BEFORE COMMISSIONERS ON BEHALF OF

ENVIRONMENT SOUTHLAND

REF APP-20181750

UNDER	the Resource Management Act 1991
IN THE MATTER OF	an application for resource consent
BY	M & C Adams as trustees of the MJ Adams Trust to: - use land for farming; - discharge agricultural effluent to land; - take and use groundwater for dairy shed operations and stock drinking water.

STATEMENT OF EVIDENCE OF MIRANDA JANE HUNTER

29 April 2019

Background

1. My name is Miranda Jane Hunter. I hold a Bachelor of Agricultural Science Degree from Lincoln College. I am member of the New Zealand Institute of Primary Industry Management (NZIPIM) and have been involved in the dairy industry in consultancy, practical farming and dairy industry leadership roles since 1986.

2. I am qualified to complete farm systems appraisals. I have developed my skills through 30 plus years working in dairy farm systems. This level of experience has been recognised nationally and internationally through judging roles, senior leadership roles and consultancy contracts.

3. I have completed the Sustainable Nutrient Management Courses, (Intermediate and Advanced) and am a Certified Nutrient Management Adviser (certified in 2014).

4. I am a Director and Shareholder of South Coast Dairies Limited which owns and operates a 135-ha dairy platform in Southland. My involvement with this property, with my other business partners, has been to develop a sustainable farming business in all facets, including environmental. The business has been awarded several environmental awards including winner of the 2011 Environment Southland Farming Award.

5. I was previously employed by DairyNZ as Regional Leader for the Southern South Island. In this role I lead the extension team (of Consulting Officers) working with dairy farmers to achieve adoption of new practices and technologies on farm (including environmental).

6. I resigned from DairyNZ in June 2012 and I am now self employed as a Farm Consultant (trading as Roslin Consultancy Limited). I work with dairy farmers throughout Southland and Otago supporting them in analysing the environmental impact of their farm systems and improving their on farm management to meet their environmental goals. I also undertake environmental projects (contracted by Industry and Government Agencies) supporting the development of good practice resources for farmers and Overseer modelling to analyse effectiveness of mitigation practices at farm scale.

7. I have read the Code of Conduct for Expert Witnesses within the Environment Court Consolidated Practice Note 2014 and I agree to comply with that Code. This evidence is within my area of expertise, except where I state I am relying on what I have been told by another person. To the best of my knowledge I have not omitted to consider any material facts known to me that might alter or detract from the opinions I express.

Overseer Modelling

8. Overseer is designed as a decision support tool and allows comparisons between farm management scenarios. As with any model there are assumptions and limitations (as outlined report[1]).

Overseer Assumptions

- 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:

- Overseer does not predict transformations, attenuation or dilution of nutrients between the root zone or farm boundary and the eventual receiving water body. A

[1] Overseer Modelling Report Prepared as part of a consent application for expanded dairying, M & C Adams, 2nd October 2018, page 7

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.

9. Overseer modelling uncertainties are acknowledged and the following steps have been taken to minimise the impact of uncertainties:

(a) Adherence to Best Practice Data Input Standards (BPDIS)

(Adams - No deviations to BPDIS were made, no work arounds required)

(b) Use of Overseer in within the models parameters (for soils, climate and farm system)

(Standard approach)

(c) Method and consistent methodology between scenarios

(Adams – discussed with ES for input and clarification)

(d) Site visit to cross check information

(Standard approach - Understanding the property and the management blocks is critical to blocking in Overseer)

(e) Blocking completed taking into account land use, management systems, soils, topography and enterprise

(Standard approach – consistent with BPDIS)

(f) Consistency in modelling between the current and proposed files (Standard approach - "apples with apples")

(g) Expertise, experience and qualifications of the user

(Standard approach - Certified Nutrient Management Adviser and Dairy Farm Systems Expertise)

(h) Outputs are reviewed against expected results relative to soils, climate, land use and inputs

(Standard approach – reviewed against previous modelling results and research trials)

(i) Overseer files are internally peer reviewed (for adherence to BPDIS, feasible farm systems and data entry)

(Standard approach - Sustainable Nutrient Management Qualifications and Dairy Farm Systems Expertise)

10. The use of Overseer as a modelling tool is recognised in the Proposed Southland Proposed Water and Land Plan[2] (PSWLP). Appendix N (of PSWLP) requires that the latest version of the Overseer model (or an approved alternative model) is used on properties over 20ha or when a material change in land use occurs. As far as I am aware no alternative to Overseer has been approved by Environment Southland.

[2] Proposed Southland Water and Land Plan, Decisions Version, 4th April 2018

11. Uncertainty around Overseer model estimates tends to be lower within the range of the calibration data set i.e. where we have the most information. Most of the calibration data used to date is focused on flat, pastoral, dairy enterprises, with primarily free-draining soils and moderate rainfall. Pastoral farms in the Waikato, Southland, Canterbury and Manawatu, form the OVERSEER calibration data set. Consistency in modelling when developing scenarios is key to creating equivalence in uncertainty. When scenarios are compared, focus should be on the difference in estimated outputs, rather than absolute numbers.

12. The Staff Report[3] comments that "Overseer provides an overarching view at block (and farm) scale, and does not account for the variation of landscape, soil and topographical types within that block (and/or farm)". This comment could be misinterpreted. As stated in the Overseer Best Practice Data Input standards, it is critical to get blocks within the farm defined as accurately as possible. Blocks should be based on land uses, management system (i.e. effluent, irrigation, support), soils, topography and enterprise. As per standard practice, correct blocking procedures have been followed in the Adams Overseer modelling.

My Involvement with M & C Adams for the M J Adams Trust

13. As part of the application for expanded dairying, the applicant engaged Roslin Consultancy Limited to prepare nutrient budgets for the current land use and the proposed expansion. The nutrient budget work was completed in conjunction with Mo Topham (previously of Farmwise, now AgriAce Limited). At the time Mo Topham was not a Certified Nutrient Management Adviser, I did the predominate amount of work on this application and took the lead role.

14. The nutrient budgets were prepared using "Overseer Best Practice Data Input Standards, March 2018). No deviations from these protocols were made during the modelling assumptions. Farm systems information was provided by Mike Adams for the current milking

[3] Staff Report for the Hearing (complied by Alex Erceg)

platform. Farm systems information for the North Block was provided to Mike Adams by the previous owner (farm systems calculations were completed to cross check this information). Information for the East Block was not available from the previous owner, assumptions were made from visual assessment, Google Earth imaging, Mike Adams knowledge, Beef and Lamb monitoring data and professional judgement. Soils areas were obtained from soils mapping provided by Landpro Ltd and soils settings from SMap. Climate settings were obtained from the Overseer climate station tool. All assumptions have been discussed in detail with Mike Adams, Mike displays a good level of understanding of the inputs and assumptions that have been used.

Results from Adams Overseer Modelling

15. The original property operates as a milking platform and is consented to peak milk 1000 cow (actual number milked = 900 cows) and all cows are wintered off. The applicants have purchased neighbouring properties – prior land use as a dairy support unit (the Northern Block) and prior land use as a sheep breeding and finishing unit (the Eastern Block). It is proposed to expand the dairy platform onto the two purchased blocks, and increase the peak cow numbers to 1150 and winter all the cows on farm. Young stock will be grazed off (from weaning) as per current practice and return as rising 2-year olds to winter with the mature cows. In addition, there is another approximately 22 hectares of land which was part of the Northern Block purchase. This 22 hectares sits outside of the dairy platform, but is assumed to be utilised to create supplementary feed which is brought to the dairy platform, as accounted for within the nutrient budget.

16. The predicted results of the nutrient budget prepared are as follows (under version 6.3.0).

Table 1: Summarised predicted results from the Overseer v6.3.0 analysis of the Adams current nutrient budgets

	Current Milking Platform (900 cows) V6.3.0	**Current Dairy Support Block (Northern Block) V6.3.0**	**Current Sheep Breeding Block (East Block) V6.3.0**	**Total Current Land Use v6.3.0**
Total Farm N Loss	15092kg	8198 kg	1395 kg	24685 kg
N Loss/ha	46	82	23	51
N Concentration in Drainage	Pastoral – 9.2 to 14.1 ppm Crop – 10.7 to 39.7 ppm	Pastoral – 4.9to 5.7 ppm Crop – 29.5 to 33.7 ppm	Pastoral – 3.2 – 3.6 ppm Crop – 27.1 ppm	
Total Farm P Loss	349 kg	175 kg	36 kg	560 kg
Average P loss/ha	1.1 kg/ha/yr	1.8 kg/ha/yr	0.6 kg/ha/yr	1.1 kg/ha/yr
Pasture Grown Kg DM / ha / year	16.1	11.0	14.0	

Table 2: Summarised predicted results from the Overseer v6.3.0 analysis of the Adams proposed nutrient budget

	Proposed Dairy Unit **(1150 cows)** **v6.3.0**
Total Farm N Loss	21893 kg
N Loss/ha	45
N Concentration in Drainage	Pastoral – 7.4 to 10.9 ppm Crop – 9.3 to 26.9 ppm
Total Farm P Loss	579 kg
Average P loss/ha	1.2 kg/ha/yr
Pasture Grown **Kg DM / ha / year**	15.8

17. Using Overseer, nutrient budgets have been constructed for the Adams, comparing the nutrient loss of the current farm system against the proposed farm system. Overseer has predicted that the nitrogen loss will decrease and phosphorus loss will increase slightly (by less than 5%). Key drivers for the reduction in nitrogen loss are:

- Decrease in winter crop area (from 54 ha to 37 ha)
- Decrease in cows wintered (from 1470 to 1200)

- Decrease in stocking rate (on a per hectare basis) (from 2.7 cows per ha across the total milking platform to 2.4 cows per ha across the total landholding)

Key drivers for the increase in phosphorus loss are:

- An increase in losses from "other sources" (predominately lanes on previously non dairy land)

18. Overseer does not recognise some farm landscape features and mitigations when predicting phosphorus loss. When phosphorus mitigations are calculated outside of Overseer, taking into account lane way management (mitigation of 12 kg P / year) and management of critical source areas on the Northern Block (45 kg P / year), it is estimated that there is predicted to be a net decrease in phosphorus loss between current and proposed scenarios of 38 kg P / year[4].

