Mo Topham
CNMA
Southland
Ph: 027 279 7449
Email: mo.topham@outlook.com

File Note: 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 in conjunction alongside the previous Overseer modelling reports, dated 1st October 2018 and the previous file note "Further information: T And J Driscoll Family trust consent application," dated 18th December 2018. Both of these reports have been included in the appendices of this file note.

Purpose of this Report

The applicant (T and J Driscoll Family Trust) have instructed further modelling to be undertaken to reduce nutrient loss in the proposed dairy farm.

Previous Modelling Results

Overseer modelling was completed for the T and J Driscoll Trust in October 2018 using Overseer version 6.3.0. Summarised results from this modelling is shown in Table 1.

Table 1. Predicted nitrogen and phosphorus losses in the current and proposed systems (From modelling report dated 1st October 2018 – in appendices)

	Current system	Proposed system
Total Farm N Loss (kg)	11,503	11,345
N Loss/ha (kgN/ha/yr)	51	51
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2

Following this modelling, Environment Southland raised concern that the predicted Phosphorus losses using Overseer are higher in the proposed than the current system. A file note was completed to quantify the impact of mitigations that are not accounted for in Overseer. Results including the phosphorus mitigations modelled outside of Overseer 6.3.0 are shown in table 2.

Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

Table 2. Predicted nitrogen and phosphorus losses in the current and proposed systems, including phosphorus mitigations modelled outside of Overseer 6.3.0 (From "Further information: T and J Driscoll Family Trust consent application" - in appendices)

	Current system	Proposed system
Total Farm N Loss (kg)	11,503	11,345
N Loss/ha (kgN/ha/yr)	51	51
Total Farm P Loss (kg)	229 (including 33kg P mitigation modelled outside of Overseer)	226 (including 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0

Using the Overseer 6.3.0 model and supporting phosphorus loss calculation outside of Overseer, it is predicted that losses of nitrogen will decrease by 1.4% and losses of phosphorus will decrease by 1.3%.

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use
- Increased cow numbers – increasing loss risk

The key driver of the decrease in phosphorus loss are shown below. In comparison to the current system the proposed has:

- Improved laneway sediment loss mitigations

Changes in Overseer since October 2018

Since October 2018 there have been two key changes in Overseer:

- Overseer moved to the OverseerFM platform. Please note that this was a change in the Overseer platform and working interface rather than a change to the mechanics of Overseer. This movement therefore created no change in predicted nitrogen and phosphorus losses.
- In February 2019 version 6.3.1 of OverseerFM was released. Version 6.3.1 made a change to the OverseerFM model relating to fodder crops. This has had a small impact on the results predicted for the T and J Driscoll Family Trust.

The Overseer files related to this consent application were reopened in OverseerFM version 6.3.1. Climate location and maintenance fertiliser inputs have been updated and the method is consistent between the current and proposed files. No other changes were made. Summary results from OverseerFM 6.3.1 are shown below with changes shown in red.

Table 3. Predicted nitrogen and phosphorus losses in the current system as modelled in OverseerFM 6.3.1

	Current Dairy Platform (3yr average)	East Block – Sheep (15-16 season)	East Block – Transition (16-17 season)	East Block – Dairy Support (17-18 season)	East block (average of 3yrs)	Current Total (averaged over 3 years)
Total Farm N Loss (kg)	11273	203	132	385	240	11513
N Loss/ha (kgN/ha/yr)	54	14	9	27	17	51
N Concentration in Drainage (ppm)	Pastoral – 10 to 13 Crops – 21 to 42	Pastoral – 3	Pastoral – 2	Pastoral - 6		
Total Farm P Loss (kg)	253	10	9	10	10	263
P loss/ha (kgP/ha/yr)	1.2	0.7	0.7	0.7	0.7	1.2
Overseer - predicted pasture grown (tDM/ha/yr)	16.2	11.8	11.8	11.9		

Table 4. Predicted nitrogen and phosphorus losses in the current and proposed systems, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system
Total Farm N Loss (kg)	11513	11348
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 10 to 29
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	226 (including 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

Further Modelling

During conversations with Environment Southland and LandPro it has become clear that under the Proposed Water and Land Plan that the applicant needs to demonstrate a farm system (through modelling) that would contribute to a clear improvement to water quality.

Key changes from the original proposal are as follows (see appendices for detailed assumptions):

- Reduction in peak cows milked (from 700 to 680)
- Reduction in young stock numbers (aligned to reduction in cow numbers)

- Reduction in nitrogen applied as fertiliser overall
- Increased use of barley as a purchased in feed (lower protein feed)
- Increase in area utilised for baleage grass wintering
- A reduction in Olsen P to 30 on the milking platform (note the Olsen P on the East Block will increase from the current 20)

The East Block has been blocked separately and additional mitigation strategies have been implemented on this block (see appendices for detailed assumptions):

- No wintering on this block (June and July)
- No grazing of livestock in the months of May to August, requiring less pasture cover May to August and a subsequent reduction in fertiliser N applications, and consequently overall lower pasture grown on this block
- No supplements fed on block
- Baleage made on the East block due to distance from cowshed
- Low solubility P fertiliser is applied (assumed Reactive Phosphate Rock in the modelling, may also be serpentine super in practice)

The results of these mitigations are shown in Table 5.

Table 5. Predicted nitrogen and phosphorus losses in the current and proposed system before and after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	**Proposed system (before further mitigations applied)**	**Proposed system (following further mitigations)**
Total Farm N Loss (kg)	11513	11348	9908
N Loss/ha (kgN/ha/yr)	51	51	44
N Concentration in Drainage (ppm)		Pastoral – 10 to 29	Pastoral – 3 to 19
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	226 (including 52kg P mitigation modelled outside of Overseer)	204 (including 52kg P mitigation modelled outside of Overseer)
P loss/ha (kgP/ha/yr)	1.0	1.0	0.9
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.2	16.0 (excluding East Block) 15.6 (East Block)

Taking into account the further mitigations made to the proposed farm system, OverseerFM predicts that overall nitrogen will decrease by 14% and losses of phosphorus will decrease by 11%. The nutrient budget, nitrogen summary and phosphorus summary are shown for each system in the appendices.

Adjustments to nitrogen losses in the proposed system

<u>Baleage grass wintering:</u>

OverseerFM has estimated that the loss of nitrogen from the grass baleage system is 567kgN (or 81kgN/ha). Modelling of the grass baleage wintering system in OverseerFM is likely to underestimate nitrogen losses as OverseerFM is not able to adequately reflect the on-farm realities of this system. OverseerFM assumes that the pasture plants will regrow post grazing and take up urinary N from the wintering activity. However, in reality, due to the soil type and climate on the applicant's property, the plants are not viable following the winter grazing. As a result the area is cultivated and regrassed in spring.

I am unaware of any research that has quantified the impact of baleage grass wintering in terms of nitrate and phosphorus loss. I have therefore completed a desktop modelling exercise that attempts to more accurately estimate the nutrient losses from this system.

The following assumptions have been made:

- Same as the proposed system file
    - Soils / climatic conditions
    - Tile drains
    - Stock numbers
    - Imported / exported supplement
    - Fertiliser and nitrogen use

- Different from the proposed system file
    - Used kale instead of pasture to allow a defoliation event and regressing activity
    - Used kale as has a similar crude protein to average quality pasture
    - Reduced yield of kale to 3TDM/ha to reflect pasture accumulated for winter in practice
    - Regrassed the area in October in line with when the applicant would usually regrass following a grass baleage wintering event
    - Direct drilled kale (rather than conventional cultivation to minimise the impact of the mineralisation of N during cultivation)

Overseer predicted that the losses from the Kale block would be 99kgN/ha (total of 693kgN lost for the 7ha wintered on). Without comparative research, it is difficult to assess the accuracy of the above results. However, from a common sense perspective, losses from the baleage grass system are likely to be more comparable to a traditional fodder crop paddock than a permanent pasture paddock. Therefore, it is predicted that the losses from the grass baleage wintering system will be 126kgN higher than predicted in the Proposed scenario.

