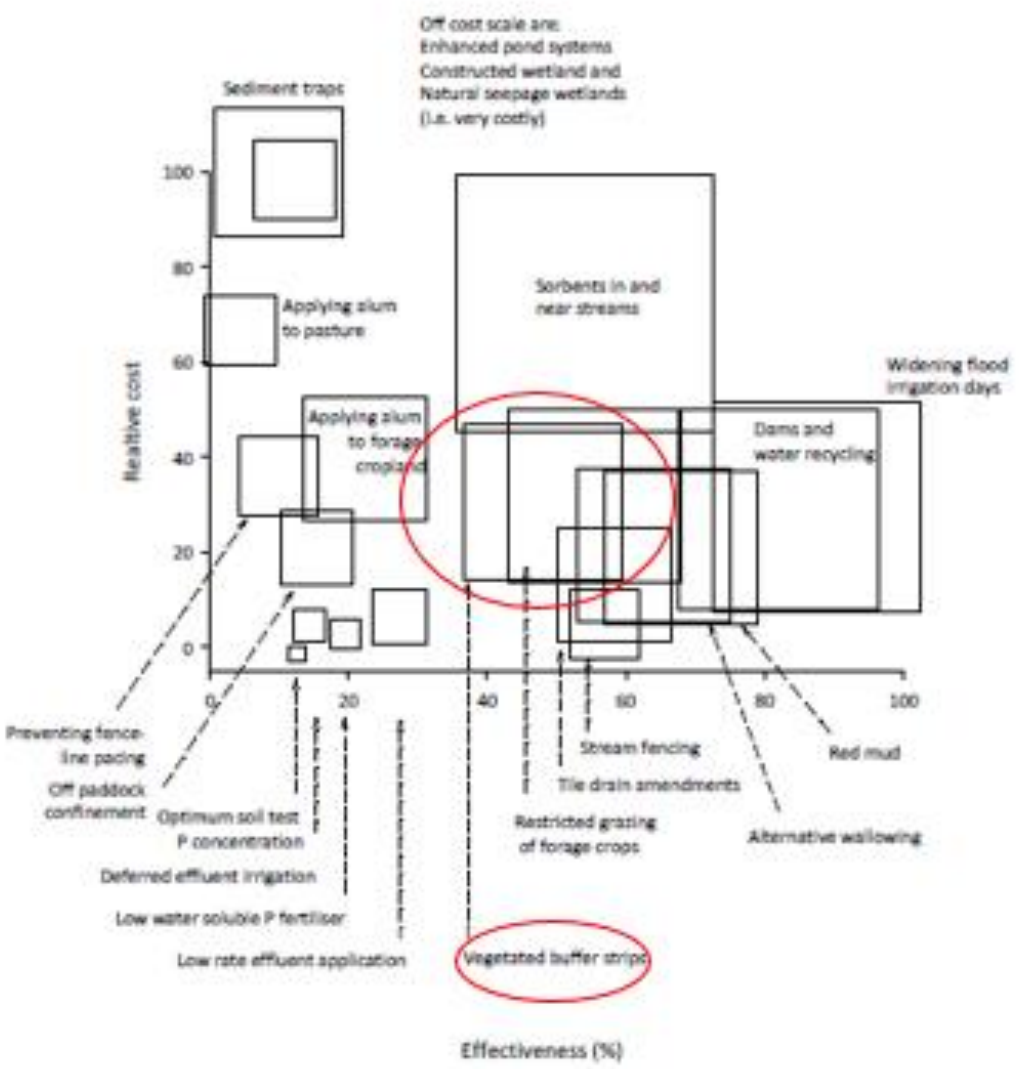

Figure 4. Diagram of the cost and effectiveness of strategies to mitigate **phosphorus** losses to water at the farm-scale. Cost is shown as the cost per kg of P mitigated relative to the most expensive strategy - sediment traps at $360 per kg P retained/ha/yr. The centre of the squares represents the mid-point in the range for each strategy, while the size represents the relative variability of cost-effectiveness for each strategy as the product of the range in percent effectiveness by the range in cost. Enhanced pond systems and the two wetland type were considerably more expensive (1400 – 4000% > sediment traps)

Figure 1 : Assessment of Strategies to Mitigate the Impact or Loss of Contaminants from Agricultural Land to Fresh Waters, June 2013

From the Overseer™ reports for the proposed dairy unit the following information has been extracted.

