Edgar Henson

Kaike Farm Limited

2705 Wairamarama Onewhero Road, Glen Murray

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1.0 Client Details

Full Name of Property Owner:	Edgar and Nona Henson
Contact Person:	Edgar Henson
Postal Address:	2706 Wairamarama Onewhero Rd, Glen Murray 2697
Phone:	021 763 900
Email Address:	edgar@hensons.co.nz
Healthy Rivers Farm Identifier:	*Office use only*

2.0 Property Details

Property Address:	2705 Wairamarama Onewhero Rd, Glen Murray
Property Owner Name:	Edgar Henson
Legal Description:	LOT 1 DPS 8863 PT LOT 1 DPS 16924
Valuation Number:	06321/080/00
Land Area (ha):	207.54
Effective Land Area (ha):	170.72
Land Use Activities:	Beef breeding, rearing and finishing
Annual Rainfall (mm):	1562
Dominant Soil Type:	Orthic Brown

3.0 Healthy Rivers/Wai Ora Details

Freshwater Management Unit:	Riverine Lakes Freshwater
Sub-Catchment Name:	Whangape
Sub-Catchment Priority:	1

4.0 Certified Farm Environment Planner

Name:	Leanna Birch
Phone:	027 295 5051
Email Address:	leanna@nzregenerate.co.nz
Identifier/certification reference:	*Office use only*
Sign-off:	
Date:	Saturday, 10 August 2019

5.0 Consents Held

No consents held at this property.

6.0 Infrastructure Management

No freshwater irrigation occurs.

No effluent irrigation occurs.

7.0 Farm Map

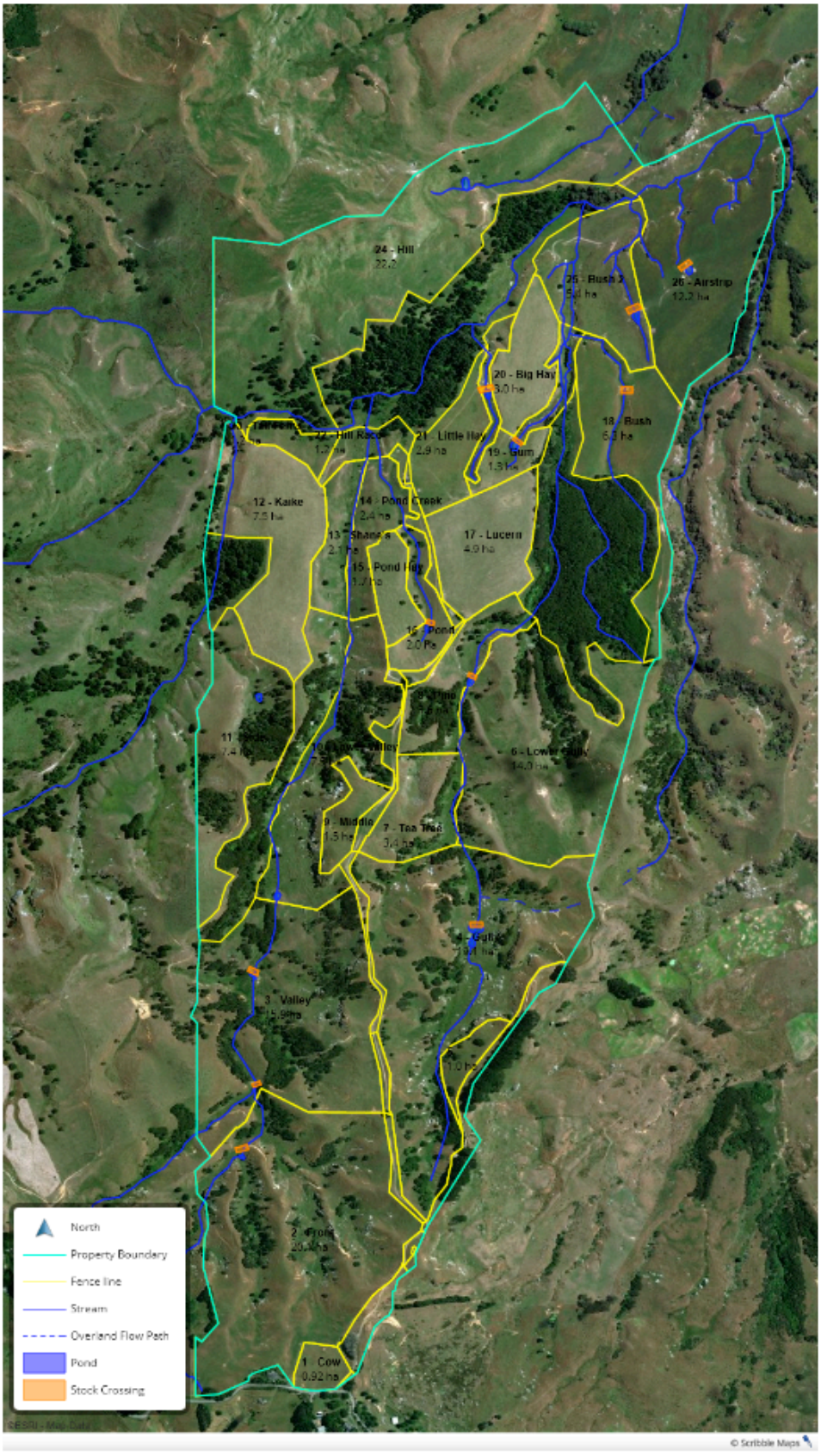


Figure 1 Map of Kaike Farm including paddock names and areas.

8.0 Kaike Farm Details

Kaike Farm is located approximately 45 minutes' drive south-west of the Te Kauwhata township. In 1951, after the war, the Allen brothers, Noel and Essie, purchased the property, which included the three surrounding properties seen today. The brothers were dairy farmers from Wellsford, but decided to try their hand at sheep and beef farming. Eventually Noel and Essie split the farm between them, and Mr Jack Flemming, Nona Henson's father, purchased {do we know what brother?} half in 1958. 2705 Wairamarama Onewhero Road block ownership was placed under Kaike Farm Limited. In 1959, Jack went on to purchase the remainder of the original block from the other brother, which Kaike Farms Ltd no longer owns. In 1972, Edgar and Nona purchased the small 2706 Wairamarama Onewhero Road block they personally own today. Nona's mother Bettie died in 2002 and father Jack passed away shortly after in 2003, leaving Edgar as the appointed director of Kaike Farm Ltd.

Since taking over, Edgar has drastically increased productivity on the farm as he started with only 55 cows and now runs over 210 at peak. Edgar put three QEII covenants on the land starting about 16 years ago in order to protect the bush. At this time, Edgar also began conducting annual water tests during the summer to quickly assess the water quality, in terms of nutrient levels. These tests have now been taken consistently for the past 16 years and the results show a clear trend of improvement. The most recent water samples were taken on the 17 January 2019 and overall showed the water quality was good (refer to section 9.1.2 below for further details). The Waikato Regional Council also monitors the health of Kaike Farm's main stream through their Regional Ecological Monitoring of Streams (REMS) project which showed the stream is in a "good" condition (refer to section 9.3 below for further details). Currently, the 2705 Wairamarama Onewhero Road block is owned by Kaike Farm Limited (Edgar Henson) and operated as a beef breeding, rearing and finishing farm.

Over the past 60 years, the Flemming/Henson family have improved infrastructure and production on this property while looking after the environment. The short-term goal for the farm is to match land use to land capability, which is currently being investigated to determine viable options. The Henson's overarching, long-term goal is to create a farm that is sustainable, both environmentally and financially to ensure the property is prosperous.

9.0 Whole Farm Risk Overview

9.1 Catchment Nutrient Priorities

Nitrogen	Phosphate	Sediment	Microbial Pathogens

9.1.1 Catchment Nutrient Data for Whangape Stream at Rangiriri-Glen Murray Rd

Contaminant	Current level[1]	Short term target	80-year target	State	Trend	NOF Band
Sediment (m)	0.18	**0.3**	**1.0**	Worst 25% of like sites	→	-
E. coli (n/100mL)[2]	120	584	540	Worst 50% of like sites	-	-
Total Nitrogen (g/m^3)	2.07	**0.69**	**0.69**	Worst 25% of like sites	↑	-
Ammonia (g/m^3)	0.005	0.134	0.05	Best 25% of like sites	↑	B
Total Phosphate (g/m^3)	0.11	-	-	Worst 25% of like sites	↑	-

[1] Current level is a 5 year average from LAWA (www.lawa.org.nz)

[2] Please note: the current level is the 5-year average, whereas the targets are measured at the 95th

[2] Please note: the current level is the 5-year average, whereas the targets are measured at the 95th percentile so unable to compare the two confidently.