Table 6. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system (following further mitigations)	Percentage change in losses
Total Farm N Loss (kg)	11513	10034 (including 126kgN adjustment modelled outside of Overseer)	12.8% reduction
N Loss/ha (kgN/ha/yr)	51	45	
N Concentration in Drainage (ppm)		Pastoral – 3 to 19	
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	204 (including 52kg P mitigation modelled outside of Overseer)	11.3% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Taking into account the further mitigations to the proposed farm system and the adjustment required for modelling the baleage grass wintering system, Overseer predicts that overall nitrogen will decrease by 13% and losses of phosphorus will decrease by 11.3%.

<u>Off site effects of wintering:</u>

No adjustment to nutrient losses to account for off site effects of wintering has been made as the number of animals wintered off farm (mixed age cows and R2 heifers) is the same in the current as the proposed. All additional stock in the proposed system will be wintered on farm and have therefore been accounted for in the modelling. The number of stock wintered on and off farm are described in detail in the appendices.

<u>Off site effects of young stock:</u>

As a result of the increased cow numbers on farm, there will also be an increase in the number of young stock reared for the property. These animals have been and will continue to be grazed off site with a third party grazier. The applicant does not have direct control over the management of these stock or the property that they are grazing. As agreed between Alex Erceg (ES) and Tanya Copeland (Landpro) in an email dated 21st February, the off site effects of these animals has not been included in the OverseerFM modelling. A copy of the relevant correspondence is available from Landpro upon request.

However, should quantification be required, I have made the following estimation of the scale of the effect of these extra young stock. The applicant rears 28% replacements (calves as a percentage of cows milked at peak). This is equivalent to 160 calves in the current system and 190 calves in the proposed system – an increase of 30 animals. Young stock are grazed off farm from weaning (1st

December), until their return as incalf heifers (1st Jun, 18months later). This system will continue to occur in the proposed scenario.

Rising 1 year old heifers have been traditionally wintered on fodder beet, although in the 2019 winter they were grazed on a baleage grass system. The off site effect of the extra young stock grazing can be estimated as follows:

- 30 rising 1 year olds, wintered on crop for 77days
- Require 5kgDM fodderbeet per head per day (the balance of the diet is made up of supplement as per standard practice)
- 5kgDM/head/day x 77days x 30animals = 11,550kgDM fodderbeet required
- At a 25,000tDM/ha yield of fodderbeet, the stock will require 0.5ha.
- It is assumed that the fodderbeet crop has losses of 225kg N/ha and 1.2kgP/ha. This is based on the losses modelled for the applicant under fodderbeet in the current scenario.

Therefore, it can be estimated that the off site effects of wintering the 30 increased rising 1 year olds is:

- 113kgN/year
- 0.6kgP/year

Please note that this estimate of nutrient losses during winter grazing is conservative, ie it is very likely to be overestimating the actual nutrient losses due to the winter feed type (fodder beet) and the intensity of the wintering (25tDM crop yield).

In addition to the winter grazing it is assumed that the additional 30 head of young stock are grass grazed when they aren't on winter crop. The 30 stock would require approximately 12ha of pasture. If this pasture has an N loss of 30kgN/ha and a p loss of 0.6kgP/ha, it can be estimated that the offsite effect of the young stock pasture grazing is:

- 360kgN/year
- 7.2kgP/year

Therefore, it can be estimated that the total offsite effect of the additional young stock is:

- 473kgN/year
- 7.8kgP/year

Note – the estimate above is intended to give an estimate of scale of effect, rather than to suggest any accuracy. There are too many variables that are unknown (including soil type, climate, stocking rate and fertiliser policy) to provide accuracy.

Table 7. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system (following further mitigations)	Percentage change in losses
Total Farm N Loss (kg)	11513	10507 (including 126kgN grass baleage and 473kgN young stock adjustments modelled outside of Overseer)	8.7% reduction
N Loss/ha (kgN/ha/yr)	51	47	
N Concentration in Drainage (ppm)		Pastoral – 3 to 19	
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	212 (including 52kg P laneway mitigation and 7.8kgP young stock adjustment modelled outside of Overseer)	7.8% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Taking into account the further mitigations to the proposed farm system and the adjustment required for modelling the baleage grass wintering system, Overseer predicts that overall nitrogen will decrease by 8.7% and losses of phosphorus will decrease by 7.8%.

Conclusions from the modelling

Table 8. Predicted nitrogen and phosphorus losses in the current and proposed system after further mitigations were included, including phosphorus mitigations modelled outside of OverseerFM 6.3.1

	Current system	Proposed system (following further mitigations)	Percentage change in losses
Total Farm N Loss (kg)	11513	10507 (including 126kgN grass baleage and 473kgN young stock adjustments modelled outside of Overseer)	8.7% reduction
N Loss/ha (kgN/ha/yr)	51	47	
N Concentration in Drainage (ppm)		Pastoral – 3 to 19	
Total Farm P Loss (kg)	230 (including 33kg P mitigation modelled outside of Overseer)	212 (including 52kg P laneway mitigation and 7.8kgP young stock adjustment modelled outside of Overseer)	7.8% reduction
P loss/ha (kgP/ha/yr)	1.0	0.9	
OverseerFM - predicted pasture grown (tDM/ha/yr)		16.0 (excluding East Block) 15.6 (East Block)	

Taking into account the further mitigations to the proposed farm system and the adjustment required for modelling the baleage grass wintering system, Overseer predicts that overall nitrogen will decrease by 8.7% and losses of phosphorus will decrease by 7.8%.

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use
- Change in the farms culling policy to one of culling earlier
- Lower protein content supplementary feed (Barley)

The key driver of the decrease in phosphorus loss are shown below. In comparison to the current system the proposed has:

- Improved laneway sediment loss mitigations
- A reduction in the Olsen P on the current dairy platform area (although an increase in Olsen P on the East Block)
- Use of Reactive Phosphate Rock fertiliser on the East Block

Appendices:

Appendix 1: Updated detailed description of modelling inputs

Appendix 2: Nutrient budgets taken from OverseerFM

Appendix 3: Overseer modelling report for the purposes of as part of a consent application for expanded dairying, dated October 2018

Appendix 4: Further information: T and J Driscoll Family Trust consent application, December 2018

Appendix 5: T and J Driscoll Family Trust – Farm Maps

Appendix 1: Updated detailed description of modelling inputs

Blocks

The farm has been split into the following pastoral (effluent and non-effluent) and fodder crop blocks. Total farm area has been taken from the legal area (ex the rates demand). The area of each block has been determined using the measure function on Beacon. Soils on the property were assessed utilising the topoclimate information. OverseerFM soil settings were obtained from SMap for all soil types.

