Dairy Green Ltd

Practical Engineering Solutions

Consents, Effluent, Stock water, Irrigation

Design through to Installation

Irrigation NZ Accredited Designer

Woldwide One Limited and *Woldwide Two Limited*

(WW1&2)

Farm Environmental Management Plan – Appendix N

Version 1.4.1

1 June 2019 – 31 May 2020

A **Phosphorus Mitigation Plan** prepared by Mr. Cain Duncan (CNMA), Tiaki Farm Source Sustainable Dairying, forms part of this FEMP. The plan provides specific details regarding on-farm features, mandatory mitigation actions and target implementation dates.

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1 Property details

Name	Woldwide One Limited and Woldwide Two Limited (WW1&2)
Physical address	Hundred Line Road East, Heddon Bush, Southland
Description of landholding ownership	The landholding is owned by Woldwide One Limited, Woldwide Two Limited, Dykes (leased) and Woldwide Farm Limited (leased). Woldwide Farm Limited owns the Horner Block.
Landholding owner's details	A and JJ de Wolde 104 Shaws Trees Road, Heddon Bush, RD3 Winton, 9783
Contact Person:	WW1 unit - Jacques Jooste - 027-4554550 WW2 unit- Hamish (Dusty) Wright: 021-440006
Legal Descriptions (WW1&2):	Part Lot 18 DP 942 Section 420 Taringatura SD Part Lot 1 DP 4092 Part Lot 18 DP 942 Part Lot 2 DP 4092 Part Lot 1 DP 4092 Part Section 417 Taringatura SD Section 418 Taringatura SD Section 419 Taringatura SD Lot 1 DP 9925 Lot 1 DP 14660 Lot 1 DP 14661 Lot 1 DP 451158 Lot 1 DP 13077 Lot 1 DP 5610 Lot 3 DP 5610 Lot 1 DP 10885
Horner Block*	Lot 4 DP399915
Land Areas:	Milking platform – 502 hectares (479 ha effective) Horner block 97 ha – slurry discharge only
Resource Consents:	Discharge consent **301663** – expiry 9/11/27 Water permit **301664** – expiry 9/11/27 Discharge consent **300626-V2** – expiry 2/12/21 Water permit **300627-V1** – expiry 2/12/21

	WW2 also holds a discharge consent (20171278-01), water permit (20171278-02) and land use consent for expanded dairy farming (20171278-03). All expire on 18/11/27 *Note: the consent holder in future consents will be "Woldwide One Limited and Woldwide Two Limited."*

*The Horner Block is a nearby cut and carry block, where slurry from the dairy platform is applied at very low depth. It is included in this FEMP for completion, although no stock is grazed there.

This document is designed to be a living document and should be updated at least yearly.

2 Maps

2.1 Accompanying notes to maps

- WW1&2 dairy platform lies north of Hundred Line Road East Road and north and south of Wreys Bush Highway.
- Stock access to land north of Wreys Bush Highway is via an underpass.
- The Horner Block, which is a cut and carry block receives slurry effluent from the dairy platform, lies to the south west of the platform.
- Topography is very flat and soils are well developed. There are minimal critical source areas. CSAs are identified, described and evaluated in the appended Phosphorous Mitigation Plan.
- Waterways are best described as surface drains, are fully fenced and flow in a north to south/south east direction.
- All crossings are culverted; stock do not have access to surface waterways. Locations where lanes cross drains are managed as critical source areas to minimise runoff from tracks and lanes into surface waterways. Further description is provided in the appended Phosphorous Mitigation Plan.
- The location, position and outfall of subsurface drainage is indicated in respective maps. The relative depth of subsurface drainage is drainage is c.800 mm. Subsurface drainage occurs in areas where Braxton soils are found. Drummond/Glenelg soils are free draining and do not have subsurface drainage installed.
- Major infrastructure includes two dairy sheds & yards, two wintering barns, two slurry effluent storage ponds, two silage pads and a stock underpass.

2.2 WW1&2 boundary

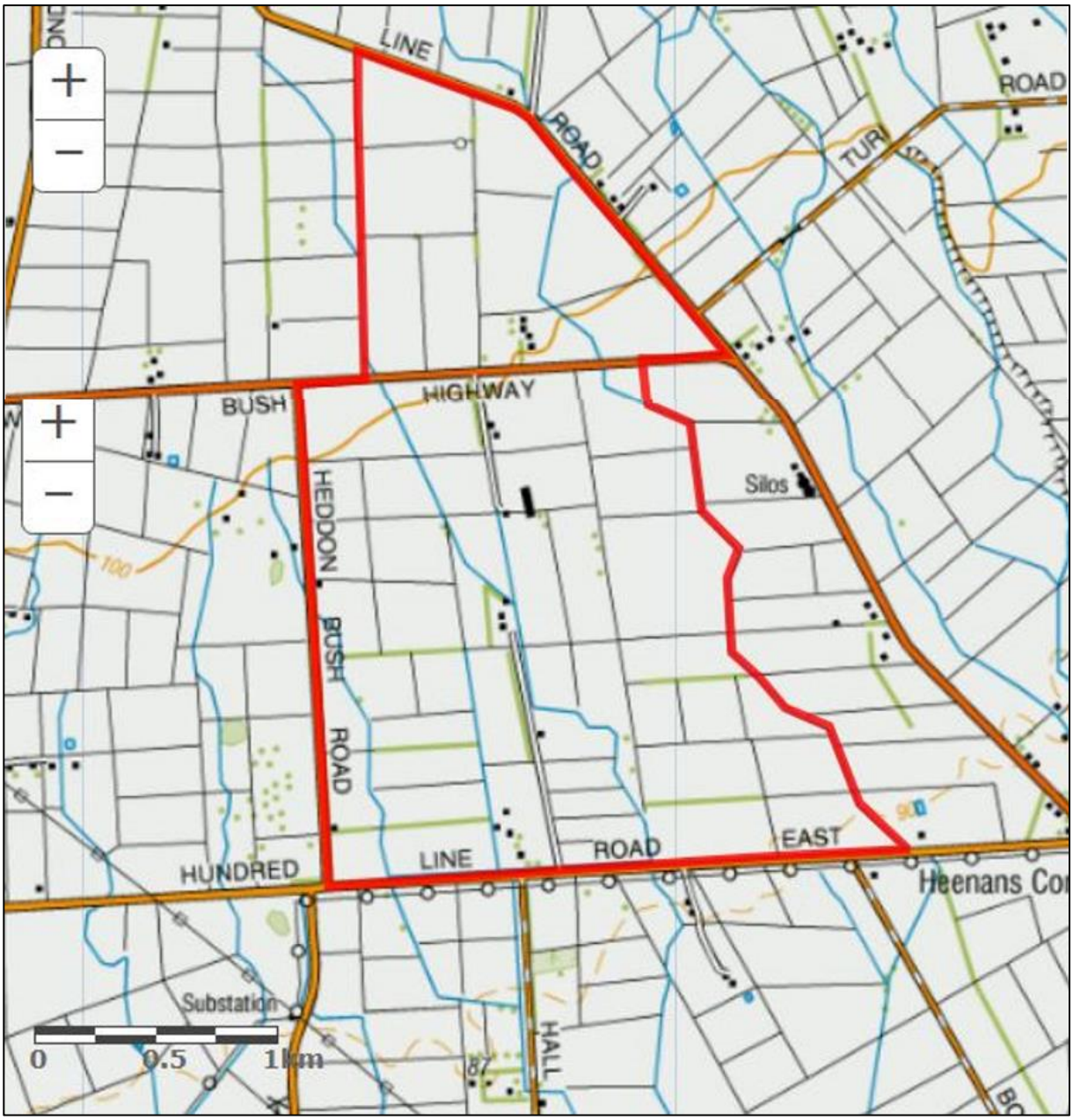


Figure 1a. WW1&2 boundary

Figure 1b. Horner Block boundary

2.3 Waterways, Stock Crossings

Figure 2. Waterways and crossings (Source: Tiaki – Phosphorous Mitigation Plan)

2.4 Critical source areas (CSAs)

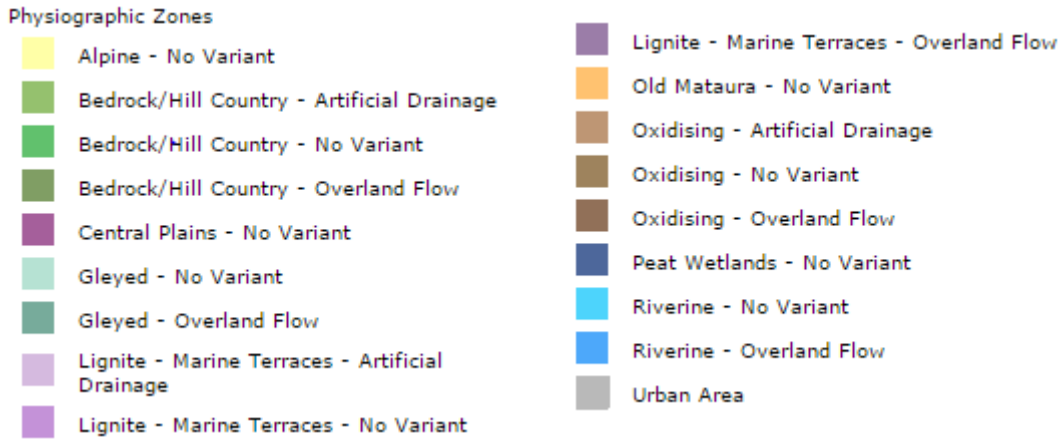
For location and descriptions, please the appended Tiaki Phosphorous Mitigation Plan.

2.5 Physiographic Zones

WW1&2 and the Horner Block overlie Oxidising and Central Plains Physiographic Zones.

Figure 3. WW1&2 - PZs

Figure 4. Horner Block - PZs



2.6 Tile drains

Figure 5. Tile drain locations at WW1 unit (annotated with red lines)

Figure 6. Tile drain locations at WW2 unit (annotated with red lines)

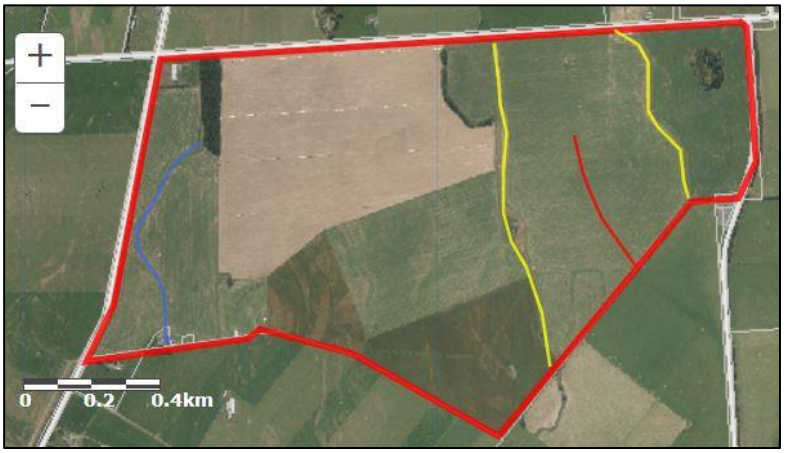


Figure 7. Tile drains at Horner Block (annotated with red line)

2.7 Riparian Vegetation and Fencing

Streams and drains flow in a north to south/south east direction. All streams and drains are fenced off to ensure cows cannot enter the waterways.

2.8 Heritage

There are no known or recorded heritage sites.

2.9 Significant Indigenous Biodiversity

There are no known or recorded sites of significant indigenous biodiversity.

2.10 Soils

The soil types and areas shown on Topoclimate appear to be incorrect, John Scandrett (Scandrett Rural Limited) carried out a field investigation and has mapped the soil as shown in Figure 8.

The soils for the Horner block have been obtained from the Topoclimate layer in Environment Southland's Beacon mapping service. The Horner block has Braxton/Pukemutu, Drmmond/Glenelg and Waiau soils as shown in Figure 9.