9.1.2 Kaike Farms water testing results from Jan 2017 to present

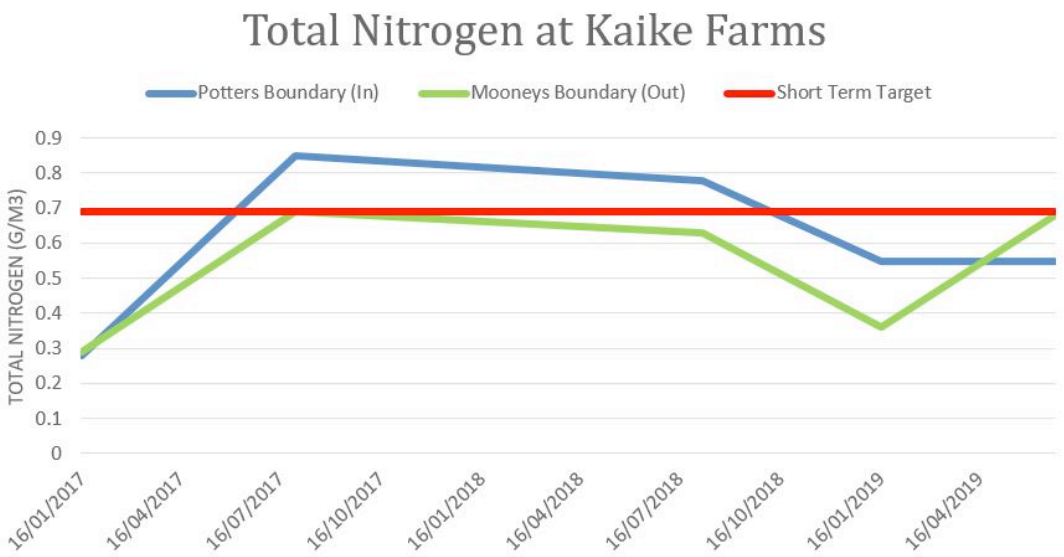


Figure 2: Graph demonstrating the change in total nitrogen over the past two year. This graph clearly shows that total nitrogen levels are lower at the property boundary leaving the farm, compared to levels entering the farm. **Figure 3** below also shows a similar trend for total phosphate.

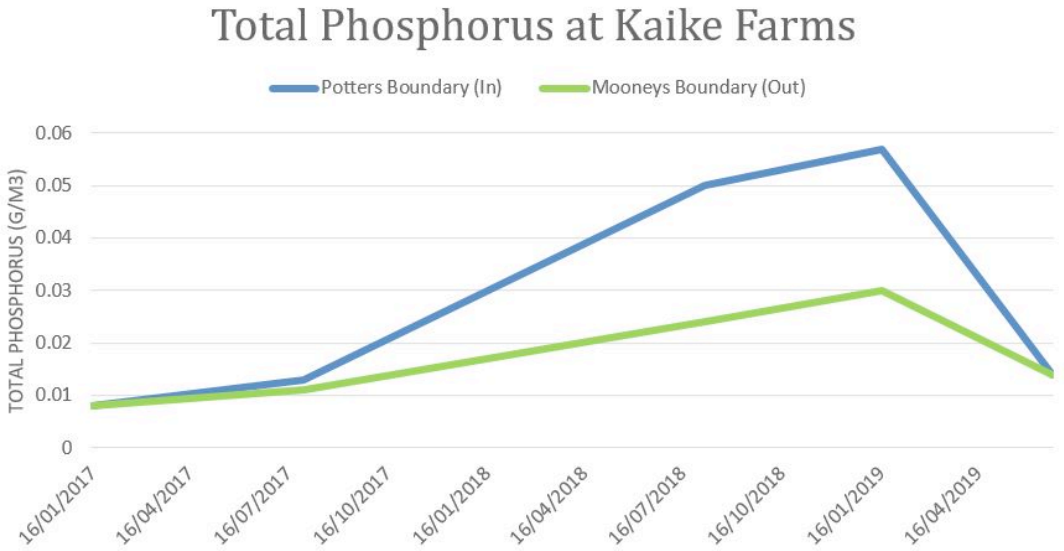


Figure 3: Graph demonstrating the change in total phosphate over the past two year. This graph clearly shows that total phosphate levels are lower at the property boundary leaving the farm, compared to levels entering the farm. **Figure 2** above also shows a similar trend for total nitrogen. Total phosphate does not have a short term target, because local government has not assigned a target at this stage.

9.2 Overview of Farm System

9.2.1 Stock System

Farm Name:	Kaike	Heifer Replacements:	5?
Total ha:	207.54	Breed:	South Devon
Effective ha:	170.72	# Cows Calving:	23
Peak Cows:	215	Calves weaned:	May
Peak Stocking Rate (SU/ha):	7.4	Start of Calving Date:	September
Average Stocking Rate (SU/ha):	6.3	Calving Length:	~12 weeks
Production 16/17 season (kg/ha):			
Northland/Waikato/BOP average production 16/17 season (kg/ha) (Beef & Lamb, 2019):			61.7

Kaike is used to breed, rear and finish beef cows and grow a portion of the supplement feed – hay. Additionally, a community of beehives and feral goats also occupy the land. The property carries about 24 South Devon breeding cows and 1 South Devon bull year round (refer to Table 1 below for further details). Calving begins in September and runs until December, and natural mating, with a South Devon bull, begins in November and runs until February. On average there is a 100% success rate for mating, due to the small herd size of breeding cows and the long mating season. However, there is occasionally the odd cow that is empty, which is determined by pregnancy diagnostic, and she will be sold. All calves born are raised on farm to R3's typically.

About 23-25 calves are born each year, with the remaining stock purchased at the sales, typically as 15 month olds. The majority of calves born on-farm, stay with their mothers until weaning in May. However, if a calf is born late it will typically stay on the mother for longer. All young beef stock are reared and finished on farm until the spring grass market where they are sold generally as R2's. However, depending on weights, some are kept through to 3 year olds.

Table 1: Stock type, numbers, effective area (ha), stocking rate (cow/ha) and stock units per hectare (SU/ha) over the 2018/2019 season. Heifer Replacement = HR.

Month	June		July		August		September		October		November	
Mixed Age Breeding Cows	24	24	23	23	23	23	23	23	23	23	24	24
Dry Heifers	42	42	72	72	72	72	72	72	49	37	15	15
R2 Heifers	36	36	16	16	16	16	16	16	16	45	59	71
R1 Heifers	9	9	11	11	11	11	11	11	11	11	11	11
Heifer Calves	0	0	0	0	0	0	1	3	4	5	6	6
Steer Calves	1	0	0	0	0	0	3	6	9	12	14	16

R1 Steers	10	10	12	12	12	12	12	12	12	12	10	10
R2 Steers	12	12	12	12	12	12	12	12	16	16	16	16
Mixed Age Steer	42	42	13	13	13	13	13	13	0	0	42	42
Bulls	1	1	1	1	1	1	1	1	1	1	1	1
Effective ha	*170.72*		*170.72*		*170.72*		*170.72*		*170.72*		*170.72*	
Cow/ha	1.0	1.0	0.9	0.9	0.9	0.9	1.0	1.0	0.8	0.9	1.2	1.2
SU/ha	6.4	6.4	5.4	5.4	5.4	5.4	5.5	5.6	4.5	5.2	6.9	7.3
Month	**December**		**January**		**February**		**March**		**April**		**May**	
Mixed Age Cows	24	24	24	24	24	24	24	24	24	24	24	24
Dry Heifers	15	15	15	15	15	42	42	42	42	42	42	42
R2 Heifers	71	76	76	76	36	36	36	36	36	36	36	36
R1 Heifers	11	11	11	11	11	9	9	9	9	9	9	9
Heifer Calves	6	6	6	6	6	6	5	3	2	1	0	0
Steer Calves	17	18	18	18	18	18	15	12	9	6	4	2
R1 Steers	10	10	10	10	10	10	10	10	10	10	10	10
R2 Steers	12	12	12	12	12	12	12	12	12	12	12	12
Mixed Age Steer	42	42	42	42	42	42	42	42	42	42	42	42
Bulls	2	2	2	2	1	1	1	1	1	1	1	1
Effective ha	*170.72*		*170.72*		*170.72*		*170.72*		*170.72*		*170.72*	
Cow/ha	1.2	1.3	1.3	1.3	1.0	1.2	1.1	1.1	1.1	1.1	1.1	1.0
SU/ha	7.2	7.4	7.4	7.4	6.0	6.8	6.7	6.6	6.6	6.5	6.5	6.4

9.2.2 Fertiliser Inputs

LandCo's Custom Blend fertiliser is applied in autumn to the majority of the farm using precision plane or ground spreaders.