Changes from original modelling (dated October 2018) are shown in red. Original modelling inputs are shown in black

Block Name	Soil Type (from Beacon)	Smap Ref	Contour	Current Dairy Platform (ha)	East Block (ha)	Proposed Land Use (ha)
Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**20.1**		**41.7 41.1**
Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**41.9**		**49.9 49.2**
Non Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**42.2**		**19.4 19.1**
Non Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**98.4**		**101.5 86.2**
East Block - Pukemutu	Pukemutu	Pukem_6a.1	Flat		**13.9**	**13.9**
Baleage winter Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.8 1.4**
Baleage winter Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**0.9 1.6**
Baleage Winter Non Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.4 0.7**
Baleage winter Non Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**1.9 3.3**
	Effective Farm Area			**202.6**	**13.9**	**216.5**
	Non productive			8.0		8.0
	Total Farm Area			**210.6**	**13.9**	**224.5**
Rotating fodder crops						
Fodder beet				2.8		
Winter Turnips				1.0		

Climate Data

- The following climate information has been used from the OverseerFM climate station tool;
  - 1094mm of rainfall (updated to 1092mm – consistent across all nutrient budgets)
  - 10.1 degrees Celsius mean annual temperature
  - Annual PET of 711mm (updated to 710mm – consistent across all nutrient budgets)

Farm System

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
File name	CURRENT PLATFORM – AUG19	CURRENT – EAST SHEEP AUG19	CURRENT – EAST TRANSITION AUG19	CURRENT – EAST DAIRY SUPPORT AUG19	PROPOSED – AUG19 MITIGATED
Milk solids production	271,130 kg MS 473 kgMS/cow Median calving date – 20th August Drying off – 31st May				329,000kgMS 319,600 kg MS 470 kgMS/cow Median calving date – 20th August Drying off – 31st May
Cows on farm (Lactating and wintered)	<u>Breed Fr J X</u> Jul 140 Aug 599 Sep 593 Oct 573 Nov 573 Dec 573 Jan 573 Feb 573 Mar 573 Apr 530 May 487 Jun 83 Peak cows: 573 *Note: Some cows wintered off farm at a grazier's property* *June – 516* *June – 459*			<u>Breed Fr J X</u> Winter grazing for 100MA (July) and 125R2 cows (Jun and Jul)	<u>Breed Fr J X</u> Jul 273 252 Aug 732 711 Sep 724 702 Oct 700 680 Nov 700 680 Dec 700 680 Jan 700 680 Feb 700 650 Mar 700 620 Apr 647 590 May 595 570 Jun 216 195 Peak cows: 700 Peak cows: 680 *Note: Some cows wintered off farm at a grazier's property* *June – 516* *July – 459* *Note: change in culling policy*

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Dairy replacements on farm	Calves are reared on farm until weaning (1-4months old) Aug - 135 Sep - 160 Oct - 160 Nov – 160		Grazing for R2 heifers May 125	Grazing for R2 heifers Jan 125 Feb 125	Calves are reared on farm until weaning (1-4months old) Aug - 152 160 Sep - 187 190 Oct - 187 190 Nov – 187 190 Note: error found in original modelling
Breeding bulls	Thirteen 2yr old Jersey bulls (Dec and Jan)				Fifteen 2yr old Jersey bulls (Dec and Jan)
Sheep		Wintered: 120 MA ewes 46replacements 3rams Coopworth 125% lambing percentage 20% replacement rate Mean lambing date of the 15th September. All non-replacement lambs sold by the end of May			
Relative productivity	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks Relative productivity of East Block Pukemutu 0.97unit due to lower N useage. All other blocks have a relative productivity of 1.

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Structures	Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time				Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time
In Shed Feeding	Management 100% of milkers fed Aug - May				Management 100% of milkers fed Aug – May
Rotating fodder crop management	2.8ha fodder beet Yield: 25tDM/ha Conventional cultivation October Fertiliser: 500kg/ha Winton Fodder Beet mix at sowing (delivering 50kg/ha N, 32kg/ha P, 75kg/ha K and 27kg/ha S) 100kg/ha Urea in December 100kg/ha Potassium Chloride in December 100kg/ha Urea in January Grazed by dairy cows May – Aug Resown in permanent pasture in September				Cows on farm in June/July are wintered on a baleage grass diet. 4ha 7ha Baleage/Grass wintering This area rotates around all blocks except the East Block Pukemutu the platform. This wintering system forms part of the property's regrassing strategy All feed required is imported (160tDM baleage) (150tDM baleage)
	1.0ha Turnips Yield: 8tDM/ha Conventional cultivation February				

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
	Fertiliser: 150kg/ha DAP and 150kg/ha super at sowing 100kg/ha Urea in March Grazed by dairy cows Jun – Aug Resown in permanent pasture in September				
Imported Supplements	In shed: 236t PKE 38t Barley (typo in original modelling) In paddock: 418tDM silage			In paddock: 65 tDM baleage	In shed: 300tDM PKE 40tDM PKE 100tDM barley 400tDM Barley 100tDM DDG In paddock: 850tDM silage (fed over entire platform) 500tDM silage (fed on all bocks except East Block) For wintering: 160tDM baleage 150tDM baleage Supplement harvested on the East block: 140tDM fed out on all blocks except East Block
Exported Supplements			130tDM baleage		
Soil Fertility	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	Olsen P 32 Olsen P 30 All other values entered at agronomic optimum

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Fertiliser	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels Note: Phosphorus applied as RPR on the East Block
Pastoral Nitrogen Fertiliser	213 kgN/ha in split applications (Aug – April)				Non Effluent blocks (Excluding East Block) 218kgN/ha (203kgN/ha) in split applications (Aug – April) Effluent Blocks 197kgN/ha (183kgN/ha) in split applications (Aug – April) East Block 154kgN/ha in split applications (Sep – Mar)
Drainage	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained
Farm dairy effluent	Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 31 ha is required to achieve a loading of less than 150 kg N / ha / year				Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 34 (now 32) ha is required to achieve a loading of less than 150 kg N / ha / year

Appendix 2: Nutrient budgets taken from OverseerFM

Report disclaimer:

The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

Current system - Dairy Platform (File name - CURRENT PLATFORM - AUG19)

Table 9. Current system whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	11,273	54
Phosphorus	253	1.2

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	201	26	2	25	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	80	11	58	9	9	6	4
Rain/clover fixation	74	0	3	5	3	7	35

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	54	1.2	12	38	61	6	20
As product	87	15	21	5	19	2	6
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	89	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	125	19	11	-3	7	3	1
Inorganic mineral	0	2	-23	0	-2	-3	-3
Inorganic soil pool	1	0	43	0	-72	6	15

Table 10. Current system Nitrogen and Phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
PUKEMUTU EFFLUENT	2474	60	13	287	273
PUKEMUTU NON EFFLUENT	4850	50	11	211	220
WAIKIWI EFFLUENT	1007	51	12	287	265
WAIKIWI NON EFFLUENT	1793	43	10	211	213
FODDER BEET	630	225	42	142	21
TURNIPS	111	111	21	72	2

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
PUKEMUTU EFFLUENT	40	1
PUKEMUTU NON EFFLUENT	79	0.8
WAIKIWI EFFLUENT	9	0.5
WAIKIWI NON EFFLUENT	17	0.4
FODDER BEET	3	1.2
TURNIPS	1	1.1

Current system – East Block sheep (File name - CURRENT - EAST SHEEP AUG19)

Table 11. East Block – Sheep whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	203	14
Phosphorus	10	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	16	0	24	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	96	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	14	0.7	7	34	33	6	19
As product	20	3	1	3	5	0	1
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	37	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	25	11	0	-8	0	0	0
Inorganic mineral	0	0	-25	0	-2	-3	-4
Inorganic soil pool	0	2	19	0	-33	4	18

Table 12. East Block - sheep nitrogen and phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
EAST BLOCK - PUKEMUTU	199	14	3	0	74