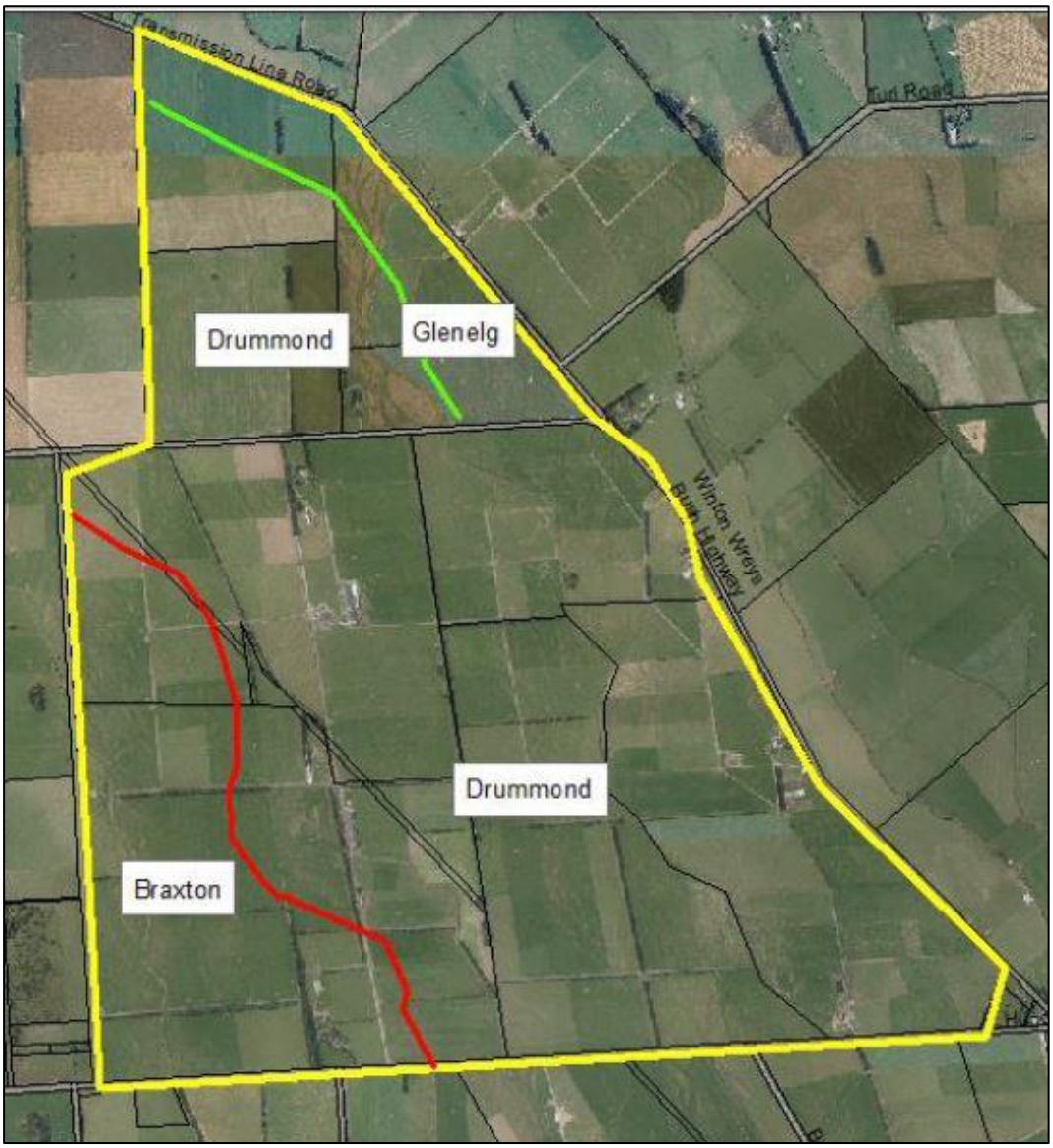


Figure 8. Soil types and boundaries at the WW1&2 according to field investigation by J. Scandrett, January 2017. Map sourced from Environment Southland.

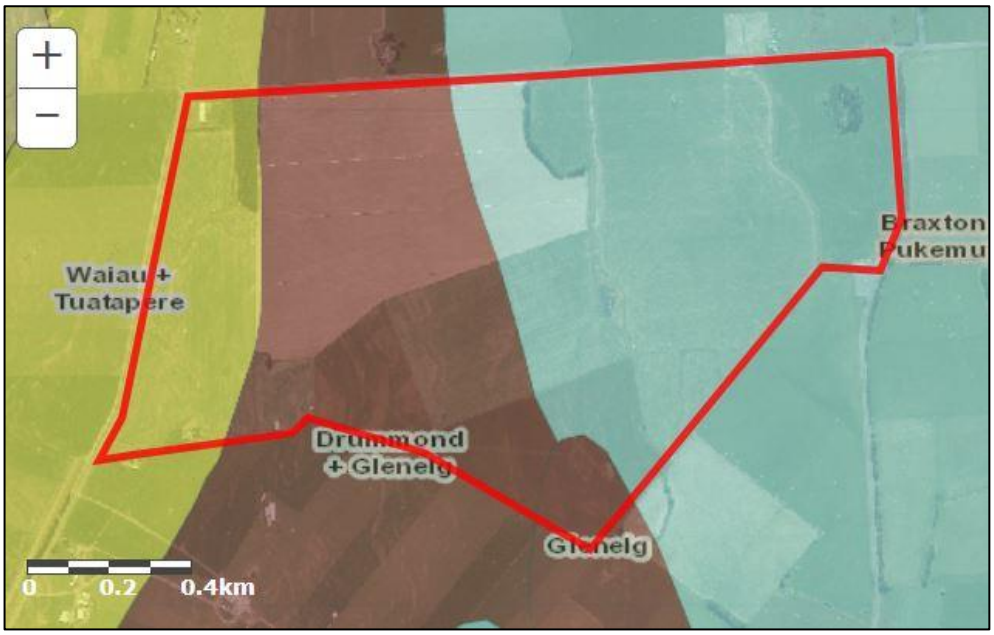


Figure 9. Soil types at the Horner Block

The vulnerability of the soils on the property are shown in Table 1.

Table 1: Vulnerability of soils at WW1&2 and Horner Block

Soil type	Compaction	Nutrient Leaching	Erodibility	Organic Matter Loss	Waterlogging
Braxton	Moderate	Slight	Slight	Slight	Severe
Drummond	Minimal	Moderate	Minimal	Slight	Slight
Glenelg	Slight	Very severe	Minimal	Moderate	Nil
Waiau	Moderate	Very severe	Slight	Moderate	Nil

3 Nutrient Management

3.1 Soils and Properties

The dominant soil types are Braxton (found on the west of the dairy platform and at the Horner Block) and Drummond types (mid to east on the dairy platform and at the Horner Block). Drummond soils may have intergrades to Glenelg soils in places. Glenelg soils are found at the north east of the dairy platform.

Drummond Soils

Drummond soils have deep potential rooting depth, with no major rooting restriction. The soils are well drained, have good aeration, and high plant available water. Textures are generally silty clay to heavy silt loam, with topsoil clay content of 35– 40%. The moderately deep phase will have gravels below 45cm depth, resulting in less rooting depth and available water.

Topsoil organic matter levels are 8–11%; P-retention values 40–70%; pH values usually above 5.7 in all horizons; cation exchange values and base saturation medium to high. Natural levels of phosphorus, potassium and magnesium are moderate, with responses to P and K occurring in intensive farming operations. Micro nutrient levels are generally adequate.

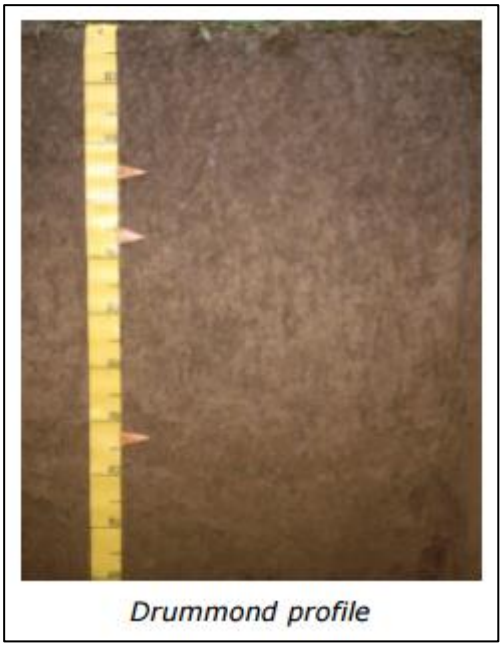


Figure 10. Drummond soil profile.

Braxton Soils

Braxton soils have a deep rooting depth and high available soil water, although the rooting depth may be limited by poor aeration during wet periods due to the poor drainage and slow subsoil permeability. Mottles occur in all horizons – another indication of poor drainage. Texture varies between heavy silt loam

and silty clay in the subsoil, and silt loam topsoil clay content is 22–30%. The soils are typically stone-free, although the moderately deep phase will have gravel between 45 and 90cm depth.

Topsoil organic matter levels range from 7 to 10%; P-retentions 30–60%, with moderate pH values (5.5–6.2) that change little down the profile. Cation exchange values are moderate and base saturation values high. Available magnesium and potassium are low. Reserve phosphorus values are low. Micro-nutrient levels are generally adequate, although boron responses in brassicas and molybdenum responses in legumes are likely.

Braxton soils have swell/crack properties. They can become waterlogged in wet conditions so tend to have subsurface drainage installed. They can crack during dry summer conditions. Deep cracks can provide a pathway for contaminants to reach groundwater via bypass drainage to the underlying aquifer.

Figure 11. Braxton soil profile.

Glenelg Soils

Rooting depth in Glenelg soils is restricted to varying degrees, depending on the gravel content and depth to the cemented pan in the subsoil. Plant available water varies from moderate to low depending on the quantity of gravel present. Textures are loamy silts and silt loams grading to sandy loams and sand. Topsoil clay content is 15–25%. Gravel occurs throughout the profile, with gravel content often above 70% in the subsoil.

Topsoil organic matter levels are 10–16%; P-retention values 50–75% and pH values moderate. Cation exchange vales are high in the topsoil but decrease down the profile with base saturation values low. Available calcium, magnesium and potassium are low, as is reserve phosphorus and sulphur. Micro-nutrient levels are generally adequate.

Figure 12. Glenelg soil profile.

Waiau Soils

Waiau soils have a moderate to slightly deep rooting depth, depending on the gravelness of the subsoil. Plant available water will vary from moderate to low depending on the amount of gravel present. The soils are well drained (sometimes excessively) and aerated. Textures are usually silt loams to sandy loams in the topsoil, grading to sand in deeper horizons, with topsoil clay content of 20–28%. Topsoils often are slightly too moderately gravelly, and moderately to extremely gravelly below.

Topsoil organic matter content is 8–13%, P-retention 40–70% and pH moderate (high 5s). Cation exchange levels are moderate, but low in the subsoil, with base saturation levels similar. Reserve calcium levels are high, magnesium levels moderate and potassium levels low. Soil reserve phosphate and sulphur levels are low. Micronutrient levels are generally adequate.

Figure 13. Waiau soil profile.

Plant Available Water (PAW)

The PAW in the top 30 cm of the soil profile values for the soils have been obtained from the Landcare SMap database and are provided in Table 2.