For the 2018/2019 season, there were two different custom blends applied to the land. The flats custom blend was applied at 450 kg/ha over 54 ha on the flat areas of the farm (please refer to Figure 4 below). The base custom blend was applied at 300 kg/ha over about 116 ha on the hill areas of the farm (please refer to Figure 5 below). This a direct reflection of soil testing to tailor nutrient applications. This is a huge benefit environmentally and financially as only deficient nutrients are applied. This means nutrients are used efficiently and no excess nutrients are applied, therefore greatly minisiming the potential of nutrient loss. This is explicitly a result of tailoring nutrient applications to soil test results. The blends also supplies a mix of slow and fast release nutrients. This means there is enough nutrients available immediately for plant uptake, while the remaining nutrients become slowly available over the following three to six months, which drastically reduces the risk of leaching and maximises returns.

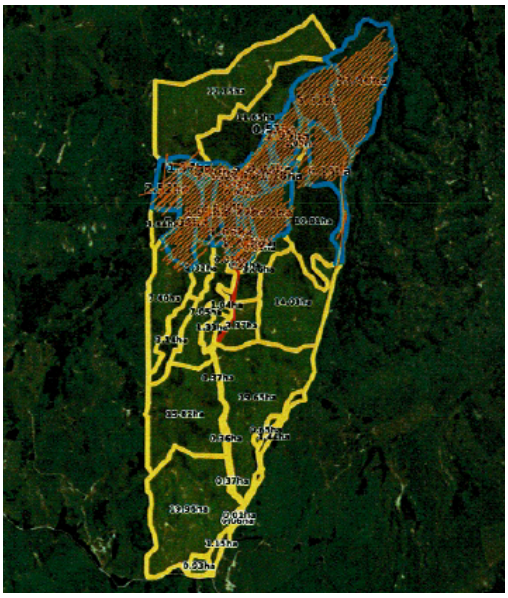


Figure 4: Map showing application area (blue/orange) of the flat custom blend.

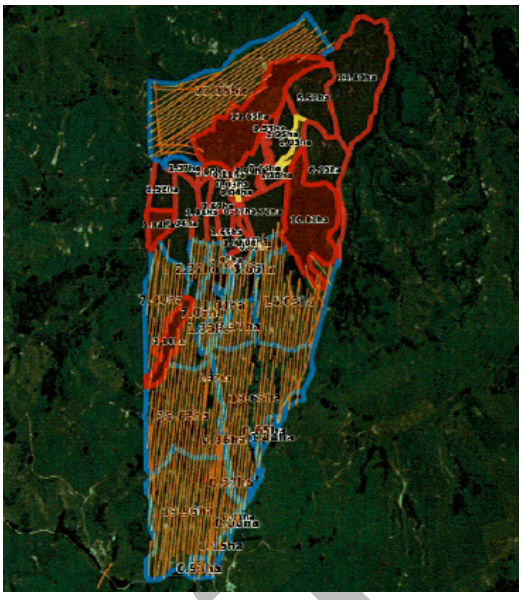


Figure 5: Map showing application area (blue/orange) of the base custom blend.

Table 2: Typical level* of nutrient input applied for Kaike Farm.

Season	Qty (t)	Item	Supplier	N (kg)	P (kg)	K (kg)	S (kg)	Ca (kg)	Mg (kg)
Autumn	22.5	Flat Custom Blend	LandCo	693	-	450	1283	1904	54
Autumn	33	Base Custom Blend	LandCo	-	-	660	742.5	2792	79.2
Total (kg)				**693**	**0**	**1110**	**2025.5**	**4696**	**133.2**
Season Total (kg)				**693**	**0**	**1110**	**2025.5**	**4696**	**133.2**

**These numbers are not definite nutrient levels added every season to Kaike Farm. The numbers do vary season to season. These numbers are provided to offer an overall example of a pattern for the level of nutrients applied and when. For exact nutrient levels applied, please see the latest Nutrient Management Plan.*

9.2.3 Supplement Feed

On this property, hay is fed out over winter to provide additional feed and roughage, and all of the hay is produced on this property. Each season, about 10.8 ha is locked up in late November to allow hay to be cut in early January. The hay is always cut from the flat area on property as it is the higher grass growth and is more appropriate for machinary use. Typically, more paddocks are locked up than required to make hay. On average, 1,500 bales are baled and stored, which is sufficient to comfortably meet the cattles' feed requirement needs over winter. However, if the season is extremely abnormal, i.e. the long dry summer experienced in 2018/2019, means additional hay may be brought in. Hay is typically fed out in the paddock using a quad bike and trailer, distributed out via hand fork. On average, 15-20 standard square bales or 1.4 - 1.9 kg DM/cow/day are fed out in winter, from July to August. Multi-mineral salt lick block are also supplied, ad-lib, to the cows in order to supplement trace minerals they may be lacking.

In addition to supplement feed, the pasture quality available to the cattle is high due to the original forage species that have adapted very well to the land. The dominant speices drought resistant ryegrass, plantain, and rosa clover. Red clover seed was

applied by plane in conjunction with fertiliser applications and the species is now apparent in patches across the farm.

9.2.4 Risks Associated with Farm System

Stocking rate follows the property's natural path of pasture growth, and supplements are fed during feed deficits or during extreme weather conditions e.g. drought. The stock policy is tailored and sustained by the land.

Importing supplement feed can increase the risk of nutrient loss because external nutrients are introduced into the cycle. There are no supplements, brought onto this farm and therefore the risk is eliminated. Additionally feeding hay out in the paddock allows grass seed can be released, which helps rejuvenate the pasture.

The last risk is fertiliser applications. The majority of fertiliser applied is slow release and the fertiliser type and application rates are tailored to soil nutrient requirements based on soil tests. Lastly, autumn applications optimise pasture growth allowing pasture to efficiently use the nutrients provided, further reducing the risk of nutrient loss. Therefore the risk of leaching from fertiliser is very low.

9.3 Ecosystem

This property has the potential for a Podocarp and Rimu-tawa forest types. Podocarp forests consist of a mixture of native conifers, such as Kahikatea-pukatea-tawa, Matai-kahikatea-totara, Kahikatea-totara and Rimu-matai-miro-totara/kamahi, Rimu-matai-miro-totara/kamahi forest types. Rimu-tawa forests were formerly common on hill country in the North Island, though has been reduced drastically due to logging and clearing. If planting is to occur on this farm in the future, these ecosystems should be considered (refer to Figure 6 below).

The Waikato Regional Council also monitors the health of Kaike Farm's main stream through their Regional Ecological Monitoring of Streams (REMS) project. This project uses the Macroinvertebrate Community Index (MCI) to reflect stream health and the results for the 2017/2018 summer season showed an MCI value of 109 = Good, and the fish survey showed native species such as longfin eel, cran's bully and koura (freshwater crayfish) at the site.

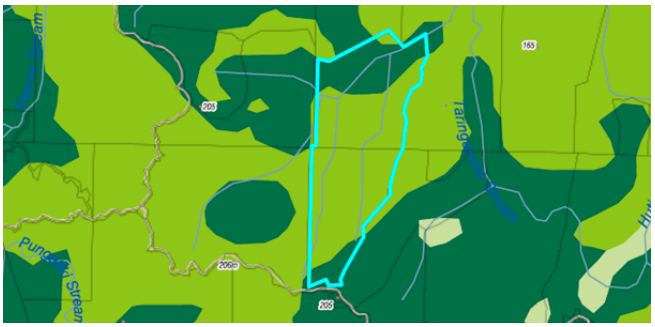


Figure 6: Image showing the potential natural vegetation (Landcare Research, 2018).

Key: Rimu-tawa Forest Podocarp Forest Property Boundary

9.4 Climate

The largest risk on this property is drought within the hill areas (please refer to Figure 5 above) due to a combination of the limestone outcrops present, reduced rainfall and the steeper slopes in these areas. Land slippages are also a risk due to the steep slopes in some areas. Flooding can also occur during high and prolonged rainfall events due to the waterways present and the topography of the farm. Annual rainfall is approximately 1562 mm, however, the flats tend to receive more rainfall than the hills. Climatic conditions contribute a moderate risk to contamination loss.

9.5 Topography

This property has a range of topography from flat to steep (refer to Figure 8 below). Figure 7 below shows the proportion of slope classes found on this property.