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
EAST BLOCK - PUKEMUTU	9	0.6

East Block – Transition (file name CURRENT - EAST TRANSITION AUG19)

Table 8. East Block – Transition whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	132	9
Phosphorus	9	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	36	203	33	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	150	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	9	0.7	15	29	29	6	19
As product	0	0	0	0	0	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	4	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	-23	11	6	-8	1	0	0
Inorganic mineral	0	0	-22	0	-2	-3	-4
Inorganic soil pool	0	0	6	0	-71	-7	10

Table 9. East Block - transition nitrogen and Phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
EAST BLOCK - PUKEMUTU	132	9	2	0	-15

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
EAST BLOCK - PUKEMUTU	9	0.7

East Block – Dairy support (file name - CURRENT - EAST DAIRY SUPPORT AUG19)

Table 11. East Block – Dairy support whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	385	27
Phosphorus	10	0.7

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	0	1	0	11	0	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	80	0	3	5	3	7	34

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	27	0.7	9	33	43	6	19
As product	9	2	1	1	5	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	39	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	78	12	4	-7	1	0	0
Inorganic mineral	0	0	-16	0	-2	-3	-4
Inorganic soil pool	0	0	98	0	-20	12	25

Table 12. East Block – Dairy support nitrogen and phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
EAST BLOCK - PUKEMUTU	381	27	6	0	139

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
EAST BLOCK - PUKEMUTU	8	0.6

Proposed system – (file name - PROPOSED - AUG19 MITIGATED)

Table 14. Proposed system whole farm nutrient budget

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	9,908	44
Phosphorus	256	1.1

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	185	22	15	25	8	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	104	14	71	9	15	7	5
Rain/clover fixation	71	0	3	5	3	7	35

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	44	1.1	13	39	54	6	20
As product	96	16	23	5	21	2	7
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	84	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	136	18	13	-5	8	3	1
Inorganic mineral	0	2	-19	0	-2	-3	-3
Inorganic soil pool	0	0	58	0	-54	6	16

Table15. Proposed system nitrogen and phosphorus summary reports

Nitrogen summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)	N IN DRAINAGE (PPM)	N ADDED (KG/HA)	N SURPLUS (KG/HA)
BALEAGE WINTER - PUKEMUTU EFF	140	88	19	234	396
BALEAGE WINTER - PUKEMUTU NON EFF	277	84	19	203	368
BALEAGE WINTER - WAIKIWI NON EFF	47	67	16	203	340
BALEAGE WINTER - WAIKIWI EFF	103	74	17	234	382
EAST BLOCK - PUKEMUTU	183	13	3	154	61
PUKEMUTU EFFLUENT	2408	49	11	234	249
PUKEMUTU NON EFFLUENT	3903	45	10	203	218
WAIKIWI EFFLUENT	1700	41	9	234	244
WAIKIWI NON EFFLUENT	719	38	9	203	205

Phosphorus summary

	TOTAL LOSS (KG)	LOSS PER HA (KG/HA)
BALEAGE WINTER - PUKEMUTU EFF	1	0.8
BALEAGE WINTER - PUKEMUTU NON EFF	2	0.7
BALEAGE WINTER - WAIKIWI NON EFF	0	0.4
BALEAGE WINTER - WAIKIWI EFF	1	0.4
EAST BLOCK - PUKEMUTU	10	0.7
PUKEMUTU EFFLUENT	43	0.9
PUKEMUTU NON EFFLUENT	67	0.8
WAIKIWI EFFLUENT	18	0.4
WAIKIWI NON EFFLUENT	8	0.4

Appendix 3: Overseer modelling report for the purposes of as part of a consent application for expanded dairying, dated October 2018

Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

T & J Driscoll Family Trust

266 O'Shannessy Road, Winton

Overseer modelling report for the purposes of as part of a consent application for expanded dairying

Report prepared for:
Tim and Jocelyn Driscoll
266 Thomsons Crossing Road East
RD1, Winton

Prepared By:
Mo Topham
FarmWise Consultant
B.Agr.Sci (Hons)
Invercargill, Southland
mo.topham@lic.co.nz

1 October 2018

Report Peer Reviewed By:
Miranda Hunter
Roslin Consultancy Limited
B.Agr.Sci

Executive Summary

T & J Driscoll Family Trust operate a high performance dairy farm near Winton, in Central Southland. The partially self-contained 210.6ha total property has a flat contour. There are two soil types on the property – Waikiwi and Pukemutu, separated by a small terrace. Calves are grazed on the platform until weaning and return to the platform as incalf heifers. Over the past three years, an average of 2.8ha of fodder beet and 1ha of winter turnips were planted. The farm has peak milked 573cows on average over the last three seasons.

In October 2016, Tim and Jocelyn purchased a neighbouring 13.9ha sheep grazing block – called the East Block. Following the purchase of the block, Tim and Jocelyn have transitioned the block into dairy support. It is proposed that the East Block (13.9ha) be converted to dairy and incorporated into the milking platform. In the proposed farm system, a portion of the herd will be wintered on 4ha with a baleage and grass diet. Young stock will continue to be grazed off farm from weaning to their return as incalf heifers.

Using Overseer (version 6.3.0) nutrient budgets have been constructed for the current land use and a proposed dairy unit nutrient budget to inform the consent application for expanded dairying. The nutrient budgets show the average nutrient losses for the last three years. Data inputs and methodology are explained in detail within this report.

A summary of the modelling output is given in Table 1. It shows a small decrease (loss than 5%) in the total Nitrogen loss from the property. Total Phosphorus loss from the property is predicted to increase (by less than 7%).

Table 13. Summary data from the Overseer analysis of the T & J Driscoll Family Trust Current and Proposed systems

	Current Total (averaged over 3 years)	Proposed system
Total Farm N Loss (kg)	11503	11345
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 9.8 – 29.3
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced effluent N application to this area
- Reduced nitrogen fertiliser use on the effluent block
  Increased cow numbers – increasing loss risk

The key driver of the increase in phosphorus loss is an increase in losses from “other sources”.

Overseer can model a range of good management practices. However, some farm specific good management practices cannot be modelled. Recommendations of further good management practices that cannot be modelled by Overseer are given within this report to further reduce the nutrient losses from this farm system.

Property legal description

Part Section 29 and 30 Block I Winton HUN

Section 1 and 2 SO 12000

Section 43, 44, 45 and 54 Block I Winton HUN

Lot 1 and 2 DP 449518

Report purpose

To quantify the losses of nitrogen and phosphorus from the current and the proposed farm systems being operated on this property. The report details the data inputs, the modelling outputs and areas of environmental risk within the system.

Disclaimer

The Overseer 6.3.0 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

The proposal

Farm objectives

T & J Driscoll Family Trust operate their farm business with the following objectives:

- To refine the farm system to maximise farm profitability – targeting $2000/ha EBIT at a $5.00 milk price
- To operate in an environmentally sustainable manner with an emphasis on continual education and improvement
- Consolidate the business to ensure it is resilient
- "Farm for the future" – the property must remain flexible to deal with changes in market forces

Current System

Nutrient budgets have been constructed to determine the average actual nutrient losses over three years (June 2015 – May 2018).

Dairy platform

T & J Driscoll Family Trust operate a high performing dairy farm near Winton, in Central Southland. The farm is owned by the Driscoll trust (JP, CA, TJ and JA Driscoll), and is operated under a lease arrangement by T & J Driscoll Family Trust (Tim and Jocelyn Driscoll). The partially self-contained 210.6ha total property has a flat contour. There are two soil types on the property – Waikiwi and Pukemutu. Calves are grazed on the platform until weaning and return to the platform as incalf heifers.