Table 2: PAW values

Soil Type	PAW_{30}
Braxton	92 mm
Drummond	146 mm
Glenelg	53 mm
Waiau	50 mm

3.2 Environmental Management Actions

To mitigate the potential loss of nutrients the following actions will be implemented:

i. Soil and herbage testing to monitor soil chemistry and inform on decisions regarding fertiliser and lime application to maintain optimum soil fertility levels. Testing should be annual until an understanding and trends have been established;

ii. Fertiliser and lime management plan prepared annually with guidance from Overseer output reports;

iii. Exclude stock from streams;

iv. Monitor soils for the formation of cracks, particularly deep cracks that can form in Braxton soil types in dry summer conditions. If and where deep cracks form avoid grazing stock and discharging effluent to the area;

v. Tracks and lanes sited away from streams where possible. Lanes constructed and maintained to divert run off away from potential waterway ingress. Water tables will be designed to shed water to pasture for riparian treatment;

vi. Effluent application depth is managed for optimum use of nutrients;

vii. Stock will be managed in a placid manner to reduce the volume of effluent generated at the dairy shed; and

viii. Winter cows off paddocks in barns. Use barns in the shoulders of the season to avoid soil compaction/runoff and optimise nutrient management.

3.3 Fertiliser Application Best Management Practices

The following practices will be implemented:

i. The spreaders used to apply fertiliser are 'Spread Mark' accredited and have Tracmap or a similar recording system to show proof of placement;

ii. Buffer distances are maintained such that there is no direct contamination of waterways from the application of fertiliser;

iii. A minimum 10 m buffer between fertiliser placement and waterways is maintained when there is no riparian strip with a minimum 5- metre setback at all times;

iv. Fertiliser is not applied to saturated soils;

v. Nitrogen-containing fertilisers are only applied to actively growing pastures;

vi. Fertiliser is not applied from 1 June to 31 July, and only in the months of May and August when soil temperature and moisture conditions are suitable;

vii. Fertiliser is not applied when or where air drift can occur beyond the farm boundaries;

viii. The need for large fertiliser dressings will be achieved through split dressings rather than a single application; and

ix. Observe 'The Code of Practice for Nutrient Management (With Emphasis of Fertiliser Use)' Fertiliser Association, 2013, ISBN 978-0-47328345-2'.

Note: The application of fertilisers is deemed a permitted activity by Environment Southland provided:

- Application must not occur within 30 m of a neighbouring residential unit without approval. Spray drift must also be minimised.

- There must be no direct discharge to water and no discharge when soil moisture exceeds field capacity. For permanently flowing waterbodies (including artificial drains), fertiliser in riparian plantings where stock is excluded can only be applied to establish the planting. If there is no riparian planting, a setback of 10 m is required.

3.4 Effluent Application Best Management Practices

To mitigate the potential effects of the discharge of effluent to land the following practices will be implemented:

i. Effluent nutrient concentrations have been tested and apply the depth that corresponds with the nutrient content of the effluent. This accounts for the higher strength nature of pond slurry compared to dairy shed effluent;

ii. The soil test values for the paddocks receiving effluent will be considered and the depth of application adjusted to suit;

iii. Defer irrigation where soil and climatic conditions are unsuitable for irrigation;

iv. At all times the management of the effluent system will comply with the discharge consent conditions, including annual N loadings per hectare at the dairy platform and the Horner Block;

v. Low depth application effluent irrigation systems and deferred storage are utilised. Very low depth application of pond slurry (1.7 mm per application) is achieved by applying slurry with the slurry tanker with the trailing shoe, at a rate of 17.2 m^3/hectare;

vi. Apply slurry at a maximum depth of 2.5 mm per application by applying 25 m^3 per hectare;

vii. Do not apply effluent to areas prone to cracking in dry summer periods. Braxton soils, with swell crack characteristics, are found on the western part of WW1&2 and at the east of the Horner Block. Monitor Braxton areas for signs of cracking and avoid if and where there is evidence of cracks;

viii. Buffer distances in the discharge consent will be followed;

ix. 7 -10 days post grazing before liquid effluent application;

x. Application of sludge solids – less than 10 mm depth to suitable ground, with consideration of climate conditions;

xi. Apply maintenance rates of nutrient to a large area rather than load up a smaller area with all the effluent/nutrient;

xii. Do not use the slurry tanker when there is risk of soil compaction due to its weight; instead employ the service of an umbilical system contractor;

xiii. Carry out maintenance on effluent management systems regularly; and

xiv. Implement, review and update an effluent management plan.

3.5 Potential Nutrient Loss Effects of Dairying

Nutrient budgets were prepared in OverseerFM Version 6.3.1 by Mr. Cain Duncan, Tiaki Fonterra, Certified Nutrient Advisor, in accordance with the latest version of the OVERSEERFM Guidance/Best Practice Data Input Standards.

Four nutrient budgets were prepared to reflect actual lawful use of land over 4 prior years at WW1&2. One nutrient budget has been prepared for the proposed farming system should consent be granted.

A nutrient budget analysis report has been prepared by Mr. Duncan and is available for review. Please refer to the report for an analysis of nutrient losses, including inputs and outputs. Nutrient budgets are available in Overseer FM for review.

A summary of the nutrient loss from Overseer calculations is provided in Table 3.

Table 3: Nutrient loss summary for WW1&2

Indices	WW1&2 – pre-expansion average over 4 years	WW1&2 - proposed	% change
N loss to water (kg/ha/y)	41	38	-7.3
N loss to water (kg/y)	20,427	18,938	
P loss (kg/ha/y)	0.7	0.7	-2.2 (-6.1)
P loss (kg/y)	360	352 (338)*	
Pasture production (kg DM/ha/y)	15,109	15,513	

*Additional P reductions calculated outside of Overseer (See Phosphorus Mitigation Plan)

3.6 Key mitigation measures

Should consent be granted, the proposed farming system will be implemented, which is expected to achieve a reduction in N and P loss on average compared to prior land use at the landholding.

Key drivers for the 7.3% reduction in nitrogen loss are:

- Removal of winter and summer crop
- Removal of cows & young stock wintered outside on crop or grass
- Expansion of the size and use of the wintering barn facilities
- More efficient use of nitrogen fertiliser

Key drivers for the 2.2% reduction in phosphorus loss are:

- Decrease in winter crop area
- Maintaining Olsen P at a target level of 30
- Expansion in the size and use of the wintering barn facilities (less wintering)

Additional P mitigation is proposed, which has calculated outside Overseer. This increases the level of P mitigation up to 6.1%. Please see WW1&2's Phosphorous Mitigation Plan for details of measures.

3.7 The Effect of Effluent Application

Effluent will be applied to the best suited soil types and topography based on time of the year, e.g. soil moisture conditions, climate conditions and pasture growth.

Account for the higher strength nature of slurry effluent when applying slurry, applying no more than 25 m^3/ha as a control to approximately 400 hectares available at WW1&2 and Horner Block.

3.8 Deep drainage of nitrogen – cracking and fissures

To reduce the occurrence of deep drainage of nitrogen and microbes, the formation of deep cracks and fissures will be prevented as much as possible. This will be achieved by:

- Maintaining a high level of pasture cover;
- Discharging effluent little and often to prevent soil from drying out and cracking.

Before each effluent application or stock grazing event, a visual assessment will be carried out to check for any cracks in the soil. If cracks do occur, the areas with cracking will be avoided and/or the activity will be moved to another part of the property where there are no cracks.

If there are substantial cracks and no areas suitable to discharge effluent, then effluent will be stored until the soil moisture level improves and cracking disappears. Given the cracks are likely to occur after prolonged dry periods in the summer, the effluent storage facility is likely to provide adequate storage volume for these events.

4 Good Management Practices

4.1 Land

Key strategies to achieve this objective:

i. Fence off all waterways;

ii. Maintain riparian vegetation;

iii. Always maintain good pasture coverage. Plant roots help to prevent soils from cracking during dry summer periods and help to avoid the formation of deep cracks;

iv. Soil test regularly and operate a fertiliser management plan;

v. Exclude stock from high risk critical collection source areas and swales when the soil is near or at field capacity. Where necessary, increase setbacks and fence off CSAs;

vi. Carry out maintenance on crossings and culverts to ensure runoff to waterways in minimised and there are no blockages;

vii. Ensure adequate buffer zones from waterways during tillage;

viii. Maintain sustainable stocking rate; and

ix. Stock management to avoid excessive pugging over high-risk months, e.g. winter cows in barn, use barns in the shoulders of the season.

4.2 Effluent and Nutrients

Key strategies to achieve this objective:

i. Prepare, implement and monitor a Nutrient Management Budget to maximise the returns and minimise losses from the resource, particularly N, P and K;

ii. Controlled, judicious and justifiable use of fertiliser and other imported nutrients including nutrients in supplementary feed;

iii. Implement an effluent management plan;

iv. Subject to soil moisture and weather conditions, irrigate effluent at every practical opportunity to keep storage ponds as empty as possible;

v. Ensure that all appropriate staff are trained and competent in the effluent system operation, and are aware of the need to continuously monitor the effluent management system, the farm's drainage networks and the potential for Braxton soil types to develop cracks;

vi. Record each application of dairy effluent, including the location of travelling irrigators and the depth applied;

vii. Record each application of slurry effluent, including paddock number and quantity (and depth) applied. Apply a standard depth;

viii. Ensure by regular and programmed checks that the supporting effluent infrastructure is in good condition, is inspected regularly and maintained under a preventative maintenance schedule;

ix. Ensure by regular inspection (that coincides with effluent application) that the farm's drains do not contain any obvious signs of dairy effluent contamination; and

x. Remain alert to new and emerging technologies that can be incorporated into the system to reduce risk, improve environmental and farm outcomes, whilst reducing input efforts and costs.

4.3 Physiographic Zones and Transport Pathways

Physiographic zones are shown on a map in figures 3 and 4. These zones have the potential for N and P to leach to waterways and groundwater through artificial drainage, deep drainage and overland flow (to a lesser extent) as shown in Table 4. Good Management Practices for these transport pathways are listed in section 4.6.

Table 4: Physiographic zones and transport pathways

Physiographic Zone	Variant	Key Transport Pathway
Central Plains	N/A	Artificial drainage, deep drainage
Oxidising	N/A	Deep drainage, overland flow

Note: Due to the flat topography, overland flow is not deemed to be a particular risk for soils except close to waterways and around CSAs following periods of prolonged, heavy rain.

4.4 Review

General good management practices and those specific to the transport pathways to be implemented in the current year are contained in the tables in sections 4.5 and 4.6. These good management practices will be reviewed annually as part of the overall review of the Farm Environmental Management Plan.

4.5 General Good Management Practices

A policy of general good management practice has been implemented since 3 June 2016. Most of the practices are described in the table 5 below have been implemented since 3 June 2016.

However, some practices described in table 5 have not been fully implemented since 3 June 2016:

*Not all cows have been wintered off paddocks in barns since 3 June 2016;

*IWG on fodder crop has occurred since 3 June 2016;

*Young stock has been grazing on farm since 3 June 2016, including IWG.

* Some individual features (e.g. lanes, CSAs) and locations have been identified in the Tiaki Phosphorous Mitigation Plan as requiring mitigation. Please refer to the plan for details, including mandatory measures and target implementation dates.

A policy of good management practice will be undertaken on farm over the coming 12-month period (see table 5). All policies will be reviewed in June 2020

Table 5. General good management practices (1 June 2019 – 31 May 2020).

Strategy Type	Summary of Management Practices
Capital	Fence and enhance riparian areas;
	Upgrade FDE handling equipment as new technology improves the utility and reduces risks of these systems.