Overseer Version

19. Original Modelling was completed utilising Overseer version 6.3.0. Subsequent to the original modelling Overseer version 6.3.1 (v 6.3.1) has been released. The original files were rerun in v 6.3.1 - this has resulted in very minor changes to modelling outputs. For completeness these are shown below (changes are shown as an alteration in red on the original report[5]):

[4] Application, Further Information, File Note, M Hunter, dated 19th November 2018
[5] Overseer Modelling Report Prepared as part of a consent application for expanded dairying, M & C Adams, 2nd October 2018

Predicted results from the Overseer modelling are shown below:

Table 3: Summarised predicted results from the Overseer v 6.3.1 analysis of the Adams current nutrient budgets

	Current Milking Platform (900 cows) V6.3.1	**Current Dairy Support Block (Northern Block) V6.3.1**	**Current Sheep Breeding Block (East Block) V6.3.1**	**Total Current Land Use V6.3.1**
Total Farm N Loss	150912kg	8198 kg	1395 kg	246845 kg
N Loss/ha	46	82	23	51
N Concentration in Drainage	Pastoral – 9.2 to 14.1 ppm Crop – 10.7 to 39.67 ppm	Pastoral – 4.9to 5.7 ppm Crop – 29.5 to 33.7 ppm	Pastoral – 3.2 – 3.6 ppm Crop – 27.1 ppm	
Total Farm P Loss	349 kg	175 kg	36 kg	560 kg
Average P loss/ha	1.1 kg/ha/yr	1.8 kg/ha/yr	0.6 kg/ha/yr	1.1 kg/ha/yr
Pasture Grow Kg DM / ha / year	16.1	11.0	14.0	

Table 4: Summarised predicted results from the Overseer v 6.3.1 analysis of the Adams proposed nutrient budget

	Proposed Dairy Unit (1150 cows) V6.3.1
Total Farm N Loss	218913 kg
N Loss/ha	45

N Concentration in Drainage	Pastoral – 7.4 to 10.9 ppm Crop – 9.3 to 26.9 ppm
Total Farm P Loss	579 kg
Average P loss/ha	1.2 kg/ha/yr
Pasture Grown **Kg DM / ha / year**	15.8

Off Site Effects

20. In Southland the dairy industry has a significant portion of their off site grazing provided by graziers. Graziers can range from sheep and beef farmers (with a small amount of dairy grazing) to specialist dairy graziers (ranging from small scale to large scale specialist graziers). Graziers can enter and exit the grazing market year by year depending on prices for sheep and beef (and grain products), price of dairy grazing and the farmers goals (including property sale and purchases). The grazing market is a very fluid market. A portion of Southland dairy animals are also grazed in Otago.

21. Key drivers of Overseer modelling are soils and climate data – this will vary from location to location. The off site dairy grazing management treatment applied (eg crop wintering versus pasture wintering) will vary between properties. The land will have an alternative use should grazing not be undertaken (the alternative use would have had a nutrient loss) - that again is "guess work". Therefore modelling the impact of off site grazing is challenging as it assumes a fictious range of assumptions which can greatly vary the results of Overseer outputs

22. The off-site effects of the increased young stock wintering has been raised in the Staff Report[6]. Calculation of offsite effects for young stock has not been raised previously by Council through a request for further information relating to the Adams application or in relation to other similar applications I have previously been involved in.

23. 234 rising 1-year olds are wintered off the property in the current operation, it is proposed to winter 300 rising 1 year olds off the property in the proposed scenario. In the current proposal all cows including rising 2-year olds are wintered on the property. There is therefore predicted to be an extra 66 rising 1-year olds wintered off site and 66 rising 2 year olds (that return home to winter).

Presently all young stock are grazed locally by a grazier, this grazier grass grazes (spread around the property, rather than intensively winter grazed) the young stock all year including winter. The same grazier has been used for the last 6 years by the Adams.

Should the young stock be intensively winter grazed in the future, the following off-site effect of the extra young stock can be estimated as follows:

- 66 rising 1-year olds, wintered off site for 77 days.
- Require 5 kg DM of fodderbeet allocated per head per day. Note balance of diet will be in supplement as per standard practice.
- At a 25,000 kg DM yield of fodderbeet, will require 1.02 ha.
- 5 kg DM / head / day[7] x 77 days x 66 head = 25410 kg DM required.
- At a crop yield of 25t DM = 1.02 ha of crop required.
- Assuming the fodderbeet crop on average has the following losses (based on the modelling assumptions from the current neighbouring support block of an average N loss of 148 kg N / ha and 1.6 kg P / ha / year).

[6] Staff Report for the Hearing (complied by Alex Erceg)
[7] Consistent with practice at the Southern Dairy Hub

Therefore, it can be estimate that the off site effects of wintering the 66 increased rising 1 year olds:

- 151kg N / year
- 1.6 kg P / year

. 19. In addition to the winter grazing it is assumed that the additional 66 head of young stock are grass grazed when they are not on winter crop. The 66 head would require approximately 25 ha of pasture, if this pasture has a N loss of 30 kg N/ ha / year and a P loss of 0.6 kg P / ha / year.

Therefore, it can be estimated that the offsite effect of grass grazing the 66 rising 1 year olds and rising 2 year olds as:

- 750 kg N / year
- 15 kg P / year

Note – the estimate above is intended to give an estimate of scale of effect, rather than suggest accuracy. There are too many variables that are unknown to provide accuracy.

Off Setting of Effects

24. The offsetting of effects has been raised in particular reference to the East Block in the Staff Report[8]. In particular the following aspects have been raised:

- The Eastern Block has not been modelled separately in the proposal, therefore the effects cannot be assessed.
- The Eastern Block is located in a different sub catchment (Opio) to the Northern Block and the existing milking platform.

[8] Staff Report for the Hearing (complied by Alex Erceg)

- Intensive winter grazing on this block increases the risk of nutrient loss.
- Risk of contaminant loss during land use change.

25. A report with information pertaining to the East Block[9] has been completed, and is attached to this evidence (refer appendices), it is recommended that this should be read in conjunction with this statement of evidence.

26. The current East Block (the neighbouring sheep breeding block) of 60.3ha was purchased in December 2017. Due to the consenting process being uncertain, a status quo use of the East Block has not been established since purchase. The East Block has been modelled in Overseer as per its pre purchase management – a sheep breeding and finishing property. The block has been used for sheep breeding and includes the intensive winter grazing of sheep on fodder crop.

[9] File Note – Adams , East Block, M Hunter, 25th April 2019

27. The current nutrient losses from the East Block are estimated by Overseer are as follows:

Table 5: Summarised predicted results from the Overseer analysis of the Current Adams East Block nutrient budgets

	Current Sheep Breeding Block (East Block) v 6.3.1
Total Farm N Loss	1395 kg
N Loss/ha	23
N Concentration in Drainage	Pastoral – 3.2 – 3.6 ppm Crop – 27.1 ppm
Total Farm P Loss	36 kg
Average P loss/ha	0.6 kg/ha/yr
Pasture Grown Kg DM / ha / year	14.0

At the time of lodging the application it was not standard Council practice to require the blocking of the East Block separately in Overseer (and this was not a standard practice for applications at the time). Subsequent to lodging the application this has become a more standard instruction by Council. It should be noted that the BPDIS advise separate blocking at catchment, rather than sub catchment level. This assumes a relatively common understanding of the term catchment as being all the tributary waters/area that feed into a named water body.

28. The proposed nutrient budget has been reblocked to block the East Block separately (this has resulted in no significant changes in the overall Adams Proposed Dairy Unit Overseer Outputs).

The proposed nutrient losses from the East Block are estimated by Overseer as follows:

Table 6: Summarised predicted results from the Overseer analysis of the Adams Proposed nutrient budgets (East Block Results)

	Proposed (East Block Results) v 6.3.1
Total Farm N Loss (including losses from fodder crops and other sources on a pro rata based on land area)	2551 kg
N Loss/ha/ year	42
N Concentration in Drainage	Pastoral – 7.4 - 10.3 ppm Crop – 9.3 - 36.9 ppm
Total Farm P Loss (including losses from fodder crops and other sources on a pro rata based on land area)	58 kg
Average P loss/ha	1.0 kg/ha/yr
Pasture Grown Kg DM / ha / year	15.8

The nitrogen loss is estimated by Overseer to increase by 83% on the Eastern Block, the key drivers for this are:

- Increase in fertiliser nitrogen use.
- Feeding of supplement on pastoral blocks.
- Spreading of effluent solids.
- Increase in allocation of "other sources".