Over the previous three seasons, the property has milked an average of 573cows at peak. There has been an average of 2.8ha fodder beet and 1ha turnips grown on farm for winter and early spring grazing. Nitrogen fertiliser has been applied at an average of 213kgN/ha in split applications from August to April over the whole milking platform. In the last three seasons, the majority of the herd has been wintered off farm at a graziers property. On average, 83 cows were wintered at home in June and July, while the remaining 516 were off farm. Early calving heifers and cows return to the platform in mid July. Bought in feed has been assumed to ensure that a feasible pasture growth rate is achieved in an average season.

East Block

In October 2016, Tim and Jocelyn purchased a neighbouring 13.9ha sheep grazing block – called the East Block. Following the purchase of the block, Tim and Jocelyn have transitioned the block into dairy support. In order to create accurate actual budgets for the previous three years, three separate budgets have been created for the East Block:

- Pre purchase use (15-16 season) – a sheep grazing block. Accurate stock numbers were not available. A conservative estimation of stocking rate and management practice has been made utilising Google Earth imaging and the Beef and Lamb farm monitoring data.
- Transition (16-17 season) – All feed grown on farm was cut as baleage. This was fed to incalf heifers or exported from the block.

- Dairy support (17-18 season) – 125incalf heifers and 100cows were wintered on a baleage/grass diet on the block. The block was grazed by heifers in January and February of 2018. All other feed grown was made into baleage.

Proposed system:

Through the development of the proposed system, a number of scenarios were run through Overseer. The proposed system detailed below was chosen as it was in line with the farm objectives, the farm system preferences and the proposed Water and Land Plan.

It is proposed that the East Block (13.9ha) be converted and incorporated into the milking platform. The total farm area would then be 224.5ha total and peak cow numbers would be increased to 700 cows. The property will winter 216cows on farm, and continue to winter the remaining 516cows off farm at a graziers property. The cows wintered on farm will be grazed of 4ha with a baleage grass diet. Young stock will continue to be grazed off farm from weaning to their return as incalf heifers. The effluent system will be extended to 93.3ha and fertiliser nitrogen applications will be targeted to 197kgN/ha on the effluent area and 218kgN/ha on the non-effluent area. Bought in feed has been assumed to ensure that a feasible pasture growth rate is achieved in an average season when consented cow numbers are being milked.

Modelling method

Nutrient losses have been estimated using the Overseer Version 6.3.0 model. Overseer is a software application that models nutrient movements within a farm system. Input data detailing the farm system is entered into the software and interpreted through the use of a series of sub-model that calculate the flow of seven major farm nutrients (Nitrogen, Phosphorus, Sulphur, Calcium, Magnesium and Sodium). Output data is reported for interpretation and to inform farm management practices. It currently requires an expert user to describe the physical and management details of a farm.

Overseer assumptions

Within the Overseer software, assumptions have been made of the farm management:

- Long term annual average model
  The model uses annual average input and produces annual average outputs
- Near equilibrium conditions
  Model assumes that that the farm is at a state where there is minimal change each year
- Actual and reasonable inputs
  It is assumed that input data is reasonable and a reflection of the actual farm system. If any parameter changes, it is assumed that all other parameters affected will also be changed.
- Good management practices are followed
  Overseer assumes the property is managed is line with accepted industry good management practice.

Overseer limitations

Key limitations of the Overseer model are:

- Overseer does not predict transformations, attenuation or dilution of nutrients between the root zone or farm boundary and the eventual receiving water body. A catchment model is needed to estimate the effects of the nutrient losses from farms on groundwater, river or lake water quality.
- Overseer does not calculate outcomes from extreme events (floods and droughts), but provides a typical years result based on a long-term average.
- Overseer does not calculate the impacts of a conversion process, rather it predicts the long-term annual average nutrient budgets for changed land use.
- Overseer is not spatially explicit beyond the level of defined blocks
- Not all management practices or activities that have an impact on nutrient losses are captured in the Overseer model
- Overseer does not represent all farm systems in New Zealand
- Components of Overseer have not been calibrated against measured data from every combination of farm systems and environment

Information on Overseer can be obtained from the following reports:

- Technical Description of OVERSEER for Regional Councils, September 2015
- Review of the phosphorus loss submodel in OVERSEER®, September 2016
- Using OVERSEER® in Regulation – Technical Resources and Guidance for Regional Councils, August 2016

Data input standards

Nutrient budgets have been constructed using the Overseer Version 6.3.0 model.

The nutrient budget have been developed in accordance with the Overseer data input protocols - “Overseer, Best Practice Data Input Standards, March 2018.” No deviations have been made from these protocols.

Modelling Inputs

To construct the nutrient budgets the following assumptions have been made;

Blocks

The farm has been split into the following pastoral (effluent and non-effluent) and fodder crop blocks. Total farm area has been taken from the legal area (ex the rates demand). The area of each block has been determined using the measure function on Beacon. Soils on the property were assessed utilising the topoclimate information. Overseer soil settings were obtained from SMap for all soil types.

Block Name	Soil Type (from Beacon)	Smap Ref	Contour	Current Dairy Platform (ha)	East Block (ha)	Proposed Land Use (ha)
Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**20.1**		**41.7**
Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**41.9**		**49.9**
Non Effluent – Waikiwi	Edendale	Waiki_30a.1	Flat	**42.2**		**19.4**
Non Effluent – Pukemutu	Pukemutu	Pukem_6a.1	Flat	**98.4**		**101.5**
East Block - Pukemutu	Pukemutu	Pukem_6a.1	Flat		**13.9**	
Baleage winter Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.8**
Baleage winter Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**0.9**
Baleage Winter Non Eff Waikiwi	Edendale	Waiki_30a.1	Flat			**0.4**
Baleage winter Non Eff Pukemutu	Pukemutu	Pukem_6a.1	Flat			**1.9**
	Effective Farm Area			**202.6**	**13.9**	**216.5**
	Non productive			8.0		8.0
	Total Farm Area			**210.6**	**13.9**	**224.5**
Rotating fodder crops						
Fodder beet				2.8		
Winter Turnips				1.0		

Climate Data

- Southland as the location setting
- The following climate information has been used from the Overseer climate station tool;
  - 1094mm of rainfall
  - 10.1 degrees Celsius mean annual temperature
  - Daily rainfall pattern setting of 731 to 1450mm, low
  - Mean annual PET of 711mm (moderate variation)

Farm System

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Milk solids production	271,130 kg MS 473 kgMS/cow Median calving date – 20th August Drying off – 31st May				329,000 kg MS 470 kgMS/cow Median calving date – 20th August Drying off – 31st May
Cows on farm (Lactating and wintered)	Breed Fr J X Jul 140 Aug 599 Sep 593 Oct 573 Nov 573 Dec 573 Jan 573 Feb 573 Mar 573 Apr 530 May 487 Jun 83 Peak cows: 573			Breed Fr J X Winter grazing for 100MA and 125R2 cows (Jun and Jul)	Breed Fr J X Jul 273 Aug 732 Sep 724 Oct 700 Nov 700 Dec 700 Jan 700 Feb 700 Mar 700 Apr 647 May 595 Jun 216 Peak cows: 700
Dairy replacements on farm	Calves are reared on farm until weaning (1-4months old) Aug - 135 Sep - 160 Oct - 160 Nov – 160		Grazing for R2 heifers May 125	Grazing for R2 heifers Jan 125 Feb 125	Calves are reared on farm until weaning (1-4months old) Aug - 152 Sep - 187 Oct - 187 Nov – 187
Breeding bulls	Thirteen 2yr old Jersey bulls (Dec and Jan)				Fifteen 2yr old Jersey bulls (Dec and Jan)
Sheep		Wintered: 120 MA ewes 46replacements 3rams Coopworth 125% lambing percentage 20% replacement rate			