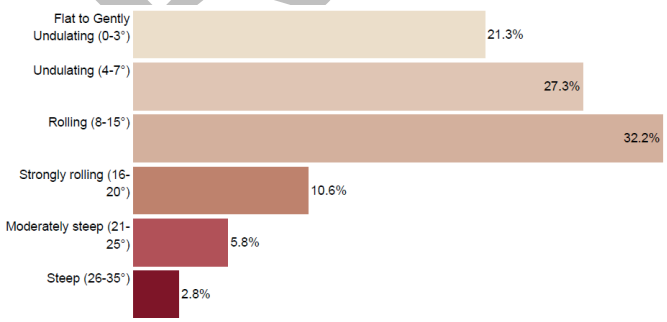


Figure 7: Graph showing the proportion of slope classes within the property (Landcare Research, 2018).

9.5.1 Slope Class A & B – Flat to Undulating (0-7°) Risk Assessment

This topography class is the lowest risk category in relation to contaminant loss. The largest risk of contaminant loss would be from nutrient leaching, however, soil type largely influences the risk level.

9.5.2 Slope Class C – Rolling (8-15°) Risk Assessment

This topography class has a moderate risk of contaminant loss due to the increased risk of overland flow potentially causing nutrient and *E. coli* runoff, and sediment loss via surface erosion and runoff.

9.5.3 Slope Class D & E – Strongly Rolling to Moderately Steep (16-25°) Risk Assessment

This topography class has a high risk of contaminant loss due to the high risk of overland flow and erosion potentially causing nutrient and *E. coli* runoff, and sediment loss via surface erosion and runoff.

9.5.4 Slope Class F – Steep (26-35°) Risk Assessment

This topography class has the highest risk of contaminant loss due to the very high risk of overland flow and erosion potentially causing nutrient and *E. coli* runoff, and sediment loss via surface erosion and runoff.

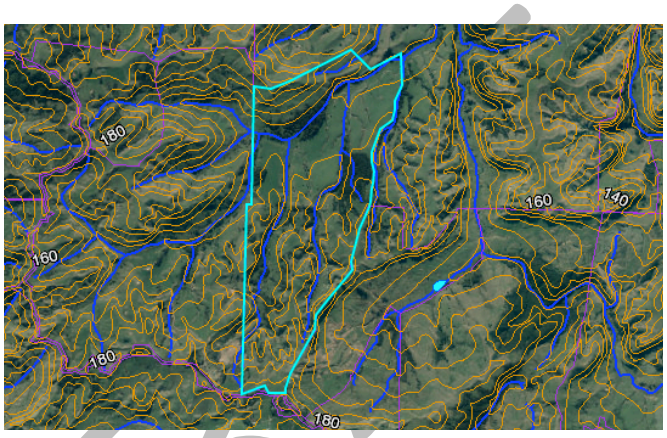


Figure 8: Topographic map showing topography on the property with 20m contours.

9.6 Soil Type

Orthic Allophanic, Orthic Brown and Yellow Ultic are the three soil orders found on this property as seen in Figure 9 below. S-map is not available for this area at present, therefore the information from the soil order map has been used for the farm.

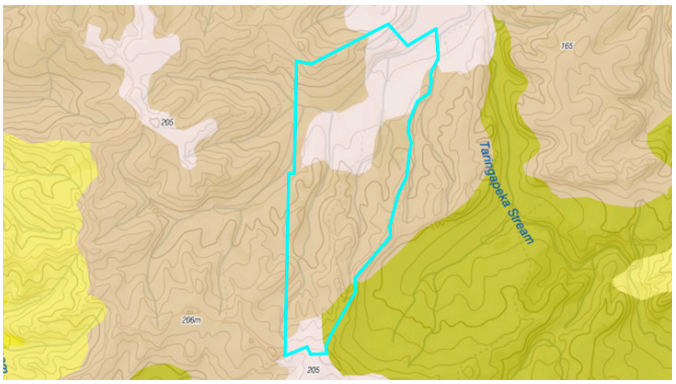


Figure 9: Soil order map outlining the three soil types found on this property.

Key: Orthic Allophanic | Orthic Brown | Yellow Ultic | Property Boundary

9.6.1 Orthic Brown (BO)

Orthic Brown soils are weak or structured sub soil, common on slopes or young land surfaces, where summer drought and winter waterlogging is uncommon. Brown soils have a brown or yellow-brown subsoil below a dark grey-brown topsoil. The brown colour comes from a thin iron oxide coating, weathered from parent material. The orthic brown soil occupies approximately 133 ha, and contains a large, active population of soil organisms, in particular earthworms. Mica/illite (non-expanding) and vermiculite (limited expansion) are dominant clay minerals. The soil has a low to moderate base saturation, therefore is typically more acidic and less basic cations (i.e. potassium, sodium, magnesium and calcium) are available for plant uptake.

There are three main ways contaminants can be lost in association with soil: leaching, runoff and erosion (refer to Table 3 below). Leaching can be influenced by bypass and matrix flow. By-pass flow provides little soil contact time and decreases the opportunity to absorb nutrients. However, by-pass flow protects the majority of nutrients because surplus water is rapidly channelled away. Matrix flow allows greater soil contact time and a greater opportunity for contaminant attenuation and filtering. Overland flow occurs when the soil is at saturation, so liquid pools on the surface and runs over the land, therefore, providing little soil contact time and drastically decreased the opportunity to attenuate contaminants. Topography and infiltration rate influences the extent of overland flow.

Table 3: Orthic Brown risk assessment for leaching, overland flow and erosion.

Pathways	Risk			Notes
Leaching	L	M	H	
Overland Flow	L	M	H	
Erosion	L	M	H	

9.6.2 Orthic Allophanic (LO)

Orthic Allophanic Soils are deep soils that are dominated by allophane (also imogolite or ferrihydrite) minerals. These minerals help maintain a porous, low density structure with weak strength, making the soil easy to dig and crumble in the hand. The soils are identified by a distinctly greasy feel when moistened and occur predominantly in the North Island volcanic ash, covering 5% of New Zealand. The Orthic Allophanic Soil occupies approximately 67 ha, and contains a large populations of soil organisms, particularly in the A horizons. Allophanic Soils have low natural fertility and a large affinity for phosphate. Because bulk density is low there is little resistance to root growth and topsoils can resist the impact of machinery or grazing animals in wet weather.

There are three main ways contaminants can be lost in association with soil; these are leaching, runoff and erosion. Refer to Table 4 below to determine the risk in terms of contaminant loss for Orthic Allophanic soils.

Table 4: Orthic Allophanic risk assessment for leaching, overland flow and erosion.

Pathways	Risk			Notes
Leaching	L	M	H	
Overland Flow	L	M	H	
Erosion	L	M	H	

9.6.3 Yellow Ultic (UY)

Yellow Ultic are strongly weathered soils that occupy approximately 8 ha. The soil has a well-structured, slowly permeable, clay-enriched subsoil horizon, which is yellow or yellow-brown. An E horizon commonly occurs immediately beneath the topsoil. The topsoil has a large and active soil organism population. The soil is typically acidic and strongly leached with low levels of calcium and other basic cations. The dominant clay minerals are kaolinite (non-expanding) and vermiculite (limited expansion). This soil can have dispersible surface horizons, therefore are susceptible to livestock treading damage and are prone to erosion.

There are three main ways contaminants can be lost in association with soil; these are leaching, runoff and erosion. Refer to Table 5 below to determine the risk in terms of contaminant loss for Yellow Ultic soils.

Table 5: Yellow Ultic risk assessment for leaching, overland flow and erosion.

Pathways	Risk			Notes
Leaching	L	M	H	
Overland Flow	L	M	H	
Erosion	L	M	H	Prone to erosion

9.7 LUC Map

Symbology:	LUC Class, Subclass and unit	Soil Type:	BO – Orthic Brown	UY – Yellow Ultic
	Rock Type – Soil Unit – Slope Class Erosion Type & Severity – Vegetation Cover		LO – Orthic Allophanic	

9.7.1 Extended Legend (LUC)

LUC	Ha	Description	Rock Type	Soil	Slope	Vegetation	Erosion	Land Use Suitability	Considerations

10.0 Contaminant Loss Risk Assessment

This section looks at the risk level of contaminant loss based on climate, topography, soil type and land use.

10.1 Greenhouse Gases

Figure 10 below is a model estimate of greenhouse gas emissions based on regional stock numbers and spatially distributed using the lands potential carrying capacity based on soil type. Based on this, greenhouse gas emissions are low. However, the Overseer v.6.3.1 shows that the 2018/2019 season emitted 2529 kg CO_2 equiv/ha/yr.