Strategy Type	Summary of Management Practices
Operational	Utilising a nutrient management plan;
	Soil testing is carried out each year; soil Olsen P levels are maintained at a biological optimum and no higher;
	Surface waterways are fully fenced and with at minimum good grass cover, fencing is maintained and stock are excluded from the riparian areas;
	*Wide riparian buffers are maintained;
	All surface waterways are culverted;
	Sufficient land area is available for the dairy operation;
	*Young stock is grazed off farm from weaning;
	*Cows are wintered off paddocks in wintering barns;
	*No intensive wintering grazing of cows on fodder crops;
	Ongoing implementation of good soil management practices;
	Nutrients from wintering of cows are stored and returned to pastures at the dairy platform and the Horner block, where they are used to promote grass growth when plants are actively growing and taking up nutrients;
	Tracks and lanes are predominantly sited away from waterways;
	Use specialist machinery when harvesting grass at the Horner Block to avoid soil compaction;
	*Lane runoff diverted to land with remedial work at lane/culvert/bridge crossings carried out as required;
	Good management practice of silage pads is implemented;
	Restricted grazing of draining pastures in autumn/spring;
	Wintering barns are used as stand-off pads during severe adverse weather events;
	Care in irrigation of FDE, especially when the ground is near or at field capacity;
	A large land application area is available to ensure N & K returns are not excessive;
	Effluent volumes are minimized at source through efficient water use;
	Appropriate FDE storage volume to allow for deferred irrigation for effluent;
	All data and maps are kept up to date and all staff are trained and informed of any changes;

Strategy Type	Summary of Management Practices
	Programmed maintenance is done in and around FDE, and piping infrastructure around the dairy shed, silage bunkers, cow yards etc.;

4.6 Good management Practices for Key Transport Pathways (1 June 2019 – 31 May 2020)

WW1&2 is classed in the Oxidising and Central Plains physiographic zones. The Horner block also is classed both in the Oxidising and Central Plains physiographic zones.

Both physiographic types are susceptible to nitrate accumulation in soils and aquifers. Nitrates are transported to the underlying aquifer via deep drainage. Central Plain's type soils (Braxton) may have risk of nitrate and contaminant (pathogen) loss to groundwater via cracks that can form in silty clay soils over extended dry summer periods. Subsequent heavy rainfall can transport nitrate or microbes down to the underlying aquifer. There is risk of contaminant loss (nutrients N and P, sediment and microbes) to surfacewaters via artificial drainage in Central Plain's type soils following heavy or prolonged rainfall.

Given the very flat topography and the tendency of soils to have good phosphorous retention, there is lower risk of contaminant loss to surface waters via overland flow. Any risk of contaminant loss to surface waters from tracks and lanes via overland flow should be mitigated by good management of areas where tracks and lanes are close to surface waters.

Recommendations described on Good Practice Management factsheets issues by Environment are implemented where practical. These measures will be reviewed annually with the inclusion of new measures where appropriate.

Table 6. Good management practices for key contaminant transport pathways.

Mitigation	Good Management Practise	Key transport pathway
Reduce accumulation of surplus N in the soil, particularly during autumn and winter, leading to reduced loss of N to groundwater and at times to surfacewaters	Inputs of N, such as fertiliser or nitrogen contained in imported feed, to be maintained at a level to minimise leaching losses	Deep drainage of nitrogen Artificial subsurface drainage
	Control the duration of grazing of pasture (on-off grazing)	
	Winter all cows in wintering barn	
	Optimise timing and amounts of effluent application to minimise leaching losses, accounting for the higher nutrient content of slurry compared to dairy shed effluent.	
	Wintering barns are also used to house cows during April, May, August and September and as stand-off pads during severe adverse weather at other times	

Mitigation	Good Management Practise	Key transport pathway
	Cut and carry feed to cows in barns	
	Time N application to meet pasture demand using split applications. Do not apply N in high risk months.	
	Reduce inputs of N where possible through optimal fertilizer application on farm, use little and often approach	
	Only apply nitrogen fertiliser if soil temperature is above 6 ºC	
	Re-sow areas of bare or damaged soil in September or October, depending on climatic conditions	
Protect soil structure, particularly in swales and near stream areas to reduce contaminant loss (P, sediment, microbes) in runoff to surfacewaters.	Only re-sow 10 % of property at most each year	Artificial subsurface drainage Overland flow
	Cultivate before 1st March to avoid Autumn loss of nutrients	
	Fence off waterways. Stock will not graze riparian strips and riparian strips are sufficiently large and well vegetated;	
	Re-sow areas of bare or damaged soil in Sept/Oct, depending on climatic conditions	
	No IWG on fodder crop is carried out	
	Avoid heavy grazing on vulnerable or wet soils. Match stock management to land use capability, e.g. avoid grazing cows on more vulnerable soils, especially when wet. Wintering barns are used during wet periods to prevent pastures from pugging.	
Reduce phosphorus use to reduce potential loss to receiving surfacewaters	Soil test whole farm every 4 years, reduce use of P fertiliser where Olsen P values are above agronomic optimum	Artificial subsurface drainage Overland flow
	Stand cows off pastures during wet periods to prevent pastures from pugging	
	Fertilise only when there is minimal risk of nutrient loss to water. Fertilise outside high-risk months in autumn and winter.	
	Manage CSAs close to surface drains to prevent runoff. Fence off major CSAs to prevent compaction and runoff.	

Mitigation	Good Management Practise	Key transport pathway
Avoid preferential flow of effluent through drains or soil cracks to prevent contaminant loss (N, P, microbes) to groundwater and/or surfacewaters	Defer effluent application when soil moisture levels are high	Artificial subsurface drainage Deep drainage
	Observe buffer zones and placement guidelines e.g. do not over tile drains or over areas where cracks have formed in the soil during high risk periods.	
	At all times observe discharge consent conditions.	
	Apply slurry effluent at very low application depth (< 2.5 mm per application)[1]	
	Apply dairy shed effluent at low application depth (at all times < 10 mm per application and less than 50% PAW)	
Manage CSAs; low areas overlying tiles close to outfalls at surface drains to protect soils, prevent erosion and reduce contaminant loss (N, P, sediment and microbes) to surfacewaters	Restrict grazing of pasture critical source areas when soils are near saturation	Overland flow
	Avoid working critical source areas and their margins	
	Leave grassed areas (or native vegetation) around critical source areas and margins	
	Reduce runoff from tracks and races (using cut offs and shaping)	
Avoid loss of contaminants (nitrate and faecal microbes) to groundwater via cracks formed in summer dry periods in Braxton soil types.	Monitor paddocks for deep cracks in summer/autumn. If and where they form, avoid grazing the area and irrigating effluent to the area.	Deep drainage

[1] Applying slurry at a maximum depth of <2.5 mm per application is a key mitigation to ensure soils are not overloaded with N from slurry, causing N leaching loss.

4.7 Key mitigation measures associated with expansion

It is proposed to milk an additional 160 cows at WW1&2 in the 2019/20 season. Changes will be made to the farming system to offset a potential increase in nutrient losses and associated effects. As summarised in sections 3.5 and 3.6 and explained in detail in the nutrient budget analysis report and the phosphorous mitigation plan, the proposed system is expected to lose less N and P than the pre-expansion system.

Key drivers of controlling nutrient losses are regarded as key mitigation measures. These are as follows:

N loss – key changes/mitigations leading to 7.3% reduction

i. Removal of summer and winter crop from WW1&2;
ii. Removal of cows & young stock wintered outside on crop (IWG) or on grass;
iii. Expansion of size and use of wintering barn facilities. The barns and effluent systems have already been upgraded to accommodate additional cows and effluent. Cows will be wintered in barns in June and July. Use of the barns will also occur in April, May, August and September;
iv. More efficient use of N fertiliser.

P loss – key mitigations leading to 6.1% reduction

v. Removal of winter crop area;
vi. Maintaining Olsen P at target level of 30;
vii. Expansion of size and use of wintering barn facilities.
viii. Additional P mitigation is proposed by mitigating runoff from specific locations and features, which has calculated been outside Overseer. Please see WW1&2's Phosphorous Mitigation Plan for details of measures, including mandatory measures and target dates for implementation.

If consent if granted for the proposed farming system, these key mitigation measures (i to vii inclusive) will be implemented in the 2019/20 season. Measure viii will be implemented as detailed in the P Mitigation Plan.

In the future any material change to the farming system will be modelled in Overseer prior to the changes being made, to ensure that the change(s) will not result in an increase in N or P loss.

5 Riparian Management

5.1 Streams, Creeks and Drains

i. All waterways are riparian fenced on both sides;

ii. Regular riparian fencing checks will be completed, and any damaged sections or breakages/breaches are repaired immediately;

iii. Calves or other stock that are found in the riparian areas will be removed immediately;

iv. Check all crossings are contoured to channel run-off onto pasture;

v. Carry out weed control as required following best practice methods;

vi. Remove drain cleanings and spread over paddocks to utilize the nutrients and to prevent material returning to the water way; and

vii. Make sure fish have passage through all culverts and underneath bridges;

viii. Plant riparian areas and maintain rank grass to reduce runoff of contaminants – see phosphorous mitigation plan for details.

5.2 Weeds and Pests

Weeds (e.g. gorse, broom, blackberry, ragwort, thistles etc.) are controlled by manually removing them or by using sprays:

i. When sprays are used to control weeds, care is taken to ensure all sprays are certified to be aquatic safe and that appropriate staff training is given to ensure good health and safety practices are fully implemented;

ii. Spraying is best carried out when there is active growth (e.g. mid/late spring). The aim is to spray plants when they are small as less chemical is required;

6 Cultivation

6.1 Cultivation

Area under cultivation

For winter 2020, no fodder crop cultivation (beet, root or brassica) is planned.

However, the move to grass to grass re-grassing is dependent on the farming system changing pending the granting of consent; it is proposed that cow numbers are increased by 160 and cows wintered in the barn are increased by 225. If the farming system remains as per the 2017/2018 season, then there may be some fodder crops sown and IWG in the future.

Re-grassing

An extensive re-grassing policy has been carried out, with most paddocks having been re-grassed at the time of writing. Approximately 5% of the farm's effective area will undergo cultivation into new grass each year. Where re-grassing occurs, paddocks are sprayed off and direct drilled with grass seed or undergo full cultivation depending on factors such as soils, drainage, paddock performance.

Forage brassica or beet crop

This is not planned in the future:

- Paddocks are sprayed off in October/November;
- Paddocks are direct drilled or fully cultivated into fodder crop from mid-October to mid-November;
- Fodder crop is IWG in over winter by cows;
- Paddocks are subsequently re-grassed in September/October;

Surplus grass is harvested as baleage.

Grass harvested at the Horner Block is fed fresh to cows in the barns or is stored as silage at the silage pad or goes to other dairy farms. Specialist machinery is used to avoid the risk of soil compaction when harvesting grass if required.

Grass production, soil structure and fertility are the primary factors in paddock selection, with poorly performing pastures targeted for renewal. Soil moisture content is also a factor in the choice of paddock selection and timing of cultivation.

6.2 Cultivation Good Management Practices

If any fodder crop is sown in the future, good management practices will be followed:

i. Where drainage depressions in crop paddocks are likely to channel sediments and nutrients to drainage, these will be left uncultivated to act as sediment traps;

ii. Direct drill paddocks where this approach is deemed to be suitable;

iii. Choose paddocks away from waterways to plant winter feed crops;

iv. Plough lines will be kept 5 metres back from the top of drain banks. This ensures at least a 5 m buffer along waterways;

v. Observe permitted activity rules as per Rule 25 clauses (a) and/or (b) of the pSWLP.

7 Intensive Winter Grazing

7.1 Stock Grazing Management

The Environment Southland Intensive Winter Grazing Rule covers the period from 1 May until 30 September. It is intended that all stock will be wintered in wintering barns during June and July 2020. Barns will also be used during April, May, August and September 2020.

However, if consent is not granted IWG may occur in the future to utilise land. If and where this occurs within the Environment Southland defined winter period, the following management will be employed. These procedures would also be applicable to returning stock in early spring.

7.2 IWG

Paddock selection

Judicious paddock selection based on the soil moisture content is a key tool. This is important not only to avoid overland flow, pugging etc. but to ensure that the pasture and soils are not damaged to any extent that would inhibit spring pasture growth. The range in soil types gives some flexibility of being able to move away from waterways to better draining soils during wet weather.

Back fencing

The eating of the excess feed will not (for spring growth reasons) result in the paddocks being eaten down hard, or pugged.