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
		Mean lambing date of the 15th September. All non-replacement lambs sold by the end of May			
Relative productivity	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks	No differences between blocks
Structures	Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time				Calving Pad Not modelled as used when ground conditions are saturated rather than for fixed time
In Shed Feeding	Management 100% of milkers fed Aug - May				Management 100% of milkers fed Aug - May
Rotating fodder crop management	2.8ha fodder beet Yield: 25tDM/ha Conventional cultivation October Fertiliser: 500kg/ha Winton Fodder Beet mix at sowing (delivering 50kg/ha N, 32kg/ha P, 75kg/ha K and 27kg/ha S) 100kg/ha Urea in December 100kg/ha Potassium Chloride in December 100kg/ha Urea in January Grazed by dairy cows May – Aug				Cows on farm in June/July are wintered on a baleage grass diet. 4ha Baleage/Grass wintering This area rotates around the platform and is part of the property's regrassing strategy All feed required is imported (160tDM baleage)

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
	Resown in permanent pasture in September				
	1.0ha Turnips Yield: 8tDM/ha Conventional cultivation February Fertiliser: 150kg/ha DAP and 150kg/ha super at sowing 100kg/ha Urea in March Grazed by dairy cows Jun – Aug Resown in permanent pasture in September				
Imported Supplements	In shed: 236tDM PKE 33tDM Barley In paddock: 418tDM Silage			In paddock: 65 tDM baleage	In shed: 300tDM PKE 100tDM Barley 100tDM DDG In paddock: 850tDM baleage For wintering: 160tDM baleage
Exported Supplements			130tDM baleage		
Soil Fertility	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	All soil test values entered at agronomic optimum (Olsen P of 20)	Olsen P 32 (soil test results June 2017) All other values entered at agronomic optimum

Description	Current Dairy Platform (average of three seasons)	East Block – Sheep (15-16 season)	East Block – Transition (16-17season)	East Block – Dairy Support (17-18season)	Proposed Land Use
Fertiliser	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels	Phosphorus, Potassium and Sulphur applied to maintain fertility levels
Nitrogen Fertiliser	213 kgN/ha in split applications (Aug – April)				Non Effluent blocks 218kgN/ha in split applications (Aug – April) Effluent Blocks 197kgN/ha in split applications (Aug – April)
Drainage	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained	100% mole and tile drained
Farm dairy effluent	Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 39 ha is required to achieve a loading of less than 150 kg N / ha / year				Holding pond Solids aren't separated from the liquid Liquid effluent is applied at a depth of <12mm to the "effluent" blocks An effluent area of at least 34 ha is required to achieve a loading of less than 150 kg N / ha / year

Predicted Overseer Results

Current land use

	Current Dairy Platform (3yr average)	East Block – Sheep (15-16 season)	East Block – Transition (16-17 season)	East Block – Dairy Support (17-18 season)	East block (average of 3yrs)	Current Total (averaged over 3 years)
Total Farm N Loss (kg)	11262	204	132	386	241	11503
N Loss/ha (kgN/ha/yr)	53	15	10	28	17	51

N Concentration in Drainage (ppm)	Pastoral – 9.9 to 12.8 Crops – 21.1 to 42.1	Pastoral – 3.2	Pastoral – 2.1	Pastoral - 6.1		
Total Farm P Loss (kg)	252	10	9	10	10	262
P loss/ha (kgP/ha/yr)	1.2	0.7	0.7	0.7	0.7	1.2
Overseer - predicted pasture grown (tDM/ha/yr)	16.2	11.8	11.8	11.9		

Proposed system

	Current Total (averaged over 3 years)	**Proposed system**
Total Farm N Loss (kg)	11503	11345
N Loss/ha (kgN/ha/yr)	51	51
N Concentration in Drainage (ppm)		Pastoral – 9.8 – 29.3
Total Farm P Loss (kg)	262	278
P loss/ha (kgP/ha/yr)	1.2	1.2
Overseer - predicted pasture grown (tDM/ha/yr)		16.2

Conclusions from the modelling

Nutrient budgets have been developed for Driscoll Dairy. These budgets compare the nutrient loss of the current farm system with the proposed farm system. Overseer has predicted that losses of nitrogen will decrease slightly (less than 5%) and losses of phosphorus will increase slightly (less than 7%).

The key drivers of a decrease in nitrogen loss are shown below. In comparison to the current system, the proposed system has:

- Increased the area that effluent is applied to – reduced N application in effluent to this area
- Reduced nitrogen fertiliser use on the effluent block
- Increased cow numbers – increasing loss risk
-

The key driver of the increase in phosphorus loss is an increase in losses from “other sources”.

Please note: Losses from “other sources” include predicted losses from laneways, calving pads and yards. The increase in losses from other sources is a result of an increase in animal excretion onto laneways. Overseer estimates amount of excreta and assumes all P ends up in dung. Some of this dung is assumed to fall on laneways and 30% of that P is assumed to be lost from the farm. Furthermore, Overseer is not spatially explicit; so it does not take into account critical source area on farms. These critical source areas accumulate overland flow from adjacent areas and deliver overland flow to surface water bodies. On farms where there is not a direct connection (or a less connection) via critical source areas, or where management mitigates risk, Overseer cannot model the impact of these at an individual farm scale.

Recommendations:

Apart from the system changes outlined above, the following recommendations are given to reduce the nutrient losses from this farm system.

Overseer can model a range of good management practices. However, some farm specific good management practices cannot be modelled. It is recommended that the following good management practices are implemented on this property:

- Fertiliser is applied at the correct rate, and is not applied in close proximity to waterways
- Identify and manage critical source areas to reduce the risk of losses. These include loses from laneways, gateways and high traffic zones.
- Stand cows off on the calving pad during periods of high soil moisture content to minimise soil damage and leaching risk.
- Fertiliser applications are made during periods of plant growth.
- An effluent management plan is in place that takes into account soil moisture and temperature, and includes a fail safe system

The nutrient budgets within this report have been developed assuming that the Olsen P is 32 and all other soil fertility measures are at the agronomic optimum. It also assumes that fertiliser is applied at a maintenance rate. A soil testing regime should be implemented and fertiliser recommendations should be developed in line with these soil testing results.

The proposed Southland Water and Land Plan is currently in process. It will be important to stay up to date with developments in Environment Southland policy and rules, including the Limit Setting Process which will develop over the next few years

A farm environmental management plan detailing the recommendations within this report should be developed for the property.