The phosphorus loss is estimated by Overseer to increase by 61% on the Eastern Block, the key drivers for this are:

- Increase in Olsen P and increased application of phosphate fertiliser.
- Spreading of effluent solids.
- Feeding of supplement on pastoral blocks.
- Increase in allocation of "other sources".

Note - the fodder crop is not estimated to be a key driver of change between the scenarios, as the current sheep breeding East Block had 6 ha of swedes and the proposed has proportionately 4.6 ha of fodder beet and 1.5 ha of summer turnips.

29. Now that it is understood that the East Block is viewed as an issue in the Staff Report, opportunities to mitigate losses from the East Block have been discussed with the Adams. The level of mitigation required to ensure that nitrogen and phosphorus losses are no higher than the current land use is significant.

The East Block sits within the Gleyed physiographic zone, there is a risk of contamination of surface water via overland flow and artificial drainage.

It should be noted that Overseer already incorporates a range of good management practices, for example:

- Effluent is applied when soil moisture conditions are appropriate and applied at the correct rate for plant uptake.
- Fertiliser are not applied during high risk periods (such as wet soil conditions).
- Waterways are fenced.

Therefore, mitigations are assumed to be practices that are beyond good management practice.

30. As with any modelling in Overseer, farm systems cannot be viewed in isolated individual changes. To ensure a farm system is feasible to implement a "suite" of changes need to be implemented to effect an overall change.

To mitigate nutrient losses on the East Block the following changes are recommended to the proposed farm system:

- No fodder crops rotating on the land in the Eastern Block, use the East Block for making of more supplement (to be utilised as supplementary feed for the fodder beet).
- No animals on the East Block (pasture) during June and July (high risk months for "pugging" damage).
- No effluent solids applied to East Block.

- Reduce nitrogen in the form of urea used on the East Block (it has been assumed that the East Block will grow less pasture as a result of this and extra supplement has been purchased to compensate for this).

In addition to the changes in the proposed farm system it is recommended that the following practices are also implemented:

- Minimising phosphorus loss from the laneways.
- Reducing losses from overland flow via critical source areas.

31. The changes to the farm system to mitigate nutrient loss on the East Block have been modelled in Overseer. As Overseer is not spatially explicit and is unable to take into account landscape features at farm scale some mitigations have been estimated outside of Overseer

Table 7: Summarised predicted results from the Overseer analysis of the Adams Proposed nutrient budgets (East Block Results - Mitigated)

	Proposed Mitigated East Block Estimated Results v 6.3.1
Total Farm N Loss	1361 kg
N Loss/ha/ year	23
N Concentration in Drainage	Pastoral – 5.1- 6.8 ppm
Total Farm P Loss	52 kg (calculated from Overseer) 15 kg P (less mitigation calculated outside Overseer) 37 kg P / year
Average P loss/ha	0.9 kg / ha / yr
Pasture Grown Kg DM / ha / year	15.1

The mitigations on the East Block have resulted in little impact in overall nitrogen and phosphorus loss.

Table 8: Summarised predicted results from the Overseer analysis of the overall Adams Proposed nutrient budgets with East Block Defined compared with East Block Mitigated)

	Proposed Dairy Unit – East Block Defined **(1150 cows)** **v 6.3.1**	**Proposed Dairy Unit – East Block Mitigated** **(1150 cows)** **v 6.3.1**
Total Farm N Loss	21891 kg	21969 kg
N Loss/ha	45	45
N Concentration in Drainage	Pastoral – 7.4 to 10.9 ppm Crop – 9.3 to 36.9 ppm	Pastoral – 5.1 to 11.1 ppm Crop – 10.2 to 38.8 ppm
Total Farm P Loss	579 kg	576 kg
Average P loss/ha	1.2 kg/ha/yr	1.2 kg/ha/yr
Pasture Grown Kg DM / ha / year	15.8	15.8 (East Block – 15.1)

32. The Staff Report also raised the issue of an increase in phosphorus loss during land use change from the potential use of capital fertilizer.

33. In July 2018, all paddock soil testing was completed by Adams Fertiliser Representative (Ravensdown). Adams undertook this investment to get an understanding of the soil fertility status, so a targeted fertilizer programme could be prepared. The results show that the Olsen P ranged from 23 to 61 (an average of 37). The majority of the property is above the agronomic optimum of 30 and will require fertilizer levels that are below maintenance (therefore capital fertilizer is not a risk during the proposed land use change)

34. Should the described suite of mitigations be implemented the nutrient loss estimated on the East Block is as follows:

Table 9: Summarised predicted results from the Overseer analysis of the Current Adams East Block mitigated nutrient budgets

	Proposed Mitigated East Block Estimated Results v 6.3.1
Total Farm N Loss	1361 kg
N Loss/ha/ year	23
N Concentration in Drainage	Pastoral – 5.1- 6.8 ppm
Total Farm P Loss	52 kg (calculated from Overseer) 15 kg P (less mitigation calculated outside Overseer) 37 kg P / year
Average P loss/ha	0.9 kg / ha / yr
Pasture Grown Kg DM / ha / year	15.1

The table below compares the current nitrogen and phosphorus loss on the East Block against the proposed nitrogen and phosphorus loss (with mitigations in place)

Table 10: Summarised predicted results from the Overseer analysis of the Current Adams East Block and Proposed East Block (mitigated) nutrient budgets

	Current East Block Results v 6.3.1	**Proposed Mitigated East Block Results v 6.3.1**
Total Farm N Loss	1395 kg	1361 kg
N Loss/ha/ year	23	23
N Concentration in Drainage	Pastoral – 3.2 – 3.6 ppm Crop – 27.1 ppm	Pastoral – 5.1- 6.8 ppm
Total Farm P Loss	36 kg	37 kg
Average P loss/ha	0.6 kg/ha/yr	0.9 kg / ha / yr
Pasture Grown Kg DM / ha / year	14.0	15.1

35. With the proposed mitigations Overseer estimates that the nitrogen will decrease in the proposed very slightly (by less than 5%). It is estimated that phosphorus will increase very slightly (by less than 5%).

Summary

36. Predicted results from the Overseer modelling are shown below:

Table 11: Summarised predicted results from the Overseer v 6.3.1 analysis of the Adams current nutrient budgets

	Current Milking Platform (900 cows) V6.3.1	**Current Dairy Support Block (Northern Block) V6.3.1**	**Current Sheep Breeding Block (East Block) V6.3.1**	**Total Current Land Use V6.3.1**
Total Farm N Loss	15091kg	8198 kg	1395 kg	24684 kg
N Loss/ha	46	82	23	51
N Concentration in Drainage	Pastoral – 9.2 to 14.1 ppm Crop – 10.7 to 39.6-ppm	Pastoral – 4.9to 5.7 ppm Crop – 29.5 to 33.7 ppm	Pastoral – 3.2 – 3.6 ppm Crop – 27.1 ppm	
Total Farm P Loss	349 kg	175 kg	36 kg	560 kg
Average P loss/ha	1.1 kg/ha/yr	1.8 kg/ha/yr	0.6 kg/ha/yr	1.1 kg/ha/yr
Pasture Grown Kg DM / ha / year	16.1	11.0	14.0	

It is recommended the following suite of mitigations are implemented;

- No fodder crops rotating on the land in the Eastern Block.
- No animals on the East Block (pasture) during June and July.
- No effluent solids applied to East Block.
- Reduce nitrogen in the form of urea used on the East Block.
- Minimising phosphorus loss from the laneways through siting of laneways, lane way maintenance and vegetative buffer zones.
- Reducing losses from overland flow via critical source areas by creating vegetative buffer zones.

When these mitigations are modelled in Overseer, the following results are estimated:

Table 12: Summarised predicted results from the Overseer v 6.3.1 analysis of the Adams proposed nutrient budgets (East Block Mitigated)

	Proposed Dairy Unit – East Block Mitigated **(1150 cows)** **v 6.3.1**
Total Farm N Loss	21969 kg
N Loss/ha	45
N Concentration in Drainage	Pastoral – 5.1 to 11.1 ppm Crop – 10.2 to 38.8 ppm
Total Farm P Loss	576 kg
Average P loss/ha	1.2 kg/ha/yr
Pasture Grown **Kg DM / ha / year**	15.8 (East Block – 15.1)

In addition to the Overseer modelling, impact of mitigations has been modelled outside Overseer (where Overseer does not reward the mitigations). These have been summarised in the following table:

Table 13: Summarised estimated impact of phosphorus m(modelled outside of Overseer)

Mitigation	Estimated mitigation on P loss
Laneway management of extra 250 cows (both the North and East Blocks)	12 kg P / year
Management of critical source areas on North Block	45 kg P / year
Management of critical source areas on the East Block	8 kg P / year
	65 kg P / year

The table below compares the current nitrogen and phosphorus loss on the East Block against the proposed nitrogen and phosphorus loss (with mitigations in place)

Table 14: Summarised predicted results from the Overseer analysis of the Current Adams East Block and Proposed East Block (mitigated) nutrient budgets

	Current East Block Results v 6.3.1	**Proposed Mitigated East Block Results v 6.3.1**
Total Farm N Loss	1395 kg	1361 kg
N Loss/ha/ year	23	23
N Concentration in Drainage	Pastoral – 3.2 – 3.6 ppm Crop – 27.1 ppm	Pastoral – 5.1- 6.8 ppm
Total Farm P Loss	36 kg	37 kg
Average P loss/ha	0.6 kg/ha/yr	0.9 kg / ha / yr
Pasture Grown Kg DM / ha / year	14.0	15.1

