Nutrient Budget Report

2020-2021 Year End

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Customer Number:	7095663
Date:	30th July 2021
Reviewed by:	Arron Hutton (CNMA)

Executive Summary

Peter Hancox has requested, using Overseer®FM v6.4.0 (4.0.0.1), a nutrient budget to represent the 2020-21-year end system undertaken on the Lincoln University Dairy Farm, located on Shands Road, Lincoln. This document is for the purpose of providing current nutrient loss values for year-end reporting for the client.

The farm holds land use consent CRC180605 to use land for a farming activity. The consented area of CRC180605 is 168ha. The property is located within the Selwyn Te Waihora (Plan change 1) Nutrient Allocation Zone. As such, the property will be required to meet the relevant rules from PC1 in line with Canterbury's Land and Water Regional Plan (LWRP).

The farm held CRC916834 and CRC010786 to use groundwater for irrigation purposes. The farm held CRC143396 to discharge effluent to land. There was also a ClearTech system installed, which was in full operation for its first season in the 2020-21 period.

The month end date used for the year end 2020-21 nutrient budget was June, which was the end month used in the baseline files. Therefore, a period of 1st July 2020 to 30th June 2021 was captured. The N loss from the root zone and P loss to second order streams for the year-end 2020-21 period are outlined below.

Table 1 - Modelling Results

	2020/21
System Type	Irrigated dairy
Area (ha)	168.2
Nitrogen leaching loss to water (total kg N)	4,365
Nitrogen leaching loss to water (kg N/ha)	26
Phosphorus runoff to water (total kg P)	227
Phosphorus runoff to water (kg P/ha)	1.4

Contents

Abbreviations

General

Non eff	no liquid effluent applied
LWT	liveweight
Pet	Potential Evapotranspiration

Overseer®FM Blocking Names Protocol

Farm block_irrigation_soil sibling

Soils

See There are seven soil types present on the property as shown in the table below. The sibling name for the soil types are used throughout this report when referring to different blocks. Each block name contains the soil type of such block.
Table 3 for Soils Information

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N. Wheadon

Nicole Wheadon
Senior Farm Environmental Consultant
Dated: 30th July 2021

Introduction

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Overseer®FM modelling of the 2020-21 system has been undertaken in accordance with the Overseer® v6.4.0 (4.0.0.1) "user guide" and has been reviewed by a certified nutrient management advisor. The following report summarises the respective Overseer®FM v6.4.0 (4.0.0.1) nutrient budget and key assumptions made.