- Breaks once eaten off, will be back fenced;
- Breaks will be sequenced to ensure grazing is towards the watercourse, leaving a “last bite”;
- If the area to be grazed is located on sloping ground, stock will be progressively grazed from the top of the slope to the bottom, with a 20 metre ‘last-bite’ strip is left at the base of the slope.
- If baleage is used, place baleage in the paddock before soil becomes too wet thereby preventing heavy vehicles from damaging the ground;
- Portable feeders will be used to feed baleage/hay/straw to stock.

Water

Where breaks do not encompass a trough, a portable trough will be used to avoid pug lanes between the water troughs and the feed breaks.

Buffer zones

There will be fenced buffer zones (minimum 5-metres) along all water ways, and higher risk areas over tiles, drainage depressions (swales) or cracked soils will be temporarily fenced off.

Wet weather

In wet weather, where there is risk of pasture and soil damage, care must be taking to minimise grazing and avoid supplement feeding and pugging within 10 metres of a waterway or drain.

8 Other Environmental Issues

8.1 Lanes and Races

Run-off from races can in some situations constitute an illegal discharge to land. These will be mitigated by:

i. Ensuring that lanes and races are not used as feed pads, cow yards, or herd holding areas;

ii. Ensuring that riparian vegetation is adequate to treat storm water;

iii. Checking after heavy rain the lane/track edge cut-outs, to ensure they are not blocked and there is no risk of large single point discharges;

iv. Install nib boarding or kerbing to prevent point source discharges from lanes and tracks to waterways occurring;

v. Gateways – to avoid compaction around the gateways and reduce lane edge wear, where possible bring the cows out of the paddock at a different gate to which they were let in; and

vi. Ensure that swales away from culverts are kept clear, and discharge is directed away from the waterway.

Annual maintenance to races can often result in the "run back" shaping over culverts and lane edge discharge cutouts not being restored. All lane edges and culverts should be checked after lane maintenance.

8.2 Silage pad

A concrete silage pad (1,200 m^2) is located adjacent to a wintering barn. It is constructed on a dry site. The silage pad has concrete walls and a dual drainage system; one for clean rainwater and one for silage leachate. Under the stack and immediately in front of it, the drains are opened into the leachate channel. This takes leachate to a sump from where it is pumped into the effluent storage pond and irrigated appropriately. The sumps in the rest of the pad are open to the farm drainage system so that clean rainwater can be diverted. Rain landing on the silage cover does not mix with leachate and is diverted to the farm drainage.

A second silage pad has been constructed on a dry site underlain by compacted clay. Rain landing on silage covers does not mix with leachate and is diverted to the farm drainage. It is managed to ensure that no leachate flows off the pad at any time and any leachate is contained at the pad.

Only wilted silage is used and stacks remain covered to minimise leachate

8.3 Underpass

An underpass connects the block north of Wrey's Bush Highway with the dairy platform south of the highway. The underpass has its own effluent system, with a dedicated sprinkler. The sprinkler irrigates rainwater and effluent that collects on the underpass at low rate and depth to nearby paddocks.

The underpass is inspected regularly to ensure that the effluent system in operating correctly and that there is no ponding of rainwater/effluent at the underpass.

8.3 Cut and Carry

Grass harvesting at the Horner Block is carried out according to best practice management. Specialist equipment is used to minimize the risk of soil compaction. Harvesting is not carried out if the risk of soil compaction cannot be avoided.

Health and safety protocols are adhered to when operating machinery.

8.4 Animal Pests

i. Rabbits, hares, possums – regular culls using night shooting, poisoning etc.

ii. Magpies – trap, shoot;

iii. Rodents – poison according to appropriate health and safety requirements

9 Emergency Response

9.1 Storage Overflow

Where the slurry ponds are approaching full very low application depth effluent irrigation (<1.5 mm depth) will be carried out on the driest part of the farm available. The umbilical system can be contracted to achieve this.

9.2 Ponding

Should light ponding be detected effluent irrigation will immediately stop. Checks should be made to ensure that there is no overland flow or that the ponding is not draining into tile lines etc.

9.3 Drainage

Overland Flow

See Ponding Section 9.2.

Discharge Ex-Tile and/or Effluent in Open Drains

i. Attempt to immediately contain the contaminants by damming the drain. This will be done by dumping a bale(s) of straw or hay in the drain and pressing down with the front-end loader, depending on drain size;

ii. Alternately earth and silage wrap will be used to seal or form the required plug; or

iii. pump out and disburse with the vacuum tanker.

12.4 General Procedures

i. Follow consent conditions/notes, mitigate effects;

ii. Advise Regional Council where the consent requires this;

iii. Seek help; and

iv. Advise authorities.

12.5 Emergency Contacts

As per contact details in Section 1.

Environment Southland – 0800 768 845 or 03 2115115

Dairy Green Limited – 03 215 4381

10 Review

Review whole effluent management plan and update by 1 June each year – and complete the version control below.

i. Development targets for coming season/plan.

ii. Nutrient Management

- Overseer Inputs
- New Overseer report if applicable

iii. Good Management Practices

iv. Implementation of key mitigation measures

v. Cultivation Areas

vi. Intensive Winter Grazing, if applicable

vii. Effluent System

- High risk/low risk effluent irrigation areas due to new tiling etc.;
- Any developments in infrastructure – i.e. new/more irrigators, extensions to effluent system, fencing changes;
- Training/retraining, etc.

viii. Emergency Contacts

Version	Date	Reviewed	Distribution List
1.0	22 August 2017	JS	A & JJ de Wolde
1.2	15 July 2018	Nessa Legg, Dairy Green Limited	A & JJ de Wolde
1.3	25 Feb 2019	Nessa Legg, Dairy Green Limited	A & JJ de Wolde
1.4	21/8/19	Nessa Legg, Dairy Green Limited	A & JJ de Wolde
1.4.1	5/9/19	Nessa Legg, Dairy Green Limited	A & JJ de Wolde

TIAKI

FARM SOURCE SUSTAINABLE DAIRYING

PHOSPHORUS MITIGATION PLAN

Version 3 - 04/09/19

FARM SOURCE

Fonterra

Dairy for life

ABOUT YOUR FARM PLAN

This Farm Plan document is the result of a tailored farm environment planning service provided to you through Tiaki Sustainable Dairying. It's part of the advantage you get through Farm Source as a member of the Fonterra Co-Operative. The purpose of this plan is to describe the environmental conditions present on your farm and the management of these conditions. From this, mitigations to potential impacts to water quality are documented and additional mitigations maybe planned, with sensible timeframes. Underpinning this plan, are the agreed national Good Farming Practices that are supported by the agricultural and horticultural sectors. Industry bodies along with Regional Councils and Central Government have developed the Good Farming Practice: Action Plan for Water Quality 2018 in a commitment to swimmable rivers and improving the ecological health of our waterways. The Dairy Industry Strategy (Dairy Tomorrow), as well as the Good Farming Practice: Action Plan for Water Quality 2018, both align with the goal for all dairy farms to have a Farm Environment Plan by 2025. Now that this plan has been created it's the plan owner's responsibility to ensure it is put into action and kept up to date as actions are completed or conditions on farm change. Tiaki Sustainable Dairying is here to help with that implementation and ongoing management through our team of Sustainable Dairying Advisors who can be contacted via the details below.

PHONE: 0800 65 65 68

EMAIL: sustainable.dairying@fonterra.com

CONTENTS:

FARM DETAILS

FARM NAME

Woldwide 1 & 2

SUPPLIER NUMBER

32650 & 32651

PLAN OWNER

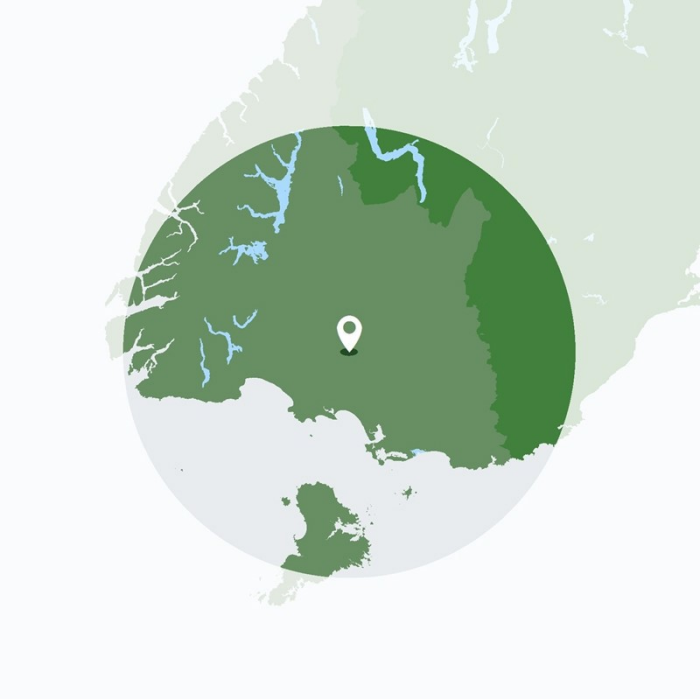
Albert De Wolde

+64 27 2272537
dewolde@farmside.co.nz

FARM ADDRESS

HUNDRED LINE RD, Winton

LOCATION



REGIONAL COUNCIL

Southland

PLAN LAST EDITED DATE

31 July 2019

POINTS OF NOTE

FARM OVERVIEW MAP

The map below presents the land on which the farming operations covered in this document occur and identifies some key points of interest. More detailed maps looking at specific environmental management topics are contained throughout the document.

- Accord Defined Stock Excluded Waterway
- Accord Defined Stock Not Excluded Waterway
- Non-Accord Defined Stock Excluded Waterway
- Non-Accord Defined Stock Not Excluded Waterway
- Farm Boundary
- Compliant Crossing
- Non-Compliant Crossing
- Non-Compliant Non-Regular Crossing
- Dispensation Crossing
- Dairy Shed

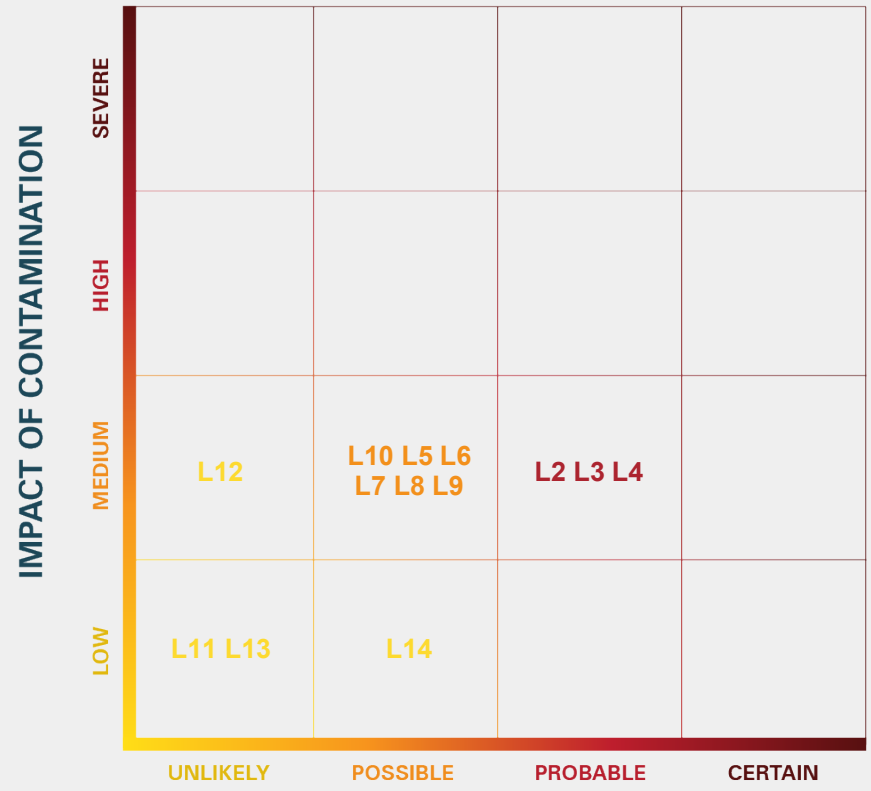
SUMMARY OF OPEN ACTIONS

This table includes all open or ongoing actions that have been agreed as part of this Phosphorus Mitigation Plan. They are organized by their target due date. **Where a target date is underlined it is a mandatory action that contributes to the calculated P loss reduction.**