When off site effects of the increased young stock are taken into account

Table 15: Summarised estimated impact of off site effects of young stock (modelled outside of Overseer)

	Estimated offsite N loss	**Estimated offsite P loss**
Intensive winter grazing	151 kg N / year	2 kg P / year
Grass grazing (outside the winter period)	750 kg N / year	15 kg P / year
	901 kg N / year	**17 kg P / year**

37. When the mitigations are modelled, estimates of mitigations and young stock off site effects are undertaken outside of Overseer, the following results are estimated:

Table 16: Summarised predicted results from the Overseer v 6.3.1 analysis of the Adams proposed nutrient budgets (including estimted impact of off site effects of young stock - modelled outside of Overseer)

	Proposed Dairy Unit – East Block Mitigated **(1150 cows)** **v 6.3.1** **Including mitigations outside of Overseer and offsite effects of young stock**
Total Farm N Loss	22870 kg
N Loss/ha	47
Total Farm P Loss	528 kg
Average P loss/ha	1.1 kg/ha/yr

Conclusion

38. Overseer modelling uncertainties are acknowledged, and the following steps have been taken to minimise the impact of uncertainties:

(a) Adherence to Best Practice Data Input Standards (BPDIS)

(Adams - No deviations to BPDIS were made, no work arounds required)

(b) Use of Overseer in within the models parameters (for soils, climate and farm system)

(Standard approach)

(c) Method and consistent methodology between scenarios

(Adams – discussed with ES for input and clarification)

(d) Site visit to cross check information

(Standard approach - Understanding the property and the management blocks is critical to blocking in Overseer)

(e) Blocking completed taking into account land use, management systems, soils, topography and enterprise

(Standard approach – consistent with BPDIS)

(f) Consistency in modelling between the current and proposed files (Standard approach - "apples with apples")

(g) Expertise, experience and qualifications of the user

(Standard approach - Certified Nutrient Management Adviser and Dairy Farm Systems Expertise)

(h) Outputs are reviewed against expected results relative to soils, climate, land use and inputs

(Standard approach – reviewed against previous modelling results and research trials)

(i) Overseer files are internally peer reviewed (for adherence to BPDIS, feasible farm systems and data entry)

(Standard approach - Sustainable Nutrient Management Qualifications and Dairy Farm Systems Expertise)

39. Pastoral farms in the Waikato, Southland, Canterbury and Manawatu, form the OVERSEER calibration data set. Consistency in modelling when developing scenarios is a key to creating equivalence in uncertainty.

40. Overseer modelling has been completed for the Adams proposal. The results show that should a significant suite of mitigations be implemented that it is estimated that there will be a decrease in nitrogen loss from the land use of 7% and a decrease in the phosphorus loss from the land use of 6%. These calculations take into account modelling completed in Overseer and estimates of mitigations and off site effects of young stock outside of Overseer.

41. In terms of the East Block it is estimated that following a significant suite of mitigations that the nitrogen loss will decrease in the proposed very slightly (by less than 5%). It is estimated that phosphorus will increase very slightly (by less than 5%).

42. A key aspect of the calculations completed is that the following mitigations are put into place:

- No fodder crops rotating on the land in the Eastern Block.
- No animals on the East Block (pasture) during June and July.
- No effluent solids applied to East Block.
- Reduce nitrogen in the form of urea used on the East Block.
- Minimising phosphorus loss from the laneways through siting of laneways, lane way maintenance and vegetative buffer zones.
- Reducing losses from overland flow via critical source areas by creating vegetative buffer zones.

The mitigations detailed should be clearly reflected in a farm environment plan prepared for the property.

Miranda Hunter
Roslin Consultancy Ltd

27th April 2019

Appendices

File Note – Adams, East Block

Date 25th April 2019

File Note Background

An application for expanded dairying has been lodged by Mike and Cindy Adams. The Staff report for the Hearing has raised as a key issue the effects arising from the change in land use from the East Block.

In particular the following aspects have been raised:

- The Eastern Block has not been modelled separately in the proposal, therefore the effects can not be assessed
- The Eastern Block is located in a different sub catchment (Opio) to the Northern Block and the existing milking platform
- Intensive winter grazing on this block increases the risk of nutrient loss
- Risk of contaminant loss during land use change

Overseer Modelling of East Block

The current East Block (the neighbouring sheep breeding block) of 60.3ha was purchased in December 2017. Due to the consenting process being uncertain, the Adams do not currently have a planned farm system for the East Block.

The East Block has been modelled in Overseer as per its pre purchase management – a sheep breeding and finishing property. The block has been used for sheep breeding and includes the intensive winter grazing of sheep on a fodder crop.

The current nutrient losses from the East Block are estimated by Overseer are as follows:

Table 1: Summarised predicted results from the Overseer analysis of the Current Adams East Block nutrient budgets

	Current Sheep Breeding Block (East Block) v 6.3.1
Total Farm N Loss	1395 kg
N Loss/ha	23
N Concentration in Drainage	Pastoral – 3.2 – 3.6 ppm Crop – 27.1 ppm
Total Farm P Loss	36 kg
Average P loss/ha	0.6 kg/ha/yr
Pasture Grown Kg DM / ha / year	14.0

At the time of lodging the application it was not standard Council practice to require the blocking of the East Block separately in Overseer (and this was not a standard practice for applications at the time). Subsequent to lodging the application this has become a more standard instruction by Council. It should be noted that the BPDIS advise separate blocking at catchment, rather than sub catchment level. This assumes a relatively common understanding of the term catchment as being all the tributary waters/area that feed into a named water body.

The proposed nutrient budget has been reblocked to block the East Block separately (this has resulted in no significant changes in overall Adams Proposed Dairy Unit Overseer Outputs), for copy of Overseer nitrogen and phosphorus output reports refer Appendix 1.

The proposed nutrient losses from the East Block are estimated by Overseer as follows:

Table 2: Summarised predicted results from the Overseer analysis of the Adams Proposed nutrient budgets (East Block Results)

	Proposed (East Block Results) v 6.3.1
Total Farm N Loss (including losses from fodder crops and other sources on a pro rata based on land area)	2551 kg
N Loss/ha/ year	42
N Concentration in Drainage	Pastoral – 7.4 - 10.3 ppm Crop – 9.3 - 36.9 ppm
Total Farm P Loss (including losses from fodder crops and other sources on a pro rata based on land area)	58 kg
Average P loss/ha	1.0 kg/ha/yr
Pasture Grown Kg DM / ha / year	15.9

The nitrogen loss is estimated by Overseer to increase by 83% on the Eastern Block, the key drivers for this are:

- Increase in fertiliser nitrogen use
- Feeding of supplement on pastoral blocks
- Spreading of effluent solids
- Increase in allocation of "other sources"

The phosphorus loss is estimated by Overseer to increase by 61% on the Eastern Block, the key drivers for this are:

- Increase in Olsen P and increased application of phosphate fertiliser
- Spreading of effluent solids
- Feeding of supplement on pastoral blocks
- Increase in allocation of "other sources"

Note - the fodder crop is not estimated to be a key driver of change between the scenarios, as the current East Block has 6 ha of swedes and the proposed has proportionately 4.6 ha of fodder beet and 1.5 ha of summer turnips.

Mitigation Opportunities on the East Block

Now that it is understood that the East Block is viewed as an issue in the Staff Report, opportunities to mitigate losses from the East Block have been discussed with the Adams. The level of mitigation required to ensure that nitrogen and phosphorus losses are no higher than the current land use is significant.

The East Block sits within the Gleyed physiographic zone, there is a risk of contamination of surface water via overland flow and artificial drainage.

It should be noted that Overseer already incorporates a range of good management practices, for example:

- Effluent is applied when soil moisture conditions are appropriate and applied at the correct rate for plant uptake
- Fertiliser are not applied during high risk periods (such as wet soil conditions)
- Waterways are fenced (but not that there is a riparian buffer zone present)

Therefore mitigations are assumed to be practices that are beyond good management practice. Mitigations tend to be farm specific, depending on individual farm risks (typically farm system, management and landscape features).

:

As with any modelling in Overseer, farm systems can not be viewed in isolated individual changes. To ensure a farm system is feasible to implement a "suite" of changes need to be implemented to effect an overall change.

To mitigate nutrient losses on the East Block the following changes are recommended to the proposed farm system:

- No fodder crops rotating on the land in the Eastern Block, use the East Block for making of more supplement (to be utilised as supplementary feed for the fodder beet)
- No animals on the East Block (pasture) during June and July (high risk months for "pugging" damage)
- No effluent solids applied to East Block
- Reduce nitrogen in the form of urea used on the East Block (it has been assumed that the East Block will grown less pasture as a result of this and extra supplement has been purchased to compensate for this)

In addition to the changes in the proposed farm system it is recommended that the following practices are also implemented:

- Minimising phosphorus loss from the laneways
- Reducing losses from overland flow via critical source areas

The changes to the farm system to mitigate nutrient loss on the East Block have been modelled in Overseer (for a summary of these changes refer to the table in Appendix 2). Overseer reports from the mitigations are shown in Appendix 3.

As Overseer is not spatially explicit and is unable to take into account landscape features at farm scale some mitigations have been estimated outside of Overseer (refer Appendix 4).

