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Further information: T and J Driscoll Family Trust consent application

Please find below a file note in relation to Overseer modelling completed for the T and J Driscoll Family Trust. This file note is intended to be read alongside the Overseer Modelling Report, dated 1st October, 2018.

Executive summary

An application for consent to use land for dairying was made by the T and J Driscoll Family Trust in October 2018. This application utilised Overseer data to quantify predicted losses of nitrogen and phosphorus from the current and proposed systems. Environment Southland has raised concern that the predicted P losses using Overseer are higher in the proposed system than the current system. However, there are a range of P loss mitigations that are not accounted for, or are not fully accounted for, in Overseer. This file note seeks to quantitatively estimate the difference in P loss between the current and proposed systems using both Overseer and the results of recent New Zealand research.

Overseer has predicted the following total P loss:

Current situation	262 kg P/yr
Proposed situation	278 kg P/yr
Difference	**16 kg P/yr increase**

The Overseer model has a reasonable degree of calibration and evaluation/validation within the nitrogen leaching sub-model. However, the P loss sub-model has been developed using a less extensive calibration and evaluation/validation base. The model is not spatially explicit and as such it uses a number of assumptions to make estimates of both N and P loss. It is important to appreciate that there are significant uncertainties associated with Overseer nutrient loss estimates and Overseer currently only provides for a very limited range of mitigation options to be incorporated.

We have considered the current mitigations in place to reduce nutrient loss from laneways and further mitigations planned. These are described in the report. Revised Overseer P loss estimates have been calculated, taking into account the effect of the laneway mitigations for the current and proposed systems:

	Overseer P loss estimate	– estimated P loss mitigated	= revised P loss
Current system	262 kg P/yr	- 33kg P	= 229kgP
Proposed system	278 kg P/yr – 19.1kgP	- 52kg P	= 226kgP
Difference			**= 3kg P/yr decrease**

Further mitigations that may be implemented in the future are to apply 50% of the phosphorus fertiliser in a low solubility form and to lower the Olsen P to 30. Overseer predicts that these mitigations would reduce P loss from the pastoral areas by a further 10 kg P.

P runoff from laneways

Overseer has a built in assumption that 30% of phosphorus deposited on laneways as dung is lost. This is accounted for in the "other sources" losses within the Phosphorus report (shown in the appendices of the consent application). Research has shown that a dairy cow consuming 15.5kgDM/day on a pasture diet will consume 0.4 kg P/week, of which 66% will be deposited in dung (shown in the table below, source: Massey University). Assuming that the farm has a lactation

season of 270 days, each cow will ingest 15.4 kg P/cow, and **10.2kgP/animal would be deposited as dung.** A study by Ledgard *et al.* (1999) reported that **5% of cow excreta was deposited on laneways.** We have assumed that Overseer incorporates this information. Overseer then assumes that for phosphorus deposited on laneways in dung, **30% is lost from the system to water.**

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

There is opportunity to mitigate the losses from laneways through careful management of bridges/culverts, buffer zone planting, laneway cambering and siting laneways away from waterways. These mitigations all reduce P loss by ensuring laneway runoff is filtered through a vegetated buffer strip. Research has shown that vegetated buffer strips can reduce P losses by 38-59% (figure 1). None of these mitigation strategies are provided for in Overseer.

As described in the application for consent, this property has already implemented some mitigations to reduce phosphorus loss from laneways. These include kickboards on the two bridges (see pictures in consent application) and having some cut outs from the lane that direct runoff into paddocks rather than into waterways. The process of applying for consent has identified areas where further mitigations could be implemented. This includes improving the kickboards on the bridges, and improving the camber and increasing the size of the buffer on the laneway south of the cowshed which runs alongside an open drain. Water flow will be redirected through vegetated areas to allow for filtering. These areas of laneway are considered critical source areas – small areas that contribute a relatively high proportion of nutrient/phosphorus losses.

These improvements in laneway management will further mitigate losses of P. A study in the Mangakino stream by McDowell et al. (2006) found that the majority (c. 80%) of P losses were occurring from a small tributary that contributed less than 20% of the flow. Investigation of the tributary found that there was a heavily used, poorly managed dairy farm stream crossing less than 200m upstream from the confluence. Management of these high risk areas of laneway can therefore have significant positive effects on expected losses.