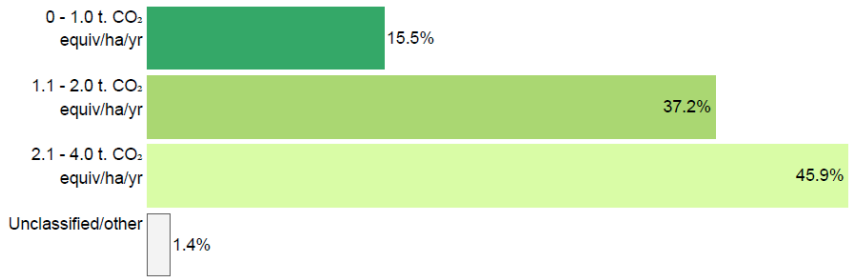


Figure 10: Greenhouse gas emissions from Landcare Research, 2018, based on 2010 to 2016.

Scale:			
	0 – 1.0 t CO_2 equiv/ha/yr		4.1 – 6.0 t CO_2 equiv/ha/yr
	1.1 – 2.0 t CO_2 equiv/ha/yr		6.1 – 8.0 t CO_2 equiv/ha/yr
	2.1 – 4.0 t CO_2 equiv/ha/yr		8.1 – 10.0 t CO_2 equiv/ha/yr
			>10.0 t CO_2 equiv/ha/yr

10.2 Sediment and Phosphate Loss Risk Assessment

Risk Level		Likelihood Level			
		Very Low	Low	Moderate	High
Impact Level	Low	Very Low	Low	Low	Moderate
	Moderate	Low	Low	Moderate	High
	High	Low	Moderate	High	**Serious**
	Serious	Moderate	High	**Serious**	**Serious**

Excessive sedimentation in waterways can increase turbidity, which reduces the penetration level of sunlight for algae can grow and reduces the vision of fish to swim, eat and breed. Additionally, sediment can infill habitats and harm fish gills, which overall reduces the health and wellbeing of the waterway.

Phosphate (P) has an effect on eutrophication and algal blooms, which reduces the overall health and wellbeing of the waterway.

Table 6: Likelihood Risk of P Loss from Various Sources.

Sediment & P Loss Risk	**Very Low**	**Low**	**Moderate**	**High**
Slope Classes on property	A & B	C	D & E	F
Relative % of area	48.6	32.2	16.4	2.8
Erosion Severability	0	1	2 & 3	4 & 5
Relative Runoff Potential	Very Low	Low	Medium	High
P fertiliser water solubility	None applied	Low	Moderate	High
P fertiliser rate (kg P/ha/yr)	None applied	11 – 50	51 – 99	>100
Stocking Rate (SU/ha)	<3.5	3.6 – 10.5	10.6 – 25.0	>25.1
Soil type leaching vulnerability	Very Low	Low	Medium	High
P fertiliser applied during a drought or before sufficient regrowth has occurred after rain.	No		Yes	
P applications are tailored to high plant growth periods i.e. autumn and spring	Yes		No	
P fertiliser is applied when the ground is saturated and/or when tile drains are running.	No		Yes	
P applications are applied in proportion to other nutrients, according to plant requirements	Yes		No	
Any point source losses?	No	Yes: minor	Yes	Yes: major

Sediment can be lost via surface erosion and runoff, and the likelihood of sediment being lost is high. This is because of the slopes class F presence, unfenced waterways, overland

flow paths, and susceptibly to drought on the slopes. Once the unfenced waterways and steep slope classes are mitigated, the likelihood risk will reduce to low (refer to 11.3.1. and 11.3.3 below for more information). This is because of the negligible and slight erosion severability and good land management i.e., grazing only light cattle at a low stocking rate on steeper areas and planting poplars to help stabilise steep slopes (refer to Figure 11 below). Additionally, all best management practices are already implemented, and there is currently no P fertiliser applied to the land.

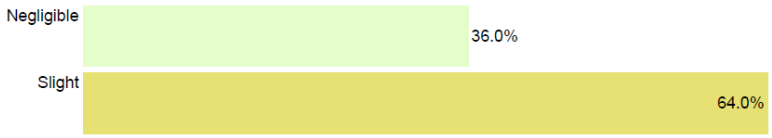


Figure 11: Graph demonstrating observed erosion severability on the property (Landcare Research, 2018).

Table 7: Impact Risk – Phosphate: soil test was taken 7 December 2018.

Sample Area	P205 Value	Optimum Value	Actions
Kaikatia	253	560	Increase Olsen P levels in the area.
NO1/Bush	195	560	Increase Olsen P levels in the area.
Lucerne	220	560	Increase Olsen P levels in the area.
Small Hay	498	560	Maintain Olsen P levels in the area.
Middle	133	560	Increase Olsen P levels in the area.
Pond Hay	252	560	Increase Olsen P levels in the area.

The overall impact level of sediment and P is low. The entire farm is below the optimum P205 value of 560 kg P/ha. This means a low level of P is available in the soil and therefore if sediment and P were lost to a waterway, the impact level is low.

Overall, the risk of sediment and P loss to surface water is moderate.

In terms of soil damage, soil pugging has a low risk of occurrence due to the susceptibility of drought over the majority of the arm. However, there is a high risk of pugging associated with the gateways and the streams located throughout the farm, particularly during high rainfall events. Therefore, fencing needs to be installed around the streams to reduce the risk to low, and it would be beneficial to metal the paddock gateways as it reduces soil damage associated with high traffic areas, but this is not vital. Stock need to be appropriately managed to ensure this risk stays low. Currently, this is being achieved by primarily grazing stock on the slopes during wet periods. Lastly, hay is fed out in paddock between July and August using a quad bike and trailer, therefore there is a very low risk of heavy machinery compacting the soil.

The soil's health is vital to the ecological and economic sustainability of land. The physical structure controls the movement of water and air through the soil, and the depth roots are able to penetrate. The chemical structure determines which nutrients are plant available, or alternatively, locked up. And a healthy soil biology increases organic matter, improves water retention and accelerates the decomposition of dung, urine and other organic matter. Damage to the soil can change these properties and reduce plant growth, regardless of nutrient status. Decline in soil physical properties takes considerable expense and many years to correct, and can increase the risk of soil erosion by water or wind. A Visual Soil Assessment (VSA) was conducted on the 22 July 2019, at the sites seen in Figure 12 below, to quickly assess the soil quality, in relation to the soil physical structure. Overall the VSA showed the soil quality was excellent.

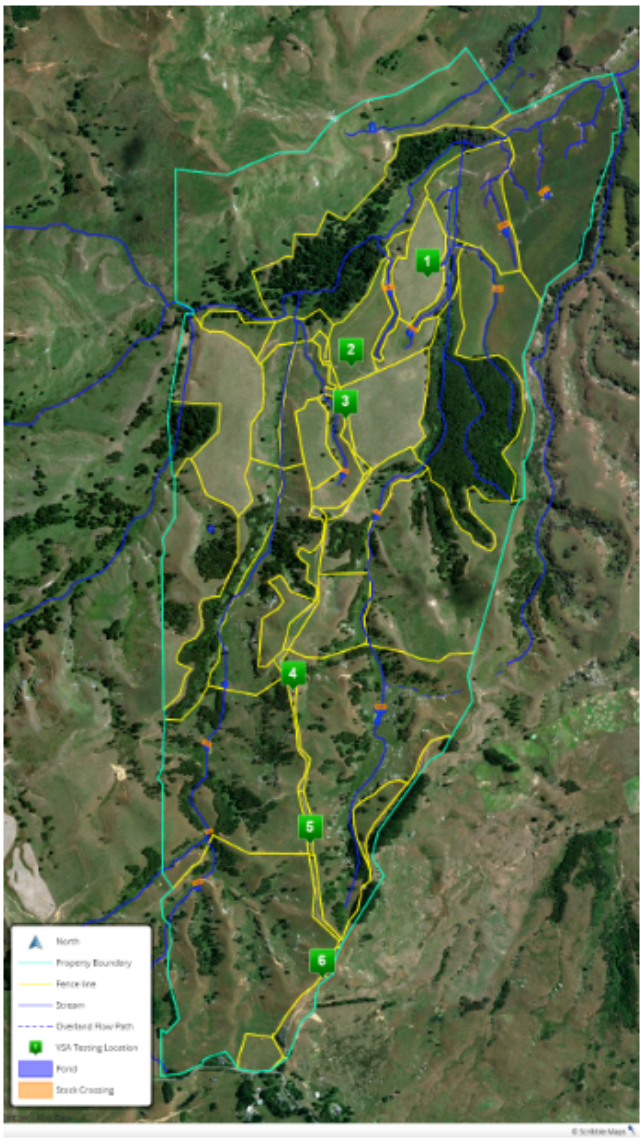


Figure 12: VSA testing locations on the 22 July 2019

10.3 Nitrogen Loss Risk Assessment

Risk Level		Likelihood Level			
		Very Low	Low	Moderate	High
Impact Level	Low	Very Low	Low	Low	Moderate
	Moderate	Low	Low	Moderate	High
	High	Low	Moderate	High	**Serious**
	Serious	Moderate	High	**Serious**	**Serious**

Nitrogen has an effect on eutrophication and algal blooms, which reduces the overall health and wellbeing of the waterway. Nitrogen (N) can be lost via two methods; leaching and runoff.