Table 3: Summarised predicted results from the Overseer analysis of the Current Adams East Block nutrient budgets

	Proposed Mitigated East Block Estimated Results v 6.3.1
Total Farm N Loss	1361 kg
N Loss/ha/ year	23
N Concentration in Drainage	Pastoral – 5.1- 6.8 ppm
Total Farm P Loss	52 kg (calculated from Overseer) Appendix 3 15 kg P (less mitigation calculated outside Overseer) Appendix 4 37 kg P / year
Average P loss/ha	0.9 kg / ha / yr
Pasture Grown Kg DM / ha / year	15.1

Impact of East Block Mitigations on Proposed Nutrient Loss

Table 4: Summarised predicted results from the Overseer v 6.3.1 analysis of the Adams proposed nutrient budgets (East Block Mitigated)

	Proposed Dairy Unit – East Block Defined **(1150 cows)** **v 6.3.1**	**Proposed Dairy Unit – East Block Mitigated** **(1150 cows)** **v 6.3.1**
Total Farm N Loss	21891 kg	21969 kg
N Loss/ha	45	45
N Concentration in Drainage	Pastoral – 7.4 to 10.9 ppm Crop – 9.3 to 36.9 ppm	Pastoral – 5.1 to 11.1 ppm Crop – 10.2 to 38.8 ppm
Total Farm P Loss	579 kg	576 kg
Average P loss/ha	1.2 kg/ha/yr	1.2 kg/ha/yr
Pasture Grown **Kg DM / ha / year**	15.8	15.8 (East Block – 15.1)

The mitigations on the East Block have resulted in little impact in overall nitrogen and phosphorus loss.

Risk of contaminant loss during land use change

Increase in phosphorus loss during land use change from the potential use of capital fertilizer has been raised in the staff report.

In July 2018, all paddock soil testing was completed by Adams Fertiliser Representative (Ravensdown), refer to Appendix 5 for soil test results. Adams undertook this investment to get an understanding of the soil fertility status, so a targeted fertilizer programme could be prepared. The results show that the Olsen p ranged from 23 to 61 (an average of 37). The majority of the property is above the agronomic optimum of 30 and will require levels that are below maintenance (therefore capital fertilizer is not a risk during the proposed land use change)

Summary

Should the described suite of mitigations be implemented mitigations be implemented the nutrient loss estimated on the East Block is as follows:

Table 5: Summarised predicted results from the Overseer analysis of the Current Adams East Block mitigated nutrient budgets

	Proposed Mitigated East Block Estimated Results v 6.3.1
Total Farm N Loss	1361 kg
N Loss/ha/ year	23
N Concentration in Drainage	Pastoral – 5.1- 6.8 ppm
Total Farm P Loss	52 kg (calculated from Overseer) 15 kg P (less mitigation calculated outside Overseer) 37 kg P / year
Average P loss/ha	0.9 kg / ha / yr
Pasture Grown Kg DM / ha / year	15.1

The table below compares the current nitrogen and phosphorus loss on the East Block against the proposed nitrogen and phosphorus loss (with mitigations in place)

Table 6: Summarised predicted results from the Overseer analysis of the Current Adams East Block and Proposed East Block (mitigated) nutrient budgets

	Current East Block Results v 6.3.1	**Proposed Mitigated East Block Results v 6.3.1**
Total Farm N Loss	1395 kg	1361 kg
N Loss/ha/ year	23	23
N Concentration in Drainage	Pastoral – 3.2 – 3.6 ppm Crop – 27.1 ppm	Pastoral – 5.1- 6.8 ppm
Total Farm P Loss	36 kg	37 kg
Average P loss/ha	0.6 kg/ha/yr	0.9 kg / ha / yr
Pasture Grown Kg DM / ha / year	14.0	15.1

With the proposed mitigations Overseer estimates that the nitrogen will decrease in the proposed very slightly (by less than 5%). It is estimated that phosphorus will increase very slightly (by less than 5%).

File Note Prepared by - Miranda Hunter

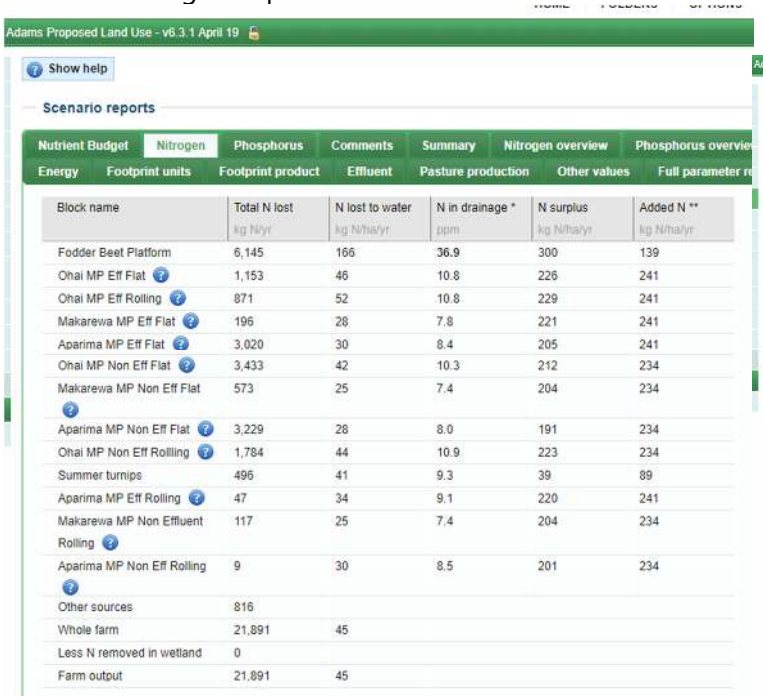
Roslin Consultancy Limited

25th April 2019

Appendices

Appendix 1 – Overseer reports for nitrogen and phosphorus comparing the Adams Proposed Dairy Unit outputs alongside the **East Block** defined as blocks outputs

Overseer Nitrogen Reports:



Adams Proposed Land Use - v6.3.1 April 19

Show help

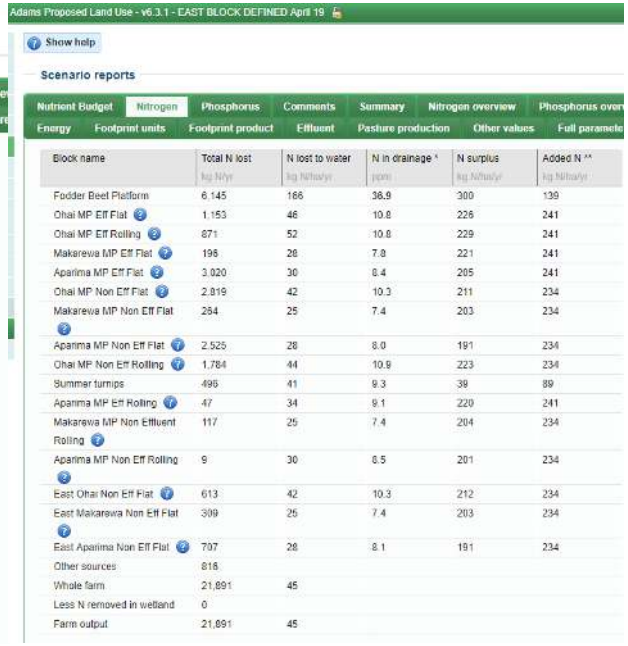
Scenario reports

Nutrient Budget | Nitrogen | Phosphorus | Comments | Summary | Nitrogen overview | Phosphorus overvie

Energy | Footprint units | Footprint product | Effluent | Pasture production | Other values | Full parameter r

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
Fodder Beet Platform	6,145	166	36.9	300	139
Ohai MP Eff Flat	1,153	46	10.8	226	241
Ohai MP Eff Rolling	871	52	10.8	229	241
Makarewa MP Eff Flat	196	28	7.8	221	241
Aparima MP Eff Flat	3,020	30	8.4	205	241
Ohai MP Non Eff Flat	3,433	42	10.3	212	234
Makarewa MP Non Eff Flat	573	25	7.4	204	234
Aparima MP Non Eff Flat	3,229	28	8.0	191	234
Ohai MP Non Eff Rolling	1,784	44	10.9	223	234
Summer turnips	496	41	9.3	39	89
Aparima MP Eff Rolling	47	34	9.1	220	241
Makarewa MP Non Effluent Rolling	117	25	7.4	204	234
Aparima MP Non Eff Rolling	9	30	8.5	201	234
Other sources	816				
Whole farm	21,891	45			
Less N removed in wetland	0				
Farm output	21,891	45			

Proposed Adams Land Use v6.3.1



Adams Proposed Land Use - v6.3.1 - EAST BLOCK DEFINED April 19

Show help

Scenario reports

Nutrient Budget | Nitrogen | Phosphorus | Comments | Summary | Nitrogen overview | Phosphorus over

Energy | Footprint units | Footprint product | Effluent | Pasture production | Other values | Full parame