Given the evidence above, it has been assumed that the Driscoll property is currently mitigating at the low end of the range of reported mitigation, i.e., 38% of the losses from laneways assumed by Overseer, for the current 573 cows.

P loss mitigated = Cows x P in dung x Excreted on lanes x assumed losses x current mitigations
Current system = 573 x 10.2kg P x 5% x 30% x 38%
= 33 kg P/yr

Revised Overseer estimated P loss (current system) = 262 kg P – 33kg P = 229 kg P

Going forward, as a result of this consent application, the Driscolls will make further mitigations to reduce laneway losses through increased use of vegetated buffers, as described above. We consider that these improvements can reduce annual P loss from laneways to the midpoint of the range of reported mitigation, i.e., 49% of the losses assumed by Overseer, for the proposed 700cows.

P loss mitigated	= Cows	x	P in dung	x	Excreted on lanes	x	assumed losses	x extra mitigations
Proposed system	= 700	x	10.2kgP	x	5%	x	30%	x 49%
	= 52 kg P/yr							

Revised Overseer estimated P loss (proposed system) = 278 kg P – 52kg P = 226 kg P

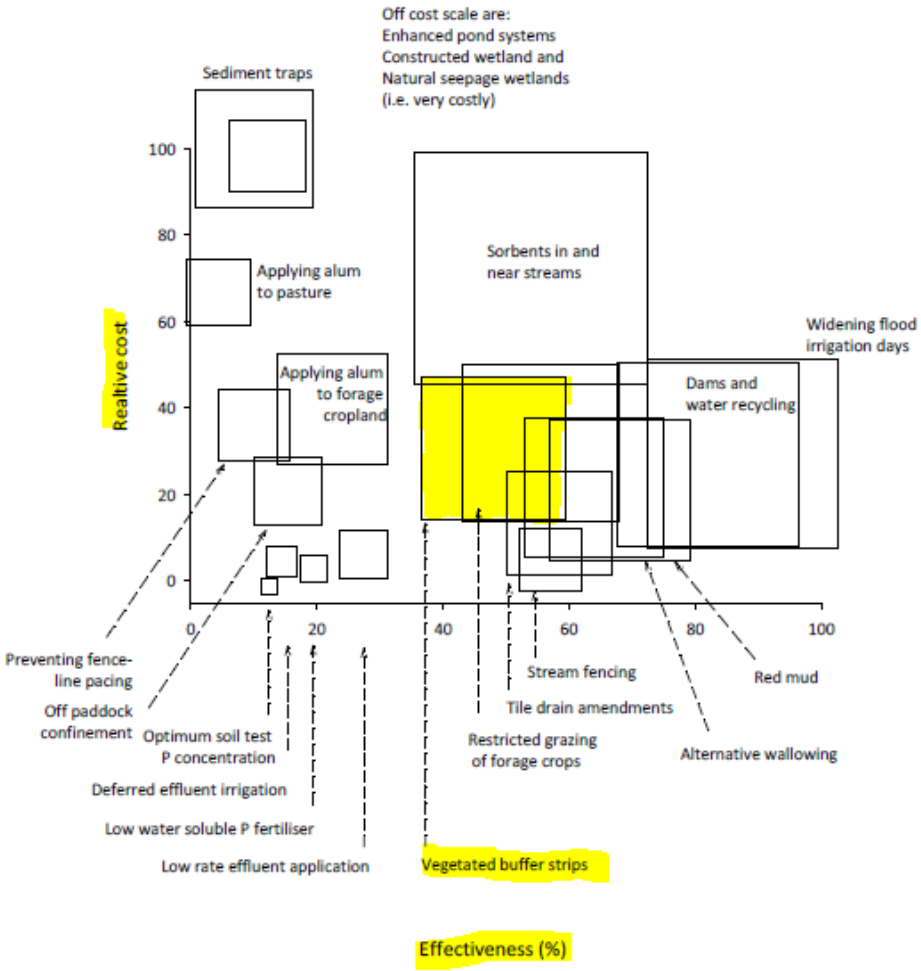

Figure 1. Diagram of the cost and effectiveness of strategies to mitigate phosphorus losses to water at the farm-scale. Cost is shown as the cost per kg of P mitigated relative to the most expensive strategy - sediment traps at $360 per kg P retained/ha/yr. From McDowell et al (2013)

Further future mitigation options:

Lower solubility Phosphorus fertilisers

The modelling completed assumed that fertiliser P would be applied as super phosphate – the most commonly used P fertiliser in New Zealand. This assumption was made in order to show a conservative estimate of losses, and to ensure that the systems were compared fairly. Going forward, the Driscolls have indicated that they are considering using RPR/serpentine super instead of super phosphate. This was not shown in the modelling as a transition to RPR/serpentine super should be untaken over a number of years in order to maintain pasture production.