CATEGORY	FEATURE TYPE & NAME	ACTION REQUIRED	TARGET DATE
L2	Race Maintenance & Management - Lane Adjacent Waterway (West of Wintering Barn)	Establish Vegetated Riparian Margin (Beside Barn)	1st August 2020
L3	Critical Source Area - Critical Source Area (Paddocks 14-15)	Increase riparian buffer (triangle paddock)	1st August 2020
L3	Critical Source Area - Critical Source Area (Paddocks 14-15)	Protect Critical Source Area (Paddocks 14-15)	1st August 2020
L4	Race Maintenance & Management - Central Lane (between WOL and WTL)	Reduction in Use of Central Dairy Lane	New Consent
L4	Race Maintenance & Management - Central Lane (between WOL and WTL)	Slope Lane and Extend Riparian Buffer-Central Lane	1st August 2020
L5	Race Maintenance & Management - Lane Beside Waterway (Paddocks 18 & 19)	Extend Riparian Margin & Slope Lane	1st February 2021
L6	Culvert Management	Build up sides of culvert (South of Paddock 34)	1st February 2021
L7	Critical Source Area - Main Culvert (South of Wintering Barn)	Install Kerb - Main Culvert South Wintering Barn	1st February 2021
L8	Overland Flow Path - Overland Flow Path (Paddock 15)	Move Temporary Lane (Paddock 15)	1st February 2021
L9	Overland Flow Path - Critical Source Area (Paddock Marcel #1)	Extend Riparian Margin (Marcel #1)	1st February 2021
L10	Race Maintenance & Management - Lane Adjacent Waterway (Paddock 34)	Modify Lane beside Creek (Paddock 34)	1st February 2021
L11	Overland Flow Path - Overland Flow Path (Paddock 34)	Extend Riparian Margin (Paddock 34)	1st August 2021
L12	Critical Source Area - Culvert - Woldwide Two Dairy Shed	Build up Culvert Sides (Beside WTL Dairy Shed)	1st August 2021
L13	Critical Source Area - Culvert (Paddock Marcel #9)	Raise sides of culvert (Marcel #9)	1st August 2021
L14	Overland Flow Path - Critical Source Area (Paddock 21)	Extend Riparian Buffer (Paddock 21)	1st August 2021

UNDERSTANDING THE RISKS ON YOUR FARM

This section provides some context to help understand the relative impact and likelihood of environmental risks that have been identified on your farm. The chart on this page together with the map on the following page can be useful when thinking about what environmental risk areas on your farm need the most focus.



HOW ARE RISK RATINGS MEASURED?

The issues plotted on the chart above have been done so based upon two measures that are assigned to a specific area of your farm where an environmental risk has been identified. 1. Impact of contamination (on the vertical axis, or the first dial) is a measure of the potential scale or significance of contaminants that may be lost from this area of your farm. It's about quantifying how bad could the outcome for the environment be; 2. Likelihood of contamination (on the horizontal axis, or the second dial) is about the chance of the contamination actually occurring from that area of your farm. It takes into account things like how far the area might be from waterways as well as the slope or aspect of the area; When combined together the two measures also give an overall 'risk rating'. The measures and the combined rating are presented for each risk area along with other descriptive information about the risk area on the subsequent pages of this document.

Example:

RISK RATING

The map below shows the location of the risk areas identified on your farm. The Risk Rating presented here is a combined measure of the impact and likelihood of contamination occurring from each risk area.

LOW MEDIUM HIGH SEVERE

L2 Race Maintenance & Management - Lane Adjacent Waterway (West of Wintering Barn)

L3 Critical Source Area - Critical Source Area (Paddocks 14-15)

L4 Race Maintenance & Management - Central Lane (between WOL and WTL)

L5 Race Maintenance & Management - Lane beside Waterway (Paddocks 18 & 19)

L6 Culvert Management

L7 Critical Source Area - Main Culvert (South of Wintering Barn)

L8 Overland Flow Path - Overland Flow Path (Paddock 15)

L9 Overland Flow Path - Critical Source Area (Paddock Marcel #1)

L10 Race Maintenance & Management - Lane Adjacent Waterway (Paddock 34)

L11 Overland Flow Path - Overland Flow Path (Paddock 34)

L12 Critical Source Area - Culvert - Woldwide Two Dairy Shed

L13 Critical Source Area - Culvert (Paddock Marcel#9)

L14 Overland Flow Path - Critical Source Area (Paddock 21)

LAND MANAGEMENT

L1 Phosphorus Loss Overview

DESCRIPTION:

The overall property comprised of Woldwide One and Woldwide Two (as proposed) has three waterways passing through it and two tributaries to these waterways. The topography of the farm is flat, resulting in very few critical source areas that would facilitate the overland flow of contaminants into adjacent waterways. The main areas likely to be responsible for phosphorus losses are laneways that run adjacent to waterways and waterway crossing points (culverts).

Overseer is not spatially explicit and is unable to take into account landscape features. It assumes a hydrological connection exists to second order streams and that there is a transport mechanism to get phosphorus to those streams. The model will over estimate phosphorus loss if a significant portion of the block is hydrologically isolated from a second order stream (Gray, 2016).

The initiation and transport of phosphorus from the landscape requires conditions conducive to either overland or subsurface flow. In many situations, P loss to the stream is dominated by overland flow since soil will sorb most phosphorus from subsurface flow, unless, as with mole-pipe drainage, there is a direct conduit to the stream (McDowell et al. 2001). In general, more P is lost from soils with increasing slope, largely as particulate phosphorus.

Critical source areas are included in the model in general terms as the model was calibrated against catchment studies where losses from critical source areas would have occurred (Gray, 2016). On this basis, protecting critical source areas is a mitigation that needs to be applied outside of Overseer and will reduce phosphorus losses further from those modelled.

The estimated reductions in phosphorus referenced in this report are derived from the following calculations and research:

Phosphorus Loss – Culverts

There will be a reduction in phosphorus loss from mitigations applied around culverts but there is no robust research information to base an estimate on. On this basis estimated reductions in phosphorus have been referenced as >0 Kg/P.

Phosphorus Loss – Lanes

Overseer automatically estimates that there will be phosphorus loss from lanes to waterways. It assumes that all excreted phosphorus ends up as dung and that 30% of the phosphorus deposited on lanes is lost to water with the remaining 70% expected to remain on the lane or return to the adjacent paddock. This is a significant assumption and a major component of modelled phosphorus loss, reported as part of "other sources" in the Overseer 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

(Fertiliser and Lime Research Centre, 2014)

From Table 1.4 above, a cow eating 15.5 kg/DM/day will consume approximately 0.4kg of phosphorus per week, of which 66% is excreted in dung. For a cow with a 290 day lactation (assume not walking on lanes outside of the milking season) this equates to 10.9 kg/P/cow/yr. Cows are conservatively walking on the farm lanes for 1 hour per day as they move to and from the dairy shed. This means 4% (1 hour is 4% of a day) of phosphorus excreted is deposited on a lane. Overseer assumes 30% of this phosphorus is then lost to water via run-off.

((10.9 x 1500 cows) x 0.04) x 0.3 = 196 kg/P/yr lost to water from dairy lanes.

In total there are 10.8km of lanes on the farm of which 1.5km are adjacent to waterways and present a risk of contaminant runoff. This represents 14% of the lanes on the farm and proportionally 28kg of the total phosphorus losses from lanes. In reality this figure is likely to be higher as many of the other lanes on the property have no hydraulic connection to waterways. On this basis, lanes beside waterways are likely to make up a much larger proportion of the total phosphorus losses from the dairy lanes on the farm.

Assuming the conservative figure of 28 kg/yr of phosphorus loss from lanes adjacent waterways and the actions contained in this plan are carried out (improved vegetative buffer strips and lane management) then phosphorus losses from these areas are estimated to reduce by 40% (conservatively based on the lower end of the range of 38-59% of the data summarised in Figure 2 below). The exception to this is at site L12 where the use of the main cow lane is to be reduced significantly (by at least 50%) due to the changes in cow flow if consent is granted. This is in addition to the management and vegetation buffer improvements. At this site a 60% reduction phosphorus reduction factor has been used.

Overall phosphorus loss from lanes is estimated to reduce by 13.1kg/P/yr as outlined in the Table 1 below:

Site and Lane Length (m)	% of Total Lanes	P Loss (kg)	Mitigations (% Reduction)	Reduction in P Loss (kg)
L5 – 207	1.9	3.7	40	1.5
L2 – 241	2.2	4.3	40	1.7
L10 – 356	3.3	6.5	40	2.6
L4 – 553	5	9.8	60	5.9
L8 - 190	1.8	3.5	40	1.4
				13.1

Table 1 – Phosphorus Loss – Lanes

Phosphorus Loss – Critical Source Areas

Overseer predicts 101kg of phosphorus will be lost to water from paddocks (effective area of 478.9ha). Assuming phosphorus loss occurs evenly over the effective area of the farm, then critical source areas and their associated catchments would account for 2.5% of the phosphorus loss from blocks on the property. This equated to 2.5kg of phosphorus.

Assuming a 50% reduction in phosphorus loss occurs through the implementation of wider, vegetated riparian buffers (at locations where critical source areas enter waterways) and better management of critical source areas then a further reduction of 1.2kg of phosphorus is estimated to occur beyond that modelled in Overseer. See Table 2 below.

Site and Catchment Area	% of Total Catchment	P Loss (kg)	Mitigations (% Reduction)	Reduction in P Loss (kg)
L11 – 0.6ha	0.13	0.13	50	0.06
L3 – 0.7ha	0.15	0.14	50	0.07
L14 – 2.7ha	0.56	0.57	50	0.29
L9 – 7.5ha	1.57	1.9	50	0.79
				1.2

Table 2 – Phosphorus Loss – Critical Source Areas

The 50% reduction is based on research that shows management of critical source areas and vegetated buffers can reduce phosphorus loss by 38-59% (Figure 1). A midpoint reduction figure of 50% has been used to account for the likelihood of more phosphorus loss occurring in critical source areas than the rest of the farm and as such, more potential for phosphorus loss reductions.

It is acknowledged by McDowell et al, 2005 in the original design of the Overseer sub-model that, in some areas, 90% of phosphorus loss may come from only 10% of the catchment area (Sharpley et al, 1999). McDowell states that defining and isolating critical source areas, combined with adaptive management over the farm is the best approach to decreasing phosphorus loss.