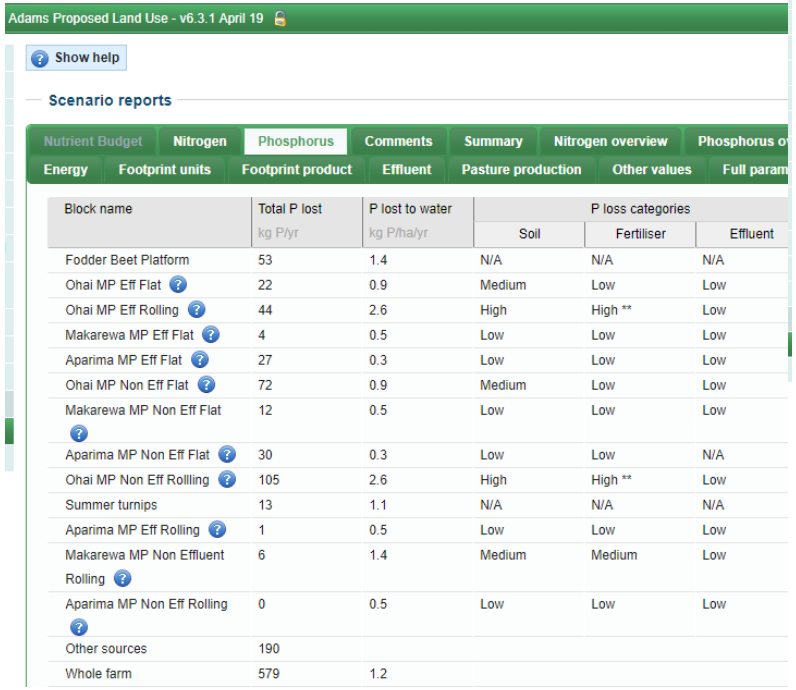
Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
Fodder Beet Platform	6,145	166	36.9	300	139
Ohai MP Eff Flat	1,153	46	10.8	226	241
Ohai MP Eff Rolling	871	52	10.8	229	241
Makarewa MP Eff Flat	196	28	7.8	221	241
Aparima MP Eff Flat	3,020	30	8.4	205	241
Ohai MP Non Eff Flat	2,819	42	10.3	211	234
Makarewa MP Non Eff Flat	284	25	7.4	203	234
Aparima MP Non Eff Flat	2,525	28	8.0	191	234
Ohai MP Non Eff Rolling	1,784	44	10.9	223	234
Summer turnips	496	41	9.3	39	89
Aparima MP Eff Rolling	47	34	9.1	220	241
Makarewa MP Non Effluent Rolling	117	25	7.4	204	234
Aparima MP Non Eff Rolling	9	30	8.5	201	234
East Ohai Non Eff Flat	613	42	10.3	212	234
East Makarewa Non Eff Flat	309	25	7.4	203	234
East Aparima Non Eff Flat	707	28	8.1	191	234
Other sources	816				
Whole farm	21,891	45			
Less N removed in wetland	0				
Farm output	21,891	45			

Proposed Adams Land Use v6.3.1 with **East Block Defined**

East Block N loss calculation –

613 (East Ohai) + 309 (East Makarewa) + 707 (East Aparima) + (6145 x 12.36%) (Fodderbeet) + (496 x 12.36%) (summer turnips) + (816 x 12.36%) (other sources) = 2551 N kg / year

Overseer Phosphorus Reports



Adams Proposed Land Use - v6.3.1 April 19

Show help

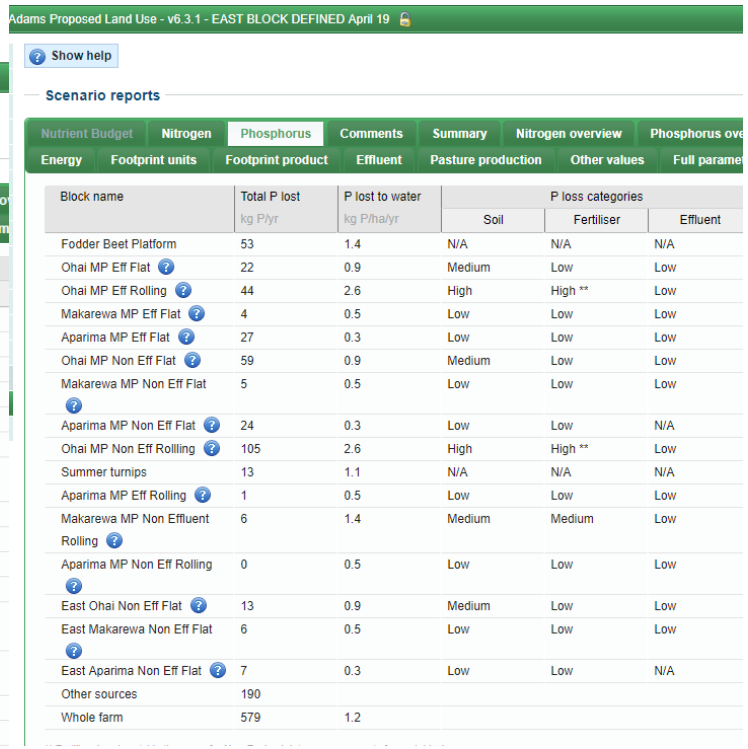
Scenario reports

Nutrient Budget | Nitrogen | Phosphorus | Comments | Summary | Nitrogen overview | Phosphorus ov

Energy | Footprint units | Footprint product | Effluent | Pasture production | Other values | Full param

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
Fodder Beet Platform	53	1.4	N/A	N/A	N/A
Ohai MP Eff Flat	22	0.9	Medium	Low	Low
Ohai MP Eff Rolling	44	2.6	High	High **	Low
Makarewa MP Eff Flat	4	0.5	Low	Low	Low
Aparima MP Eff Flat	27	0.3	Low	Low	Low
Ohai MP Non Eff Flat	72	0.9	Medium	Low	Low
Makarewa MP Non Eff Flat	12	0.5	Low	Low	Low
Aparima MP Non Eff Flat	30	0.3	Low	Low	N/A
Ohai MP Non Eff Rollling	105	2.6	High	High **	Low
Summer turnips	13	1.1	N/A	N/A	N/A
Aparima MP Eff Rolling	1	0.5	Low	Low	Low
Makarewa MP Non Effluent Rolling	6	1.4	Medium	Medium	Low
Aparima MP Non Eff Rolling	0	0.5	Low	Low	Low
Other sources	190				
Whole farm	579	1.2			

Proposed Adams Land Use v6.3.1



Adams Proposed Land Use - v6.3.1 - EAST BLOCK DEFINED April 19

Show help

Scenario reports

Nutrient Budget | Nitrogen | Phosphorus | Comments | Summary | Nitrogen overview | Phosphorus ove

Energy | Footprint units | Footprint product | Effluent | Pasture production | Other values | Full parame

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
Fodder Beet Platform	53	1.4	N/A	N/A	N/A
Ohai MP Eff Flat	22	0.9	Medium	Low	Low
Ohai MP Eff Rolling	44	2.6	High	High **	Low
Makarewa MP Eff Flat	4	0.5	Low	Low	Low
Aparima MP Eff Flat	27	0.3	Low	Low	Low
Ohai MP Non Eff Flat	59	0.9	Medium	Low	Low
Makarewa MP Non Eff Flat	5	0.5	Low	Low	Low
Aparima MP Non Eff Flat	24	0.3	Low	Low	N/A
Ohai MP Non Eff Rollling	105	2.6	High	High **	Low
Summer turnips	13	1.1	N/A	N/A	N/A
Aparima MP Eff Rolling	1	0.5	Low	Low	Low
Makarewa MP Non Effluent Rolling	6	1.4	Medium	Medium	Low
Aparima MP Non Eff Rolling	0	0.5	Low	Low	Low
East Ohai Non Eff Flat	13	0.9	Medium	Low	Low
East Makarewa Non Eff Flat	6	0.5	Low	Low	Low
East Aparima Non Eff Flat	7	0.3	Low	Low	N/A
Other sources	190				
Whole farm	579	1.2			

Proposed Adams Land Use v6.3.1 with **East Block Defined**

<u>East Block P loss calculation</u> –

13 (East Ohai) + 6 (East Makarewa) + 7 (East Aparima) + (53 x 12.36%) (Fodderbeet) + (13 x 12.36%) (summer turnips) + (190 x 12.36%) (other sources) = 58 kg P / year

Appendix 2 – Summary of farm system changes required to mitigate nitrogen loss from the East Block