Leaching occurs when dissolved nutrients move down the soil profile, with percolating water, to below the root zone. Overland flow or runoff occurs when the soil is at saturation so excess liquid pools on the surface and runs over the land. Both provide little soil contact time and drastically decreases the opportunity to attenuate nitrogen. Topography and infiltration rates influence the extent and rate of overland flow. Leaching is the primary method of N loss with N sources being urine and dung patches, FDE, and fertiliser.

Table 8: Likelihood Risk of N Loss from various sources.

N Loss Risk	**Very Low**	**Low**	**Moderate**	**High**
N fertiliser solubility	Non applied	Low	Moderate	High
N fertiliser rate (kg N/ha/yr)	<20	21 - 100	101 - 200	>201
Stocking Rate (SU/ha)	<3.5	3.6 – 10.5	10.6 – 25.0	>25.1
Crude Protein in supp. feed	<30%			>30%
Slope class N fertiliser is applied too	A & B	C	D	E
Soil type leaching vulnerability	Very Low	Low	Medium	High
Adequate FDE storage?	N/A			
N fertiliser applied during a drought or until sufficient regrowth has occurred after rain.	No		Yes	
N applications are tailored to	Yes		No	

high plant growth periods i.e. autumn and spring				
N fertiliser applied during high drainage months i.e. winter	No		Yes	
Applied to a low N leaching vulnerability soil?			Yes	No
N fertiliser is applied when the ground is saturated and/or when tile drains are running.	No		Yes	
N applications are applied in proportion to other nutrients, according to plant requirements	Yes		No	
Any point source discharges?	No	Yes: minor	Yes	Yes: major

The overall likelihood of N loss is high. This is primarily due to the stock included permanent streams, ponds and wetlands (refer to section 11.3.1 for further details). However, once these areas are mitigated, the likelihood risk will reduce to low provided N inputs do not drastically change. Overland flow paths do occur on this property, which increases the likelihood of N loss from these paths during an overland flow event. Overall the farm has a low nitrogen leaching value of 15 kg N/ha/yr, based on Overseer v.6.3.1 from the 2018/2019 season.

Additionally, Landcare Research estimates the properties nitrate leaching based on Overseer and the average leaching rate per stock unit in 2015. This was then combined with the lands potential carrying capacity, based on soil type and climate to estimate the average nitrate leaching, which is shown in Figure 13 below. Based on this, the potential for nitrate leaching is very low to low. However, the Overseer number provides a tailored number to estimate nitrogen leaching.

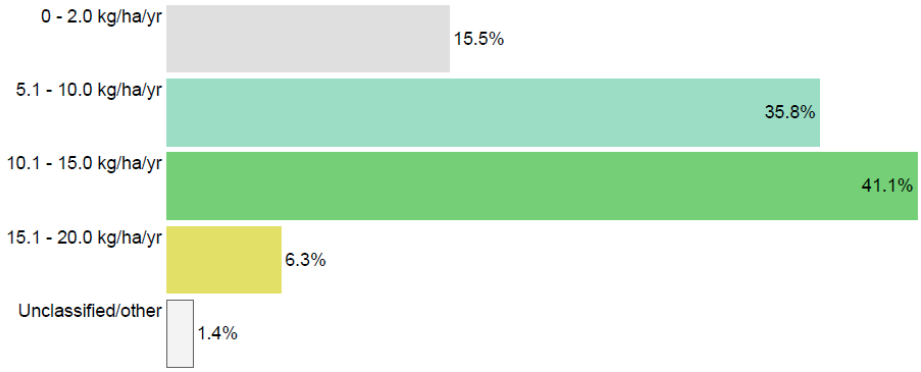


Figure 13: Potential nitrate leaching in 2015 (Landcare Research, 2018).

Scale:		5.1 - 10.0 kg/ha/yr		20.1 - 30.0 kg/ha/yr
	0 - 2.0 kg/ha/yr		10.1 - 15.0 kg/ha/yr		30.1 - 40.0 kg/ha/yr
	2.1 - 5.0 kg/ha/yr		15.1 - 20.0 kg/ha/yr		>40.0 kg/ha/yr

Lastly, N loss from fertiliser is low as N fertiliser is only applied once a year in autumn to 55 ha of flat to undulating topography. The fertiliser is a custom blend, with the source of N in the Sulphate of Ammonium, which is a slow release form of N, which reduces the risk of runoff and leaching.

The impact level for N is low as N fertilisers are applied during autumn, low crude protein supplements are fed, and the stocking rate is low. Overall the risk level of N loss to surface water is moderate.

10.4 *E. coli* Loss Risk Assessment

Risk Level		Likelihood Level			
		Very Low	Low	Moderate	High
Impact Level	Low	Very Low	Low	Low	Moderate
	Moderate	Low	Low	Moderate	High
	High	Low	Moderate	High	**Serious**
	Serious	Moderate	High	**Serious**	**Serious**

E. coli is a microbial pathogen that comes from faeces of any organism and reduces the quality of surface water because it can cause illness when ingested. Guidelines require *E. coli* levels to stay below 540 cfu/100 mL to ensure the water is safe.

E. coli can be lost from two sources, dung patches and FDE applications, via two methods, runoff and leaching. Runoff occurs when the soil is at saturation and liquid pools on the

surface generating the potential for the liquid, and anything on the surface of the land, to run off into a nearby waterway.

Table 9: Likelihood Risk of *E. coli* Loss from various sources.

***E. coli* Loss Risk**	**Very Low**	**Low**	**Moderate**	**High**
Slope Classes on property	A & B	C	D & E	F
Relative % of area	48.6	32.2	16.4	2.8
Stocking Rate (SU/ha)	<3.5	3.6 – 10.5	10.6 – 25.0	>25.1
Any point source discharges?	No	Yes: minor	Yes	Yes: major

The likelihood of E. coli reaching a waterway is high. There are multiple waterways running through this property in multiple locations, with the mainstream discharging into the Taringapeka Stream and eventually into Lake Whangape. All of the permanent waterways are not currently fenced to exclude stock, meaning there is a high likelihood of direct contamination. However, once these areas are mitigated, the likelihood risk would reduce to low. This is because E. coli is only able to contaminate the waterways due to runoff from dung patches. This risk of this occurring would be low due to the low stocking rate.