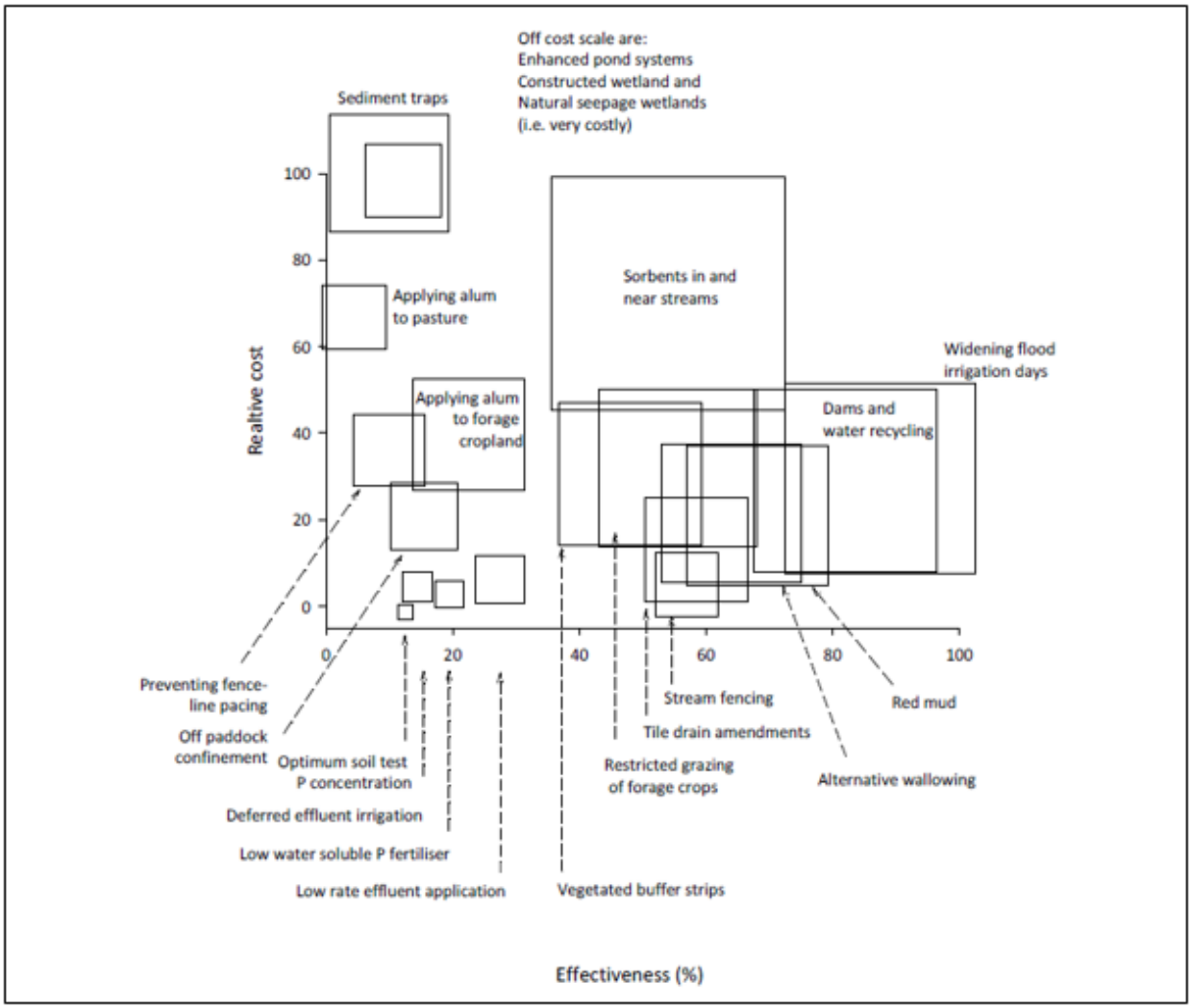


Figure 1 - Cost and effectiveness of strategies to mitigate phosphorus losses (McDowell et al, 2013)

Based on the topography of the property, it is likely that significantly more phosphorus will be lost through a small number of critical source areas rather than evenly over the property. On this basis, the estimated phosphorus loss from critical source areas is likely to be underestimated and thus the overall reductions achieved from implementing riparian buffers and better management of critical source areas.

References:

Fertiliser and Lime Research Centre. (2014). *Sustainable Nutrient Management Introductory Notes and Mastery Test*. Massey University.

Gray, C.W., Wheeler, D.M. and McDowell, R. (2016). *Review of the phosphorus loss submodel in OVERSEER®.* Report prepared for OVERSEER® owners under AgResearch core funding contract A21231(A). AgResearch. Report RE500/2015/050.

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McDowell, RW; Sharpley, AN; Beegle, D and Weld J. (2001). *Comparing phosphorus management strategies at the watershed scale*. Journal of Soil and Water Conservation 56: 306-315.

McDowell, R; Wilcock, B and Hamilton, D. (2013). *Assessment of Strategies to Mitigate the Impact or Loss of Contaminants from Agricultural Land to Fresh Waters.* Report prepared for MfE. AgResearch. Report RE500/2013/066.

Sharpley, AN; Gburek, WJ; Folmar G and Pionke, HB. (1999). *Sources of phosphorus exported from an agricultural watershed in Pennsylvania*. Agricultural Water Management 41: 77-89.

LAND MANAGEMENT

L2

Race Maintenance & Management

Lane Adjacent Waterway (West of Wintering Barn)

IMPACT OF CONTAMINATION  +  LIKELIHOOD OF CONTAMINATION = HIGH RISK RATING

DESCRIPTION:

Main lane to the west of the Woldwide One wintering barn running adjacent to a waterway. There is 1-2m riparian buffer, which is wider to the north. Due to the location of farm infrastructure there is minimal opportunity to extend the riparian margin wider. There is minimal vegetation cover in the riparian margin to filter any run-off.

This area will be planted in low native grasses such as red tussock and carex secta (1m intervals) to filter any run-off and utilise the associated nutrients. Between plantings the riparian buffer will be maintained in a healthy sward of rank grass. In addition to this, any areas of the lane that slope towards the waterway will be modified to slope in the opposite direction.

Estimated Reduction in Phosphorus: 1.7 Kg/P

GPS Co-ordinates: 1225117, 4889012

IMAGES:

OPEN ACTIONS:

Establish Vegetated Riparian Margin (Beside Barn) (MANDATORY ACTION)

The riparian margin between the main dairy lane and the waterway to the west of the Woldwide One wintering barn will be maintained in a healthy vegetative cover of native grasses (1m spacings) to filter run-off and utilise any associated nutrients.

TARGET DATE: **1st August 2020**

LAND MANAGEMENT

L3

Critical Source Area

Critical Source Area (Paddocks 14-15)

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = HIGH RISK RATING

DESCRIPTION:

Low lying area at the eastern end of paddocks 14 and 15 on either side of the dairy lane. At times this area holds water which subsequently enters the creek at either end of the CSA. The area is partly fenced off but is still grazed.

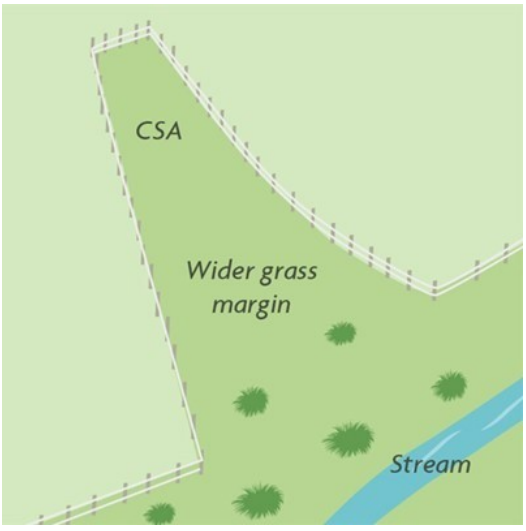
Being one of the few critical source areas on the farm means this area is likely to have a disproportionately high loss of sediment and phosphorus compared to other areas of the farm.

The riparian margin where the gully enters the adjacent waterway will be extended and maintained as a minimum in rank grass (or planted in native grasses such as carex secta or red tussock) to filter any overland flow that may occur under normal rainfall conditions.

Estimated Reduction in Phosphorus: 0.07 Kg/P

GPS Co-ordinates: 1224779, 4889616

IMAGES:



OPEN ACTIONS:

Increase riparian buffer (triangle paddock) (MANDATORY ACTION)
The riparian margin where the gully (Critical Source Area) enters the waterway will be extended to a minimum of 5m and maintained in rank grass (or planted in native grasses such as carex secta or red tussock) to filter any overland flow that may occur under normal rainfall conditions. See photo above.
TARGET DATE: 1st August 2020

LAND MANAGEMENT

L4

Race Maintenance & Management

Central Lane (between WOL and WTL)

IMPACT OF CONTAMINATION  +  LIKELIHOOD OF CONTAMINATION = HIGH RISK RATING

DESCRIPTION:

Main dairy lane running between Woldwide One and Woldwide Two. Currently this is used frequently by stock from Woldwide Two to access paddocks to the south, south east and south west of the dairy shed. Changes in cow flow will result in a number of these paddocks being accessed by different lanes. This will significantly reduce the frequency of stock movements along this section of the central lane (minimum of 50% reduction in stock movements) and the corresponding amount of dung (and associated phosphorus) deposited on the lane. In addition to the reduction in lane usage the lane will be sloped away from the adjoining waterway and the riparian buffer extended by 1m and maintained as a minimum in rank grass (or planted in native grasses such as carex secta or red tussock).

Estimated Reduction in Phosphorus: 9.8 Kg/P

GPS Co-ordinates: 1225043, 4889449

IMAGES:

OPEN ACTIONS:

Reduction in Use of Central Dairy Lane (MANDATORY ACTION)
Reduce the use of the central dairy lane between Woldwide One and Woldwide Two by a minimum of 50%.
TARGET DATE: New Consent Issued

Slope Lane and Extend Riparian Buffer-Central Lane (MANDATORY ACTION)
The lane will be sloped away from the adjoining waterway and the riparian buffer extended by 1m and maintained as a minimum in rank grass (or planted in native grasses such as carex secta or red tussock).
TARGET DATE: 1st August 2020

LAND MANAGEMENT

L5

Race Maintenance & Management

Lane beside Waterway (Paddocks 18 & 19)

IMPACT OF CONTAMINATION  +  LIKELIHOOD OF CONTAMINATION = MEDIUM RISK RATING

DESCRIPTION:

Main dairy lane running adjacent to a waterway. There is a small riparian buffer but this is not well vegetated and provides minimal opportunity for filtering contaminants off the lane. The lane is relatively wide in this area and as such the fence will be moved out 1m and a rank grass (or native plants such carex secta and red tussock) established to assist in filtering any run-off.

In a number of places, the lane does slope away from the adjacent waterway but during upcoming lane maintenance the entire lane will be sloped away from the creek.

Estimated Reduction in Phosphorus: 1.5 Kg/P

GPS Co-ordinates: 1225522, 4888560

IMAGES:

OPEN ACTIONS:

Extend Riparian Margin & Slope Lane (MANDATORY ACTION)
Extend the riparian margin by a minimum of 1m and establish a good sward of rank grass (or plant native grass such as carex secta and/or red tussock) to assist with filtering run-off from the lane. In addition to this the lane will be sloped away from the waterway.
TARGET DATE: 1st February 2021

LAND MANAGEMENT

L6 Culvert Management

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = MEDIUM RISK RATING

DESCRIPTION:

Culvert crossing the waterway to the south of paddock 34. The culvert has no raised sides which allows any runoff to flow off the side into the underlying water. Building up the sides of the culvert and directing run-off back into the paddock or at a minimum into a grass riparian area will assist with filtering sediment and associated phosphorus.

Estimated Reduction in Phosphorus: >0 Kg

GPS Co-ordinates: 1225572, 4888488

IMAGES:

OPEN ACTIONS:

Build up sides of culvert (South of Paddock 34)
Build up the sides of the culvert crossing the waterway to the south of paddock 34. This will prevent the direct deposition of sediment and associated phosphorus into the underlying waterway and allow for filtering via a grass buffer.
TARGET DATE: 1st February 2021

LAND MANAGEMENT

L7

Critical Source Area

Main Culvert (South of Wintering Barn)

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = MEDIUM RISK RATING

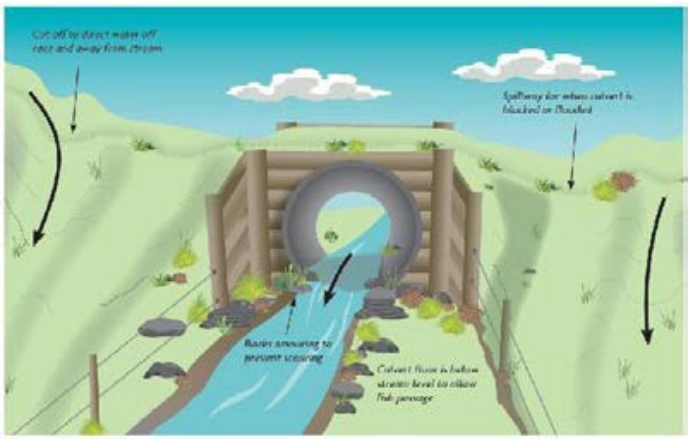
DESCRIPTION:

The main lane culvert to the south of the wintering barn on Woldwide One. A kerb will be installed on the sides of the concrete lane going over the culvert to prevent direct run-off into the underlying waterway. The kerb will direct run-off back into the adjacent paddocks.