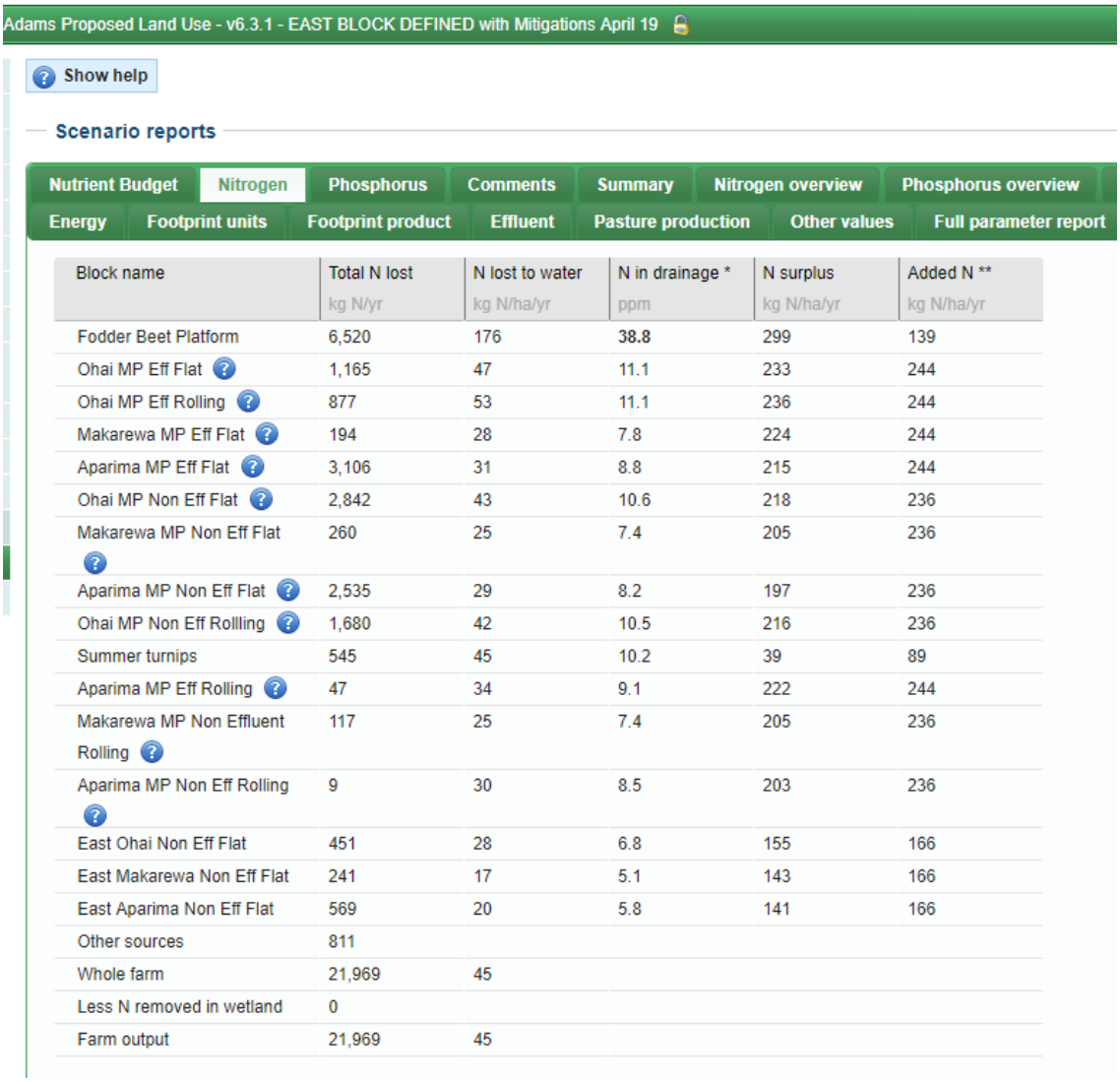
The changes are summarised in red the following table

Farm System

Description	**Proposed dairy Unit (including East Block mitigations)**
Milk solids production	552,000 kg ms Mean calving date 23rd August Dry Off 31st May
Cows peak **milked** and **wintered**	Breed (Fr J X) July 1200 Aug 1170 Sept 1160 Oct 1150 Nov 1150 Dec 1150 Jan 1090 Feb 1090 March 1030 Apr 970 May 900 June 1200 Cows peak milked = 1150 34 bulls (Angus) Dec and Jan
Dairy replacements on farm	300 calves (all off property by 1st of January)
Sheep	
Milking shed feeding	100% of cows fed during lactation
Structures	None
Area crop	37.0 ha fodderbeet (yield 20 t DM / ha) Conventional cultivation Nov Fert at sowing 47N, 38P, 50K, 18S 100 kg urea in Jan and March

	GrazedApril (2 hours), May (3 hours) June to Aug with cows <u>12 ha Summer turnips</u> (yield 8 t DM / ha) Conventional cultivation Oct 350 kg CM 15 at sowing 80 kg urea in Dec Grazed by cows Feb (3 hours) Resown into pasture March Foddercrops rotated through pastoral areas – excluding the East Block
Supplements	<u>Imported</u> • ~~400~~ 420 t DM PKE (fed in paddocks) • ~~425~~ 445 t DM of barley grain (fed in milking shed) • 200 t DM baleage (fed on fodderbeet)
Soil tests and fertiliser	Soil fertility at the agronomic optimum and that maintenance fertiliser is applied each year.
Nitrogen	<u>Non Effluent</u> (excluding the East Block) 224 kg N / ha split Aug to March <u>Non Effluent East Block</u> 168 kg N / ha split Sept to Aug <u>Effluent</u> 196 kg N / ha split Aug to March
Farm dairy effluent	Holding pond Solids separated and applied to all blocks except the East Block 12 to 24mm application 71 ha required to achieve a loading of less than 150kg N / ha from effluent

Appendix 3 - Overseer Reports – Proposed Adams Landuse – East Block **Mitigations** Included



Adams Proposed Land Use - v6.3.1 - EAST BLOCK DEFINED with Mitigations April 19

Show help

Scenario reports

Nutrient Budget | Nitrogen | Phosphorus | Comments | Summary | Nitrogen overview | Phosphorus overview

Energy | Footprint units | Footprint product | Effluent | Pasture production | Other values | Full parameter 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
Fodder Beet Platform	6,520	176	38.8	299	139
Ohai MP Eff Flat	1,165	47	11.1	233	244
Ohai MP Eff Rolling	877	53	11.1	236	244
Makarewa MP Eff Flat	194	28	7.8	224	244
Aparima MP Eff Flat	3,106	31	8.8	215	244
Ohai MP Non Eff Flat	2,842	43	10.6	218	236
Makarewa MP Non Eff Flat	260	25	7.4	205	236
Aparima MP Non Eff Flat	2,535	29	8.2	197	236
Ohai MP Non Eff Rollling	1,680	42	10.5	216	236
Summer turnips	545	45	10.2	39	89
Aparima MP Eff Rolling	47	34	9.1	222	244
Makarewa MP Non Effluent Rolling	117	25	7.4	205	236
Aparima MP Non Eff Rolling	9	30	8.5	203	236
East Ohai Non Eff Flat	451	28	6.8	155	166
East Makarewa Non Eff Flat	241	17	5.1	143	166
East Aparima Non Eff Flat	569	20	5.8	141	166
Other sources	811				
Whole farm	21,969	45			
Less N removed in wetland	0				
Farm output	21,969	45			

Overseer Nitrogen Report - Proposed Adams Landuse – East Block **Mitigations** Included

<u>East Block N loss calculation</u> –
451 (East Ohai) + 241 (East Makarewa) + 569 (East Aparima) + ((811 x 12.36%) (other sources) = 1361 N kg / year

Adams Proposed Land Use - v6.3.1 - EAST BLOCK DEFINED with Mitigations April 19

Show help

Scenario reports

Nutrient Budget | Nitrogen | Phosphorus | Comments | Summary | Nitrogen overview | Phosphorus overvi

Energy | Footprint units | Footprint product | Effluent | Pasture production | Other values | Full parameter

Block name	Total P lost kg P/yr	P lost to water kg P/ha/yr	P loss categories		
			Soil	Fertiliser	Effluent
Fodder Beet Platform	53	1.4	N/A	N/A	N/A
Ohai MP Eff Flat	22	0.9	Medium	Low	Low
Ohai MP Eff Rolling	43	2.6	High	High **	Low
Makarewa MP Eff Flat	4	0.5	Low	Low	Low
Aparima MP Eff Flat	26	0.3	Low	Low	Low
Ohai MP Non Eff Flat	58	0.9	Medium	Low	Low
Makarewa MP Non Eff Flat	5	0.5	Low	Low	Low
Aparima MP Non Eff Flat	23	0.3	Low	Low	Low
Ohai MP Non Eff Rollling	103	2.6	High	High **	Low
Summer turnips	13	1.1	N/A	N/A	N/A
Aparima MP Eff Rolling	1	0.5	Low	Low	Low
Makarewa MP Non Effluent Rolling	6	1.4	Medium	Medium	Low
Aparima MP Non Eff Rolling	0	0.5	Low	Low	Low
East Ohai Non Eff Flat	15	0.9	Medium	Medium	N/A
East Makarewa Non Eff Flat	7	0.5	Low	Low	N/A
East Aparima Non Eff Flat	7	0.3	Low	Low	N/A
Other sources	190				
Whole farm	576	1.2			

Overseer Phosphorus Report - Proposed Adams Landuse – East Block **Mitigations** Included

East Block P loss calculation –

15 (East Ohai) + 7 (East Makarewa) + 7 (East Aparima) + (190 x 12.36%) (other sources) = 52 kg P / year