Block	Area (effective)	P loss / ha / year (1)	P loss from run off / ha / year (2)	P Loss from run off / year	Management of critical source areas (38% reduction)
Ohai non effluent flat	58.1	0.9	0.7	41	16
Makarewa non eff flat	3.2	0.5	0.4	1	0
Makarewa non eff rolling	5.3	1.4	1.2	6	2
Ohai non eff rolling	30.1	2.6	2.4	72	27
					45 kg P / year reduction

(1) Table 12, Proposed system phosphorus loss report, Overseer Modelling report, Hunter and Topham 2018

(2) Extracted from individual block reports of the Overseer™ proposed nutrient budget

The mitigation of P loss from critical source areas and vegetated buffer zones is likely to capture the P loss in run off (rather from the other loss pathways). An effectiveness of 38% has been assumed (based on the lower end of the range of 38 to 58% on figure 1 above).

It is therefore assumed that management of critical source areas would reduce phosphorus loss by 45 kg per year from the proposed scenario. Those strategies would need to be included in a more detailed Farm Environment Plan.

Phosphorus Loss – Off Site Effects

As the current dairy support blocks were currently wintering 1470 cows, it was assumed in the application that an extra 530 cows would need to be wintered elsewhere. This estimated an off-site effect of 28 kg phosphorus per year.

This estimate was based on cows wintered on similar soils on 17.3 ha of fodder beet. It is unknown if the extra 530 cows are alive and wintered in Southland, or in a different location. However, that land would have been used for something else so a net increase (rather than total increase) should be taken into account.

A conservative estimate can be made using the phosphorus loss from the sheep operation. The current neighbouring sheep breeding block had an average phosphorus loss of 0.6 kg P / ha / year.

Therefore, assuming the land was previously used for sheep (when cows are sent to graze

17.3 ha x 0.6 P / ha / year = 18 kg P / year prior land use

Phosphorus Loss - Other

Other mitigation measures not calculated are:

Cultivation practices

Grazing management and practices (especially of winter crops)

Summary

Overseer™ does not recognise some farm landscape features and mitigations that could be used on farm when calculating phosphorus loss. In this file note calculations (outside of Overseer) have been completed to gain an estimate of the impact of these practices on the phosphorus loss results for the Adams property.

Lane way management	12 kg P / year
Managing critical source areas on the 99.6 ha block	45 kg P / year
Off site effects (prior land use)	18 kg P / year
	75 kg P / year

Conclusion

The Overseer™ modelling submitted with the Adams application predicted the following:

P loss to increase between the current and proposed scenarios by	19 kg P / year
P loss to increase due to off site effects by	28 kg P / year
Potential total increase of	**47 kg P / year**

Through calculations completed outside Overseer™ to quantify the proposed mitigations the following has been calculated

Lane way management	12 kg P / year
Managing critical source areas on the 99.6 ha block	45 kg P / year
Off site effects (prior land use)	18 kg P / year
Potential decrease through mitigations proposed	**75 kg P / year**

Therefore, including the phosphorus mitigation strategies that are not modelled in Overseer™, there is predicted to be a net decrease in phosphorus loss between the current and proposed scenarios of **28 kg P / year**. Taking account of the earlier indications of the uncertainties of modelling phosphorus loss in Overseer modelling, this would still indicate a significant reduction in phosphorus loss.

There is likely to be further reduction of phosphorus loss than shown above if the mitigations proposed on the current dairy farm and the sheep breeding block are also analysed.

Please note:

Every attempt has been made to complete the above calculation conservatively and reference assumptions to research. It should be noted that this is not an easy task to quantify.

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