Current system - Dairy Platform

Table 14. Current system whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	201	24	2	34	0	0	0
Rain/clover N fixation	74	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Supplements	80	11	58	9	9	6	4
Nutrients removed							
As products	87	15	21	5	19	2	6
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	89	0	0	0	0	0	0
To water	53	1.2	12	46	61	6	20
Change in farm pools							
Plant Material	0	0	-2	0	0	0	0
Organic pool	125	19	11	-3	7	3	1
Inorganic mineral	0	2	-23	0	-2	-3	-3
Inorganic soil pool	1	-2	43	0	-72	6	15

Table 15. Current system Nitrogen report

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
Waikiwi Effluent	1,003	51	**11.4**	264	285
Pukemutu Effluent	2,464	60	**12.8**	272	285
Waikiwi non effluent	1,793	43	9.9	213	211
Pukemutu non effluent	4,850	50	11.2	220	211
Fodder Beet	630	225	**42.1**	21	142
Turnips	111	111	**21.1**	2	72
Other sources	410				
Whole farm	11,262	53			
Less N removed in wetland	0				
Farm output	11,262	53			

Table 16. Current system Phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
Waikiwi Effluent	9	0.5	Low	Low	Low
Pukemutu Effluent	39	0.9	Medium	Low	Medium
Waikiwi non effluent	17	0.4	Low	Low	N/A
Pukemutu non effluent	79	0.8	Medium	Low	N/A
Fodder Beet	3	1.2	N/A	N/A	N/A
Turnips	1	1.1	N/A	N/A	N/A
Other sources	104				
Whole farm	252	1.2			

East Block – Sheep

Table 17. East Block – Sheep whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	16	0	24	0	0	0
Rain/clover N fixation	97	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	20	3	1	3	5	0	1
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	37	0	0	0	0	0	0
To water	15	0.7	7	35	33	6	19
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	25	11	0	-8	0	0	0
Inorganic mineral	0	0	-25	0	-2	-3	-4
Inorganic soil pool	0	2	19	0	-33	4	18

Table 18. East Block - sheep nitrogen report

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
East block - Pukemutu	200	14	3.2	74	0
Other sources	4				
Whole farm	204	15			
Less N removed in wetland	0				
Farm output	204	15			

Table 19. East Block - Sheep phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	9	0.6	Low	Low	N/A
Other sources	1				
Whole farm	10	0.7			

East Block – Transition

Table 8. East Block – Transition whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	36	204	33	0	0	0
Rain/clover N fixation	152	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	0	0	0	0	0	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	162	24	203	17	46	11	9
To atmosphere	4	0	0	0	0	0	0
To water	10	0.7	15	30	29	6	19
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	-24	12	6	-8	1	0	0
Inorganic mineral	0	0	-22	0	-2	-3	-4
Inorganic soil pool	0	0	5	0	-72	-7	10

Table 9. East Block - transition nitrogen report

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
East block - Pukemutu	132	9	2.1	-15	0
Other sources	1				
Whole farm	132	10			
Less N removed in wetland	0				
Farm output	132	10			

Table 10. East Block - Transition phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	9	0.7	Low	Low	N/A
Other sources	0				
Whole farm	9	0.7			

East Block – Dairy support

Table 11. East Block – Dairy support whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	0	0	0	8	0	0	0
Rain/clover N fixation	81	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Nutrients removed							
As products	9	2	1	1	5	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	40	0	0	0	0	0	0
To water	28	0.7	9	30	43	6	19
Change in farm pools							
Plant Material	-75	-14	-94	-11	-23	-8	-7
Organic pool	79	12	4	-7	1	0	0
Inorganic mineral	0	0	-16	0	-2	-3	-4
Inorganic soil pool	0	-1	98	0	-21	12	25

Table 12. East Block – Dairy support nitrogen report

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
East block - Pukemutu	381	27	6.1	139	0
Other sources	5				
Whole farm	386	28			
Less N removed in wetland	0				
Farm output	386	28			

Table 13. East Block – Dairy support phosphorus report

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
East block - Pukemutu	8	0.6	Low	N/A	N/A
Other sources	2				
Whole farm	10	0.7			

Proposed system

Table 14. Proposed system whole farm nutrient budget

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	199	21	0	30	0	0	0
Rain/clover N fixation	73	0	3	5	3	7	35
Irrigation	0	0	0	0	0	0	0
Supplements	103	21	97	16	22	11	7
Nutrients removed							
As products	99	17	24	5	21	2	7
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	87	0	0	0	0	0	0
To water	51	1.2	13	49	59	6	20
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	138	20	15	-3	8	4	1
Inorganic mineral	0	2	-19	0	-2	-3	-3
Inorganic soil pool	0	2	67	0	-62	9	17

Table15. Proposed system nitrogen report

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
Waikiwi Effluent	1,887	45	10.2	241	249
Pukemutu Effluent	2,662	53	**11.5**	249	249
Waikiwi non effluent	830	43	9.8	210	215
Pukemutu non effluent	5,030	50	11.1	217	215
Baleage winter - waikiwi Eff	88	111	**25.2**	506	249
Baleage winter - Pukemutu Eff	120	133	**29.3**	530	249
Baleage winter - Waikiwi Non Eff	40	99	**22.6**	451	215
Baleage winter - Pukemutu Non Eff	240	126	**28.3**	498	215
Other sources	449				
Whole farm	11,345	51			
Less N removed in wetland	0				
Farm output	11,345	51			

Table 20. Proposed system phosphorus report

Block name	Total P lost kg P/yr	P lost to water 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 sources	121				
Whole farm	278	1.2			

Farm Map

Figure 1. Driscolls farm map showing the current and proposed effluent areas

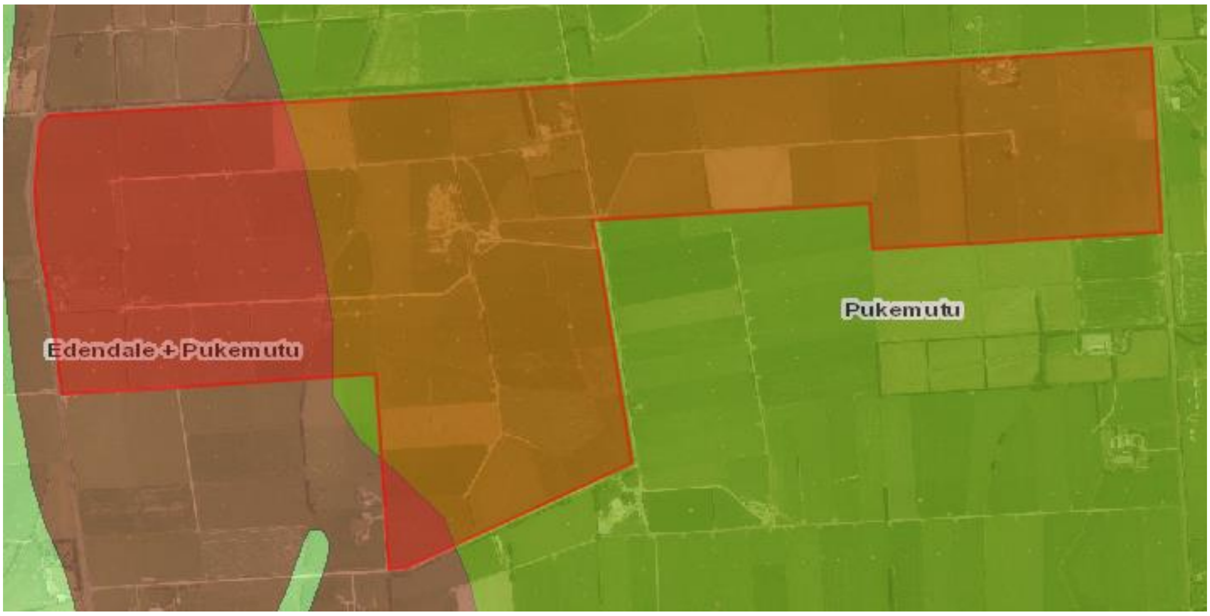

Figure 2. Driscolls farm map showing the soil types on farm

Report disclaimer:
The OverseerFM 6.3.1 model has been utilised to assess the nutrient losses from this property. Details of how the property is operated currently, and how the property will be operated going forward have been gathered from the farm owner. Where accurate data was unavailable, conservative assumptions have been made using professional judgement.