Estimated Reduction in Phosphorus: >0 Kg/P

GPS Co-ordinates: 1225140, 4888897

IMAGES:



OPEN ACTIONS:

Install Kerb - Main Culvert South Wintering Barn
Install a kerb on the concrete lane at the point it goes over the main culvert. This will direct run-off into the adjacent paddock.
TARGET DATE: 1st February 2021

LAND MANAGEMENT

L8

Overland Flow Path

Overland Flow Path (Paddock 15)

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = MEDIUM RISK RATING

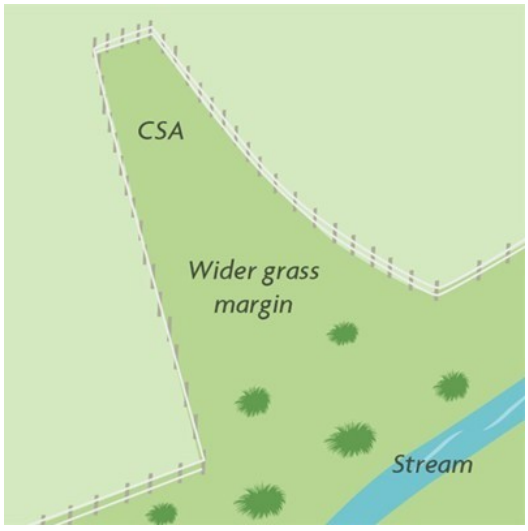
DESCRIPTION:

Fenced off strip at the southern end of paddock 15. Area used as an unformed lane to reach paddock 35. There is an overland flow path down to the south west corner of paddock 15 where run-off can exit into the adjacent waterway. The proximity of the unformed lane to the adjacent waterway also results in a high risk of run-off directly into the creek. The temporary lane will be moved 2-3m back from the waterway when in use and the resulting area left as rank grass to filter any run-off. The riparian buffer at the south west corner of paddock 15 will be extended and maintained in rank grass (or planted in native grasses such as carex secta, red tussock and toetoe).

Estimated Reduction in Phosphorus: 1.4 Kg/P

GPS Co-ordinates: 1225270, 4888883

IMAGES:



OPEN ACTIONS:

Move Temporary Lane (Paddock 15) (MANDATORY ACTION)
Move the temporary lane so it is at least 2m back from the waterway. Leave the resulting area in rank grass to filter any run-off. The riparian buffer at the low point at the south west corner of paddock 15 will be extended and maintained in rank grass (or planted in native grasses such as carex secta, red tussock and toetoe).
TARGET DATE: 1st February 2021

LAND MANAGEMENT

L9

Overland Flow Path

Critical Source Area (Paddock Marcel #1)

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = MEDIUM RISK RATING

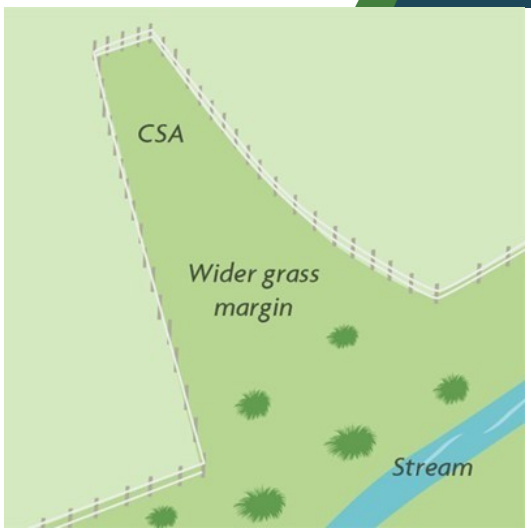
DESCRIPTION:

Swale/low area running through Marcel paddock 1. Overland flow will be concentrated in this area following heavy rain and make its way down into the adjacent waterway. The riparian margin will be increased to a minimum of 5m where the swale enters the adjoining waterway and maintained in rank grass or planted in native grasses such as red tussock, carex secta or toetoe.

Estimated Reduction in Phosphorus: 0.79 Kg/P

GPS Co-ordinates: 1225180, 4890863

IMAGES:



OPEN ACTIONS:

Extend Riparian Margin (Marcel #1) (MANDATORY ACTION)
Extend the riparian margin in Marcel Paddock 1 to a minimum of 5m where the critical source area enters the adjoining waterway. This area will be left in rank grass or planted in native grasses such as carex secta, red tussock or toetoe.
TARGET DATE: 1st February 2021

LAND MANAGEMENT

L10

Race Maintenance & Management

Lane Adjacent Waterway (Paddock 34)

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = MEDIUM RISK RATING

DESCRIPTION:

Dairy lane on the boundary of Woldwide One and Woldwide Two, south of paddock 34. The lane is lined on the southern side with a row of tall gum trees, which will impact on the ability of the lane to dry out. There is a 1-1.5m riparian buffer between the lane and the creek, which is maintained in rank grass. Some re-contouring of the lane will occur to ensure it slopes away from the waterway along its full length. In addition to this the large gum trees will be removed and replaced with low growing native plantings such as flax, toetoe and red tussock. This will still provide stock shelter, aesthetic and biodiversity outcomes but not impact on the drying out of the lane.

Estimated Reduction in Phosphorus: 2.6 Kg/P

GPS Co-ordinates: 1225279, 4889150

IMAGES:

OPEN ACTIONS:

Modify Lane beside Creek (Paddock 34) (MANDATORY ACTION)
Re-contour the dairy lane at the southern end of paddock 34 (between Woldwide One and Woldwide Two) so it slopes away from the dairy lane. In addition to this the gum trees will be removed to prevent shading of the lane, allowing it to dry out (reducing the likelihood of water ponding and running off). This area will be replanted in low natives such as flax, toetoe and red tussock to maintain biodiversity and aesthetic values.
TARGET DATE: 1st February 2021 (Tree removal to occur up until 2023)

LAND MANAGEMENT

L11

Overland Flow Path

Overland Flow Path (Paddock 34)

IMPACT OF CONTAMINATION  +  LIKELIHOOD OF CONTAMINATION = LOW RISK RATING

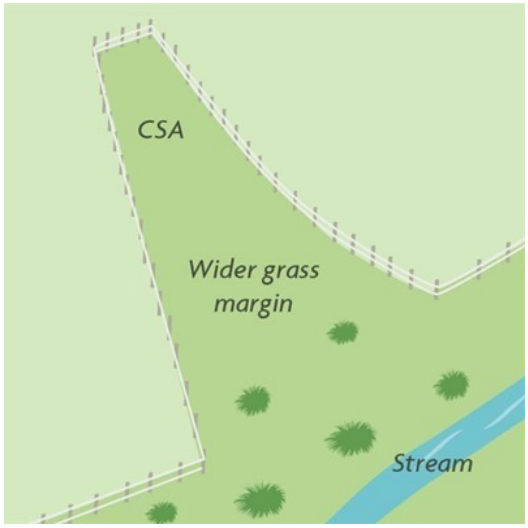
DESCRIPTION:

Small gully/swale running through paddock 34. In heavy rainfall events this will collect rainwater and associated contaminants from the surrounding land and direct them down to the waterway. Extending the riparian buffer and maintaining it in rank grass (or plant with native grasses such as Carex Secta or Red Tussock) in the location where the swale enters the creek will assist with filtering sediment and associated phosphorus.

Estimated Reduction in Phosphorus: 0.06 Kg/P

GPS Co-ordinates: 1225520, 4888729

IMAGES:



OPEN ACTIONS:

Extend Riparian Margin (Paddock 34) (MANDATORY ACTION)
Extend the riparian margin where the small swale in paddock 34 enters the adjacent waterway. Maintain this area in rank grass or plant in native grass species such as red tussock or carex secta.
TARGET DATE: 1st August 2021

LAND MANAGEMENT

L12

Critical Source Area

Culvert - Woldwide Two Dairy Shed

IMPACT OF CONTAMINATION  +  LIKELIHOOD OF CONTAMINATION = LOW RISK RATING

DESCRIPTION:

Main culvert to the west of the dairy shed at Woldwide Two. The culvert will be improved to reduce the risk of contaminants off the lane flowing into the underlying waterway by building up the sides of the culvert and creating a wider buffer on the north side of the culvert where there is un-utilised space. Run-off will be directed off the culvert into adjacent paddocks or as a minimum into a grassed riparian area.

Estimated Reduction in Phosphorus: >0 Kg/P

GPS Co-ordinates: 1224995, 4889689

IMAGES:

OPEN ACTIONS:

Build up Culvert Sides (Beside Woldwide Two Dairy Shed)
Build up the sides of culvert and create a wider riparian buffer on the north side of the culvert where there is un-utilised space. Direct run-off into adjacent paddocks or as a minimum into a vegetated riparian margin.
TARGET DATE: 1st August 2021

LAND MANAGEMENT

L13

Critical Source Area

Culvert (Paddock Marcel#9)

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = LOW RISK RATING

DESCRIPTION:

Lane culvert into Marcel Paddock #9. The culvert is in good condition along with the lane overlying it. The sides of the culvert will be raised to prevent contaminants off the lane running directly into the underlying waterway. Run-off will be directed out into the adjacentpaddocks.

Estimated Reduction in Phosphorus: >0 Kg/P

GPS Co-ordinates: 1225248, 4890530

IMAGES:

OPEN ACTIONS:

Raise sides of culvert (Marcel #9)
Raise the sides of the culvert to prevent contaminants off the lane running directly into the underlying waterway. Run-off will be directed out into the adjacent paddocks.
TARGET DATE: 1st August 2021

LAND MANAGEMENT

L14

Overland Flow Path

Critical Source Area (Paddock 21)

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = LOW RISK RATING

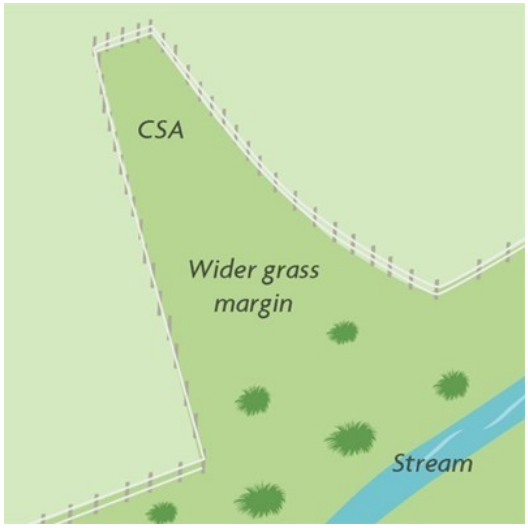
DESCRIPTION:

Shallow swale through paddock 21 that slopes down to the adjacent waterway. The swale will be a conduit for overland flow off the surrounding paddock during heavy rainfall events. Due to the flat topography of the farm and the small number of critical source areas, small swales as identified in paddock 21 are likely to carry a disproportionately high level of contaminants compared to the rest of the farm. On this basis having a wider riparian buffer where the swale enters the adjoining waterway and maintaining the buffer in rank grass or native grasses such as carex secta or red tussock will filter contaminants and reduce losses to surface waterways.

Estimated Reduction in Phosphorus: 0.29 Kg/P

GPS Co-ordinates: 1224876, 4889610

IMAGES:



OPEN ACTIONS:

Extend Riparian Buffer (Paddock 21) (MANDATORY ACTION)
Extend the riparian margin in the location where the low area through paddock 21 enters the adjoining waterway. This will be maintained in rank grass or planted in native grasses such as Carex Secta, Red Tussock or Toetoe.
TARGET DATE: 1st August 2021