Appendix 4

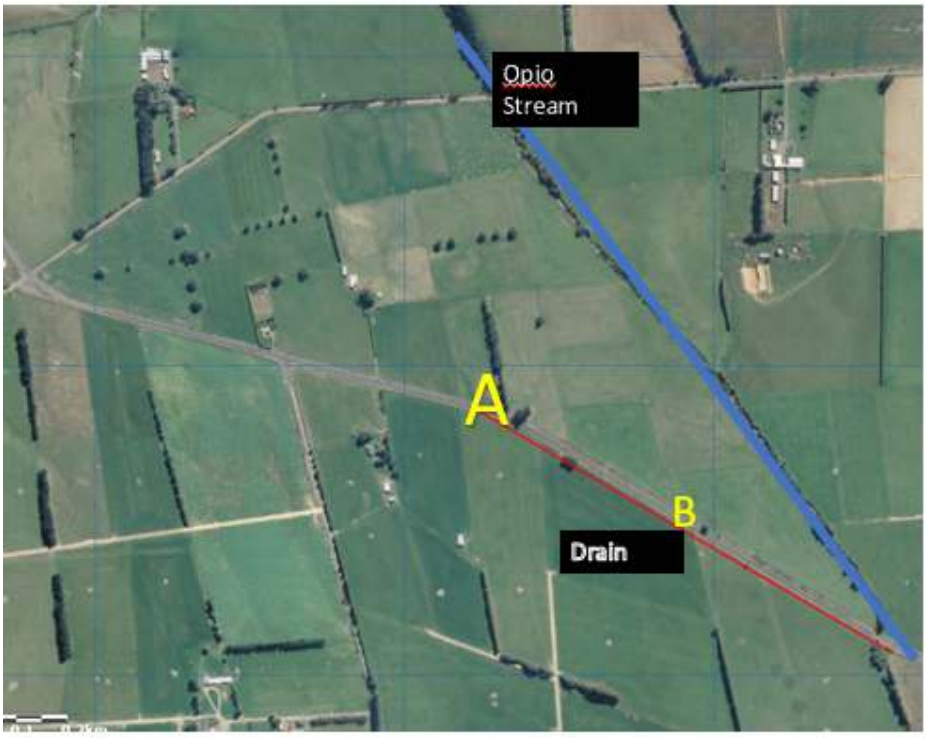
Mitigating phosphorus loss on the East Block

In addition to the removal of fodder cropping and effluent solids from the East Block (which has been modelled in Overseer). There is an opportunity to mitigate phosphorus loss through interception of contaminants along hydrological pathways.

As Overseer is not spatially explicit and is unable to take into account landscape features at farm scale these mitigations have been estimated outside of Overseer.

Mitigations identified on the East Block:

- Reducing losses from overland flow via critical source areas
- Minimising phosphorus loss from the laneways



East Block

The above image of the East Block shows the following:
Blue – Opio Strea
Red – open drain
A – exit point of 2 tile drains (major)
B – exit point of 1 tile drain (minor)

Reducing losses from overland flow via critical source areas

The previous sheep and beef breeding unit had completed a significant riparian fencing programme adjacent to the Opio Stream. There is also a large open drain that runs adjacent to the Wreys Bush – Nightcaps Road, this drain feeds into the Opio Stream (at the boundary of the property).

Mike Adams has observed during times of high rainfall that the overland flow, flows into the drain (rather directly into the Opio Stream). The tile drains (exit point of tile drains marked on image as A and B) on the property feed into this drain (tile drains generally take the direction of the natural fall).

This loss pathway allows the opportunity for further mitigation of phosphorus loss through vegetative buffer zones (in particular around critical source areas, such as swales). Currently there is a narrow vegetative buffer zone along this drain. Increasing this to a minimum of 3 m all along the drain, with a larger buffer at the critical source areas provides the opportunity for further mitigation. With good buffers this has a good potential for mitigating overland flow. Management of critical source areas and vegetated buffers have been shown to reduce phosphorus loss by 38 to 58%. The actual mitigation will depend on the catchment area, size an vegetation of buffer zone. The shape of the block relative to the buffer zone should allow a good level of filtering of contaminants. So have assumed a 48% mitigation (mid point of the range).

To quantify the estimated mitigation:

From the Overseer™ reports for the proposed dairy unit (with East Block mitigations) the following information has been extracted.

Block	**Area (effective)**	**P loss / ha / year**	**P loss from run off / ha / year**	**P Loss from run off / year**	**Management of critical source areas (48% reduction)**
East Ohai Non Effluent Flat	16.4	1.2	0.7	11.5	4.4
East Makarewa Non Effluent Flat	13.9	0.5	0.4	5.6	2.7
East Aparima Non Effluent Flat	27.9	0.3	0.1	2.8	1.3

					8.4 kg P / year reduction

It is recommended that the siting of the buffer zones is developed in conjunction with the Environment Southland Land Sustainability Team to ensure that a modelled mitigation is achieved.

Further mitigation may be able to be achieved with tile drain amendments (there are 3 tile systems across the property). This has not been quantified as this is outside my area of expertise and would need to be discussed with the Environment Southland Land Sustainability Team. The type and detail of the construction will influence the scale of mitigation. Research has shown tile drain amendments have a very high effectiveness for phosphorus loss (range of mitigation of 50 to 62%).

Minimising phosphorus loss from the laneways

With the establishment of lanes on the East Block, Overseer has automatically estimated that there will be phosphorous loss from these lanes.

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.

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

The East Block is 12.4 % of the area of the farm, therefore 17 kg P / year is assumed to be deposited on races as faces and lost to water. (note this has been included in previous phosphorus loss mitigations – so this calculation is East Block specific – and will not be used at farm level)

To reduce the risk of loss of phosphorus to water the following aspects will be critical:

- Siting of lane away from waterways (both the Opio stream and the drain)
- A vegetative buffer between lanes and waterways
- Siting of underpass away from waterways (and effluent contained from underpass)

Assuming the siting of lanes, vegetated buffer zones and lane management reduces the estimation by 38% (conservatively based on the lower end of the range of 38 to 58% of the data summarised in figure1 below), 6.5 kg P / year is estimated to be mitigated. With the mitigations proposed the mitigation achieved is likely to be higher than 38%.

Siting lanes at least 10 metes from water ways. maintaining laneways to prevent build up, ensuring that there is vegetated buffer zones and increased buffer zones around swales is likely to result in a mitigation at the upper end of the range (estimated mitigation of P loss of 10 kg P / year).

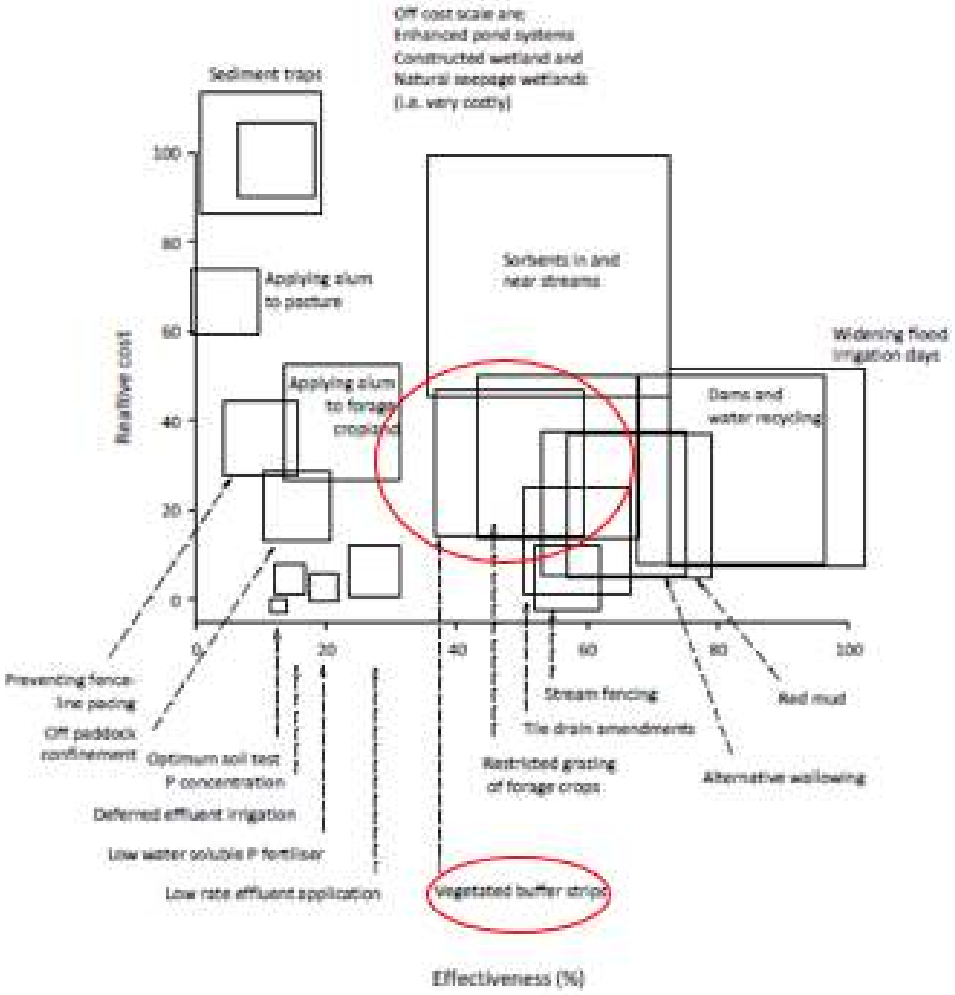


Figure 4. Diagram of the cost and effectiveness of strategies to mitigate **phosphorus** losses to water at the farm-scale. Cost is shown as the cost per kg of P mitigated relative to the most expensive strategy - sediment traps at $360 per kg P retained/ha/yr. The centre of the squares represents the 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

Summary - Mitigating phosphorus loss on the East Block

There is an opportunity to mitigate phosphorus loss through interception of contaminants along hydrological pathways.

Mitigations identified on the East Block (calculated outside of Overseer):

- Reducing losses from overland flow via critical source areas
- Minimising phosphorus loss from the laneways

Results from these calculations are:

Mitigation	**Mitigation Calculated**
Reducing losses from overland flow via critical source areas	8 kg P / year
Minimising phosphorus loss from the laneways	7 kg P / year
	15 kg P / year **Estimated total mitigation**