OverseerFM 6.3.1 predicted results have been extracted from the model on 22 August 2019

Appendix 4: Further information: T and J Driscoll Family Trust consent application, December 2018

FarmWise

Mo Topham
Southland
Ph: 027 546 7623
Email: mo.topham@lic.co.nz

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 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

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 Predicted 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

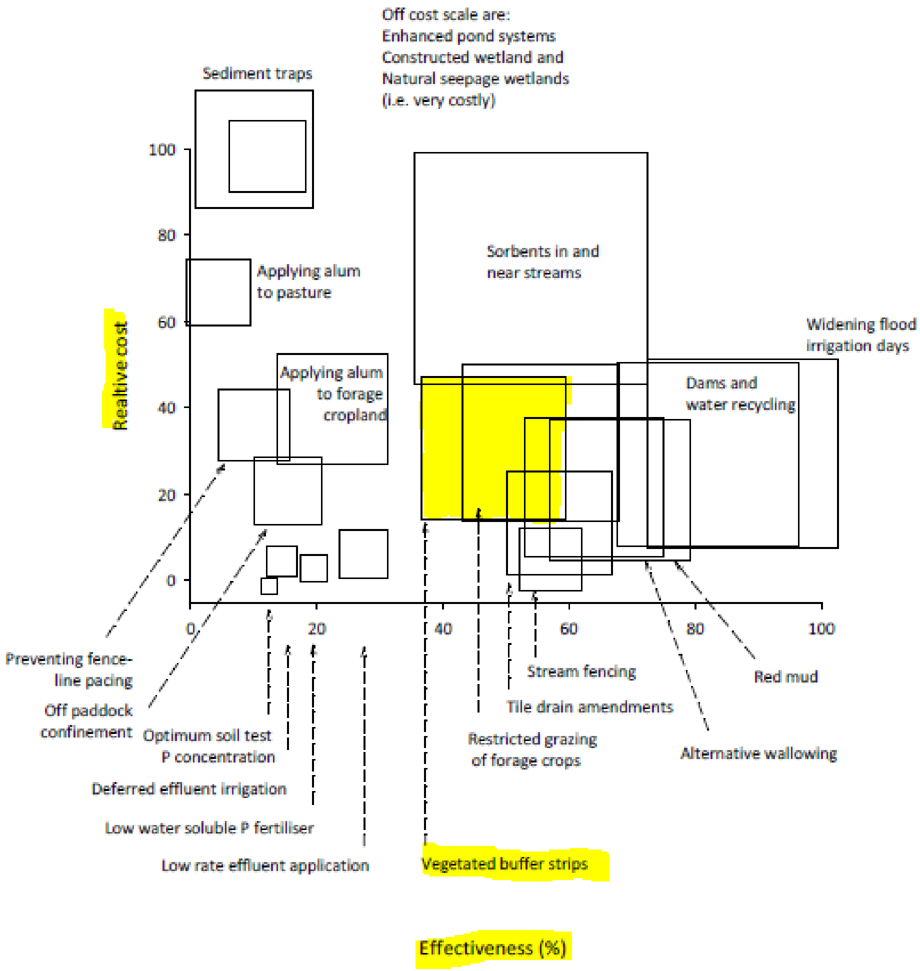

Figure 3. Diagram of the cost and effectiveness of strategies to mitigate phosphorus losses to water at the farm-scale. Cost is shown as the cost per kg of P mitigated relative to the most expensive strategy - sediment traps at $360 per kg P retained/ha/yr. From McDowell et al (2013)

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:

	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 10 kg P.

References

Ledgard, S., Penno, J., & Sprosen, M. (1999). Nitrogen inputs and losses from clover/grass pastures grazed by dairy cows, as affected by nitrogen fertiliser application. *Journal of Agricultural Science 132*, 215-225.

Massey University. (n.d.). Introductory Notes and Mastery Test. In *Massey University Sustainable Nutrient Management .*

McDowell, R., Hawke, M., & Mcintosh, J. (2006). Assessment of a novel technique to remove phosphorus from streamflow. *Soils and Society. Proceedings of the New Zealand Society of Soil Science Conference, Rotorua*, 29.

McDowell, R., Wilcock, B., & Hamilton, D. (2013). *Assessment of Strategies to Mitigate the Impact or Loss of Contaminants from Agricultural Land to Fresh Waters.* Prepared for MfE.

McNaught, K., Karlovsky, J., & Hogg, D. (1968). Serpentine-superphosphate and dolomite as magnesium sources on Whakarewarewa sandy loam. *New Zealand Journal of Agricultural Research*, 849-862.

Orchiston, T., Monaghan, R., & Laurenson, S. (2013). Reducing Overland Flow and Sediment Losses From Winter Forage Crop Paddocks Grazed by Dairy Cows. *Fertiliser and Lime Research Conference.* Palmerston North.

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

Appendices:

Table 21. 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 22 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 23. 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			

Appendix 5: T and J Driscoll Family Trust – Farm Maps

Farm Map

Figure 4. Driscolls farm map showing the current and proposed effluent areas, and the East Block.

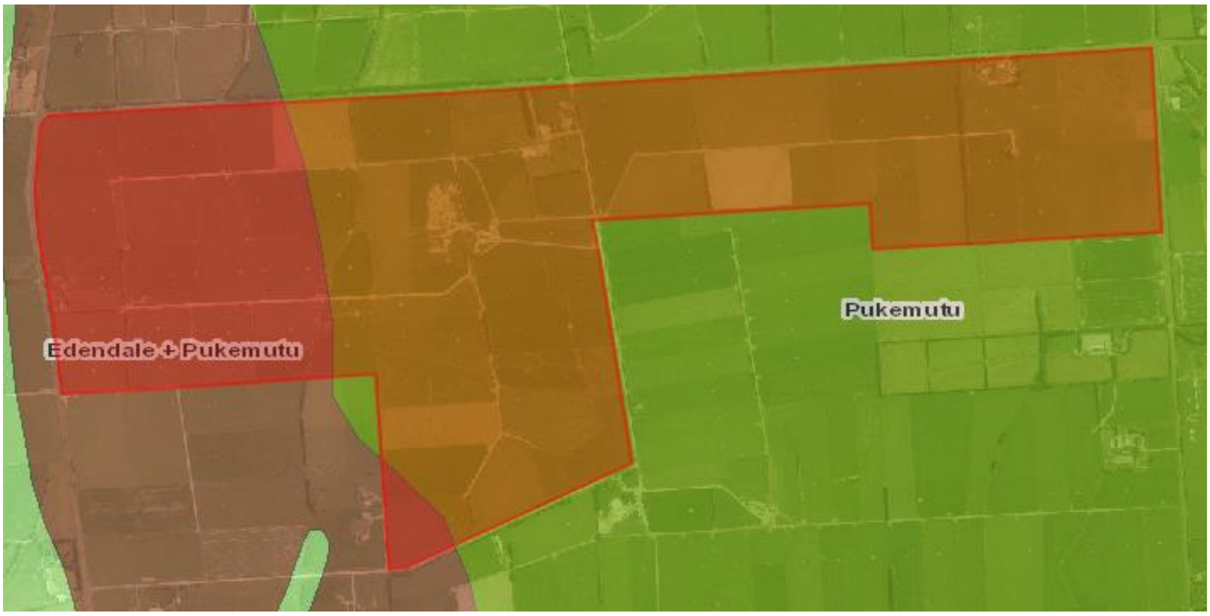

Figure 5. Driscolls farm map showing the soil types on farm