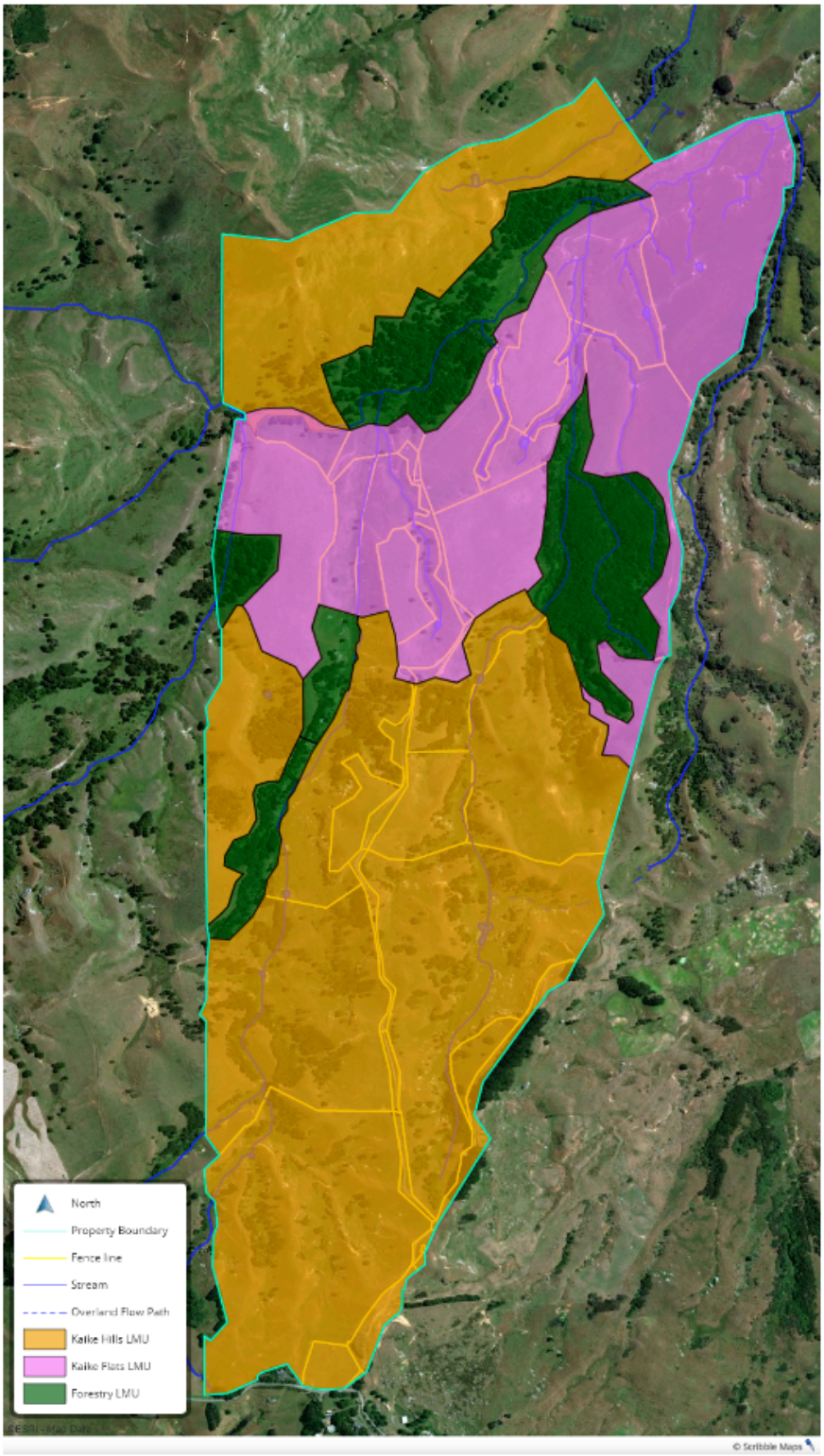
The impact level of *E. coli* on surface water is moderate. This is because when cattle are involved there is a chance of an event causing *E. coli* levels to go above 540 cfu/100 mL. Also, *E. coli* contamination can cause illness for humans and stock.

E. coli typically enters surface water via runoff rather than leaching. This is because leaching *E. coli* into a waterway typically takes time, and by this stage, the bacteria have usually died. Therefore, typically the likelihood and impact level are very low.

Overall, the risk of *E. coli* loss from this farm is high.

11.0 Land Management Units

11.1 Land Management Units Map

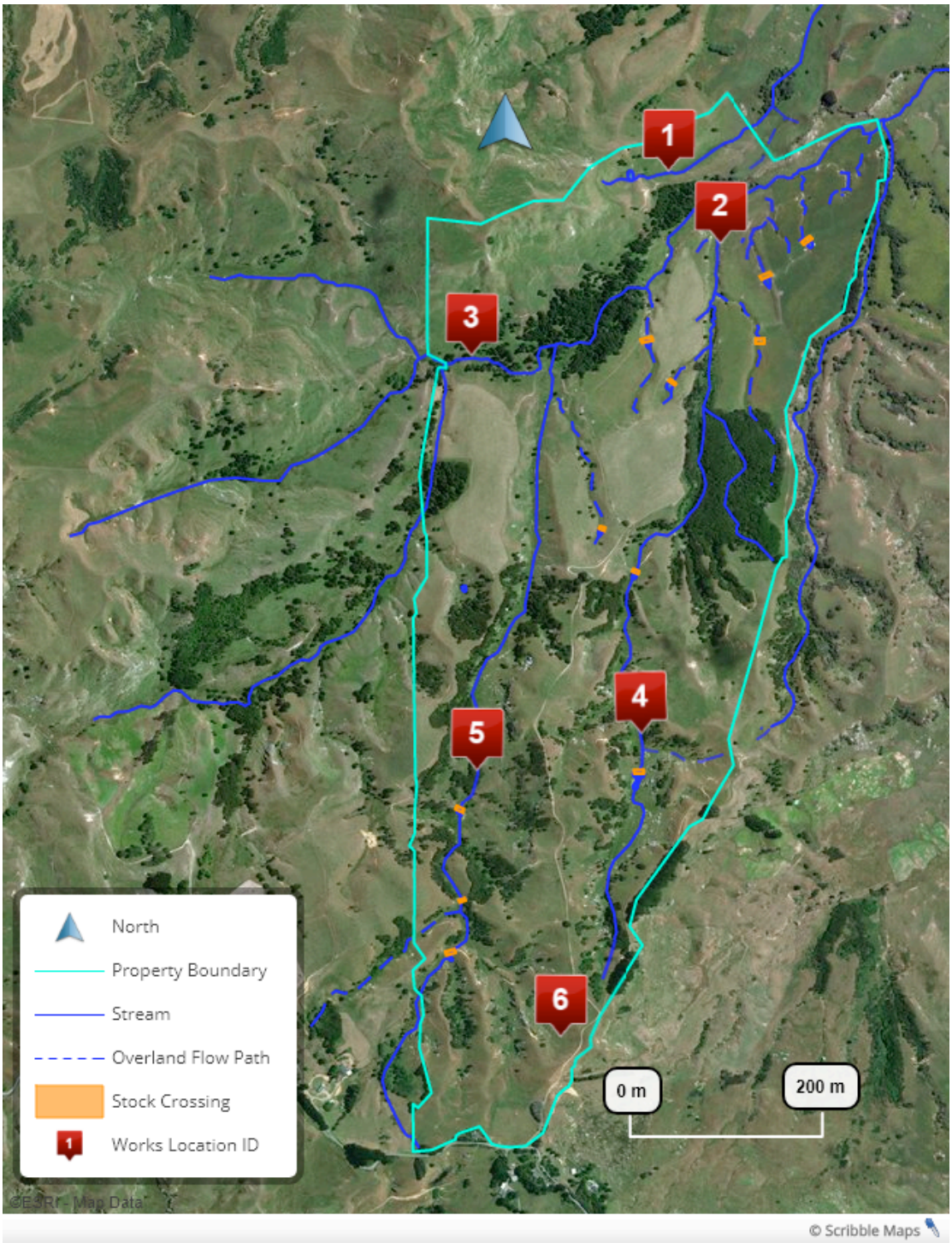


11.1.1 Strengths and Weaknesses

LMU	Area (ha)	Description	Strengths	Weaknesses
Kaike Flats	59.5	Primarily used for finishing and hay production. Flat topography with good soil. Good subdivision – high production area.	• Dominantly free draining • Good soil structure • Well-aerated soil • Deep topsoil • Soil is resistant to pugging • Flat land • Naturally sheltered in most areas • Stable (no erosion) • Low nutrient leaching risk • Good quality pasture – good mixed sward • Low in weeds • Good stock access to water • Crossings over waterways to prevent stock walking through	• Waterways can restrict drainage during a high rainfall event • Prone to flooding in areas around the streams • Wetland and permanent stream not stock excluded • Overland flow paths • Less than optimum soil fertility • Base saturation is not within optimum levels
Kaike Hills	118.8	Primarily used to graze beef cattle. Rolling to steep topography with good soil. Appropriate subdivision.	• Free draining • Good soil structure • Well-aerated soil • Dominantly deep topsoil • Rolling land is resistant to pugging and ideal during the winter when lightly stocked. • Stable (no signs of erosion) • Low nutrient leaching risk • Good stock access to water • Crossings over waterways to prevent stock walking through	• Overland flow paths • High runoff risk • Exposed limestone outcrops • Shallow topsoil in some areas • Less than optimum soil fertility • Base saturation is not within optimum levels • Low quality pasture • Wetland and permanent stream not stock excluded • Prone to flooding in areas around the streams
Forestry	29.2	Mixed native plants.	• Three QEII Covenanted bush blocks	• Moderately steep land

			• Free draining • Stable (no erosion) • Covered with mature exotic and native trees • Creates great shelter for animals in the surrounding paddocks • Several streams run through these areas	• High runoff risk • Prone to flooding in areas around the streams • Bush blocks are not fully fenced to exclude stock