Super phosphate fertiliser is 100% water soluble. In comparison, serpentine super and Reactive Phosphate Rock (RPR) have lower water solubility - 2.9% and 0% respectively (McNaught et al, 1968). As a result, the risk of P loss is higher in situations where super phosphate has been applied compared to RPR or serpentine super.

To show the effectiveness of this as a mitigation, I have modelled applying a maintenance application of P as 50% super phosphate and 50% RPR instead of 100% super phosphate. Please note that the amount of P, in kg P per ha, has not changed, but the form of the fertiliser has. Overseer assumes that serpentine super has the same solubility as superphosphate (Wheeler and Watkins, 2016), and therefore the same fertiliser runoff risk profile. However, due to it's similar water solubility, serpentine super is expected to have similar losses of P as RPR. **This change in fertiliser form has resulted in a reduction in predicted P loss by 4kgP**. The Overseer P loss reports are shown in the appendices.

Soil Olsen P

Olsen P is a commonly used measure of plant available soil P. From an agronomic perspective, the optimum Olsen P level is 30. The Driscolls have an average Olsen P of 32. In the modelling completed for the Driscoll's it was assumed that maintenance fertiliser would be applied going forward, and that the Olsen P would therefore remain the same.

The consent application process has highlighted the environmental risk of a higher Olsen P to Tim and Jocelyn. As a result Tim and Jocelyn are considering reducing their Olsen P. **Overseer predicts that a reduction in Olsen P from 32 to 30 is expected to reduce P loss by 6kgP**. The Overseer P loss reports are shown in the appendices.

Conclusions:

Overseer has predicted the following total P loss:

Current situation	262 kg P/yr
Proposed situation	278 kg P/yr
Difference	**16 kg P/yr increase**

We have considered the current mitigations in place to reduce nutrient loss from laneways and further mitigations planned. These are described in the report. Revised Overseer estimates have been calculated, taking into account the effect of the laneway mitigations for the current and proposed systems:

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Further mitigations that may be implemented in the future are to apply 50% of the phosphorus fertiliser in a low solubility form and to lower the Olsen P to 30. Overseer predicts that these mitigations would reduce P loss from the pastoral areas by 10 kg P.

References

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Wheeler, D., & Watkins, N. (2016). *Overseer Technical Manual: Characteristics of Fertilisers.* AgResearch.

Appendices:

Table 1. Block P loss table, as estimated by overseer for the Proposed system (same as in the consent application)

Farm name: Driscolls Proposed FINAL 1Oct

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.5	Low	Low	Low
Pukemutu Effluent	46	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	82	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.5	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	n/a
Other farm sources	121				
Whole farm	278	1.2			

Table 2 Block P loss table, as estimated by overseer for the Proposed system – after applying 50% of the phosphorus fertiliser in a lower solubility form.

Farm name: Driscolls Proposed FINAL 1Oct - 50% RPR

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.4	Low	Low	Low
Pukemutu Effluent	45	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	79	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.4	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	1	0.8	Medium	Low	n/a
Other farm sources	121				
Whole farm	274	1.2			

Table 3. Block P loss table, as estimated by overseer for the Proposed system – after reducing Olsen P to 30.

Farm name: Driscolls Proposed FINAL 1Oct - Olsen P 30

Block Phosphorus

Block name	Total P lost (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	19	0.4	Low	Low	Low
Pukemutu Effluent	44	0.9	Medium	Low	Medium
Waikiwi non effluent	8	0.4	Low	Low	n/a
Pukemutu non effluent	79	0.8	Medium	Low	n/a
Baleage winter - waikiwi Eff	0	0.4	Low	Low	Low
Baleage winter - Pukemutu Eff	1	0.9	Medium	Low	Medium
Baleage winter - Waikiwi Non Eff	0	0.4	Low	Low	n/a
Baleage winter - Pukemutu Non Eff	2	0.8	Medium	Low	n/a
Other farm sources	120				
Whole farm	272	1.2			