11.2 Works Programme Map



11.3 Works Programme

11.3.1 Permanent Streams, Ponds and Wetlands

Risk Description: Permanent stream, pond and wetland stock exclusion		
L	M	H
Nitrogen	Phosphate	
Sediment	Bacteria	
Location ID from Map: 1, 2, 3, 4 & 5		
Mitigation Action: - Install a 5-wire fence, where 1 and 3 are hot to exclude stock. Ensure setback is at least 1 m back from the edge of the stream, pond and wetland banks. - Plant natives in the proposed fenced area of the waterways. - Implement weed control to enhance the growth of natives. - Implement pest control.		
Mitigation Explanation: The wetlands were originally converted into ponds for stock watering purposes, however, water troughs have since been installed in all paddocks meaning the ponds are no longer required and can revert back into their former wetland state. Fencing off all permanent streams, ponds and wetlands means nitrogen, phosphate and bacteria cannot be excreted directly into the surface water. Also, fencing prevents bank erosion and pugging, therefore sediment loss. Planting will help to reinstate the former wetlands, increase biodiversity and help reduce the amount of nitrogen, phosphate, sediment and microbial pathogens entering the freshwater way, by filtering runoff and absorbing nutrients from leaching. Pests have a large influence over native flora and fauna species populations. Possums, rats and mustelids can have a large impact on native bird species and numbers as they prey on the young. Whereas, possums and rats will eat the new seedlings and fruit, which greatly affects the survival and natural regeneration of flora species. Therefore it is vital to reduce the pest numbers in order to be able to increase the population of native fauna and flora species in the area.		
Time Frame for Completion or Ongoing: - Fencing – 1 March 2025 - Planting – When funding becomes available - Weed & Pest Control – Once area is planted		

11.3.2 Bush Blocks

Risk Description: Bush block stock exclusion		
L	M	H

Nitrogen	Phosphate
Sediment	Bacteria
Location ID from Map: Forestry LMU	
Mitigation Action: ☜ Install a 5-wire fence, where 1 and 3 are hot to exclude stock. ☜ Maintain weed control. ☜ Implement pest control.	
Mitigation Explanation: Fencing off the bush blocks to exclude stock prevents surface erosion and vegetation damage, therefore sediment and P loss. Plants increase biodiversity by providing shade and habitat, and help protect the soil from erosion. Trees create a canopy that reduces the amount of water hitting the ground, therefore there is less runoff. Additionally, their roots helping to bind the soil and hold it in position, and absorb a large amount of water and nutrients, reducing a lot of excess. Pest control is important as they have a large influence over native flora and fauna species population survival. Possums, rats and mustelids can have a large impact on native bird species and numbers as they prey on the young. Whereas, possums and rats will eat the new seedlings and fruit, which greatly affects the survival and natural regeneration of flora species. Therefore it is vital to reduce the pest numbers in order to be able to increase the population of native fauna and flora species in the area.	
Time Frame for Completion or Ongoing: ☜ Fencing – 1 March 2025 ☜ Weed & Pest Control – Once area is fenced	

11.3.3 LUC 8 – Moderate Soil Erosion Risk

Description: Poor pasture quality and very steep topography – requires retirement		
L	M	H
Nitrogen	Phosphate	
Sediment	Bacteria	
Location ID from Map: 6		
Mitigation Action: ☜ Continue investigating viable options for appropriate land use change.		
Mitigation Explanation: Steeper slopes are more likely to cause erosion, and the heavier the animal the higher		

the risk increases. Excluding stock and changing the land use is essential for reducing the risk of slips and soil erosion in this area. The best possible land use for these areas to both reduce soil erosion and increase productivity is currently being investigated.
Time Frame for Completion or Ongoing: ☜ Decision and implemented by 2024

11.3.4 Soil Pugging

Risk Description: Soil pugging		
L	M	H
Nitrogen	Phosphate	
Sediment	Bacteria	
Location ID from Map: Flat LMU and around streams		
Mitigation Action: ☜ Keep this stocking rate at a similar level to avoid more stock on the soil over winter. ☜ Farm Policy = Over winter, graze stock on the hills and avoid any break feeding on the flats.		
Mitigation Explanation: Pugging causes damage to the soil structure, which can cause compaction. This decreases the soils infiltration rate, which can increase the runoff potential, therefore, increasing the risk of contaminant loss. Pugging also increases the risk of sediment and phosphate loss because vegetation cover is removed so the soil is exposed to the elements. Installing metal in the highly trafficked areas such as gateways and raceways will greatly the reduce risk of pugging and compaction damage in these areas.		
Time Frame for Completion or Ongoing: ☜ Ongoing		

11.3.5 Flood Risk

Risk Description: Flooding during high rainfall periods		
L	M	H
Nitrogen	Phosphate	
Sediment	Bacteria	
Location ID from Map: Around streams		

Mitigation Actions: • Farm policy – do not allow stock on this area while flooded, or when flooding is possible based on past knowledge and predicted weather forecast. • Avoid applying fertiliser before a large rainfall event.
Mitigation Explanation: The flood plain has a high risk of nitrogen, phosphate, sediment and *E. coli* loss when a flood occurs. Therefore, the farm policy of excluding stock from this area at appropriate times will eliminate any additional contaminants directly entering the floodwater, predominately from dung patches. Also, avoiding the flood plain when completely saturated eliminates the risk of soil damage/pugging. The characteristics associated with the orthic brown soil type, and the rolling topography within the surrounding area of the stream, have a low risk of flooding, however, due to the nature of streams during high rainfall events, the overall risk of flooding is moderate.
Time Frame for Completion or Ongoing: • Ongoing

11.3.6 Overland Flow Path

Risk Description: Overland flow paths present		
L	M	H
Nitrogen	Phosphate	
Sediment	Bacteria	
Location ID from Map:		
Explanation: The overland flow paths are not permanent therefore fencing is not required. However, the overland flow paths do have a high risk of nitrogen, phosphate, sediment and *E. coli* loss during a high rainfall event. Avoid stocking these areas during high rainfalls periods if practical.		
Time Frame for Completion or Ongoing: • Ongoing		

12.0 Nutrient Management

12.1 Nitrogen Management

	kg N/ha/yr
What is the 75th percentile of nitrogen leaching for the FMU?	Unknown
Nitrogen Reference Point (14/15 year)	12
Current Nitrogen Leaching	15

13.0 Monitoring Report

	Indicator	Location	Baseline Year (2019)	2020	Comments
Soil Health	Soil Quality (VS Score)	1	25 - Excellent		
		2	25 - Excellent		
		3	25 - Excellent		
		4	22 - Good		
		5	28 - Excellent		
		6	25 - Excellent		

	Soil Fertility	Total Base Saturation (%)	Ca %	Mg %	K %	Na %	pH	P (kg/ha)	Sulphate Sulphur (mg/kg)
	OPTIMUM	Ca + Mg = 80%	68%	12%	2-5	0.5-3	6.0-6.3	560	6-8
	Kaikatia	61.65	50	11.5	3.3	1.3	5.6	253	40
	NO1/Bush	61.9	51.4	10.5	4.2	1.3	5.6	195	36
	Lucerne	62.4	50.1	12.3	3.5	1.5	5.6	220	39
	Small Hay	57.9	49.4	8.5	2.7	1.4	5.4	498	45
	Middle	62.1	46.9	15.2	6.1	1.4	5.7	133	37
	Pond Hay	60.8	49.2	11.6	4.1	1.0	5.6	252	52

Water Quality	Water Quality Testing – Hills Laboratory	Base – Jan 2019	TN	Nitrate-N + Nitrite-N	TKN	TP
		Boundary - in	0.55	0.006	0.55	0.057
		Boundary -out	0.36	<0.002	0.36	0.03
		Solar Spring	0.32	<0.002	0.32	0.029
		Hill Spring	2.7	1.06	1.66	0.25
	REM MCI Testing	2018	109 - Good			

14.0 Summary of Actions in Priority Order

Name	Location ID	Mitigation Description	Completion Date
Streams, Ponds and Wetlands	1, 2, 3, 4 & 5	Fence the permanent streams, ponds and wetland with a 5-wire fence, with a 1 m setback.	1 March 2025
		Plant area with natives if desired.	When funding becomes available
		Implement pest and weed control.	Once area is fenced
Bush blocks	Forestry LMU	Fence the bush blocks with a 8-wire fence with a 1 m setback.	1 March 2025
		Implement pest and weed control as close to planting as possible.	Once area is planted
Retire steep area	6	Investigate viable land uses for this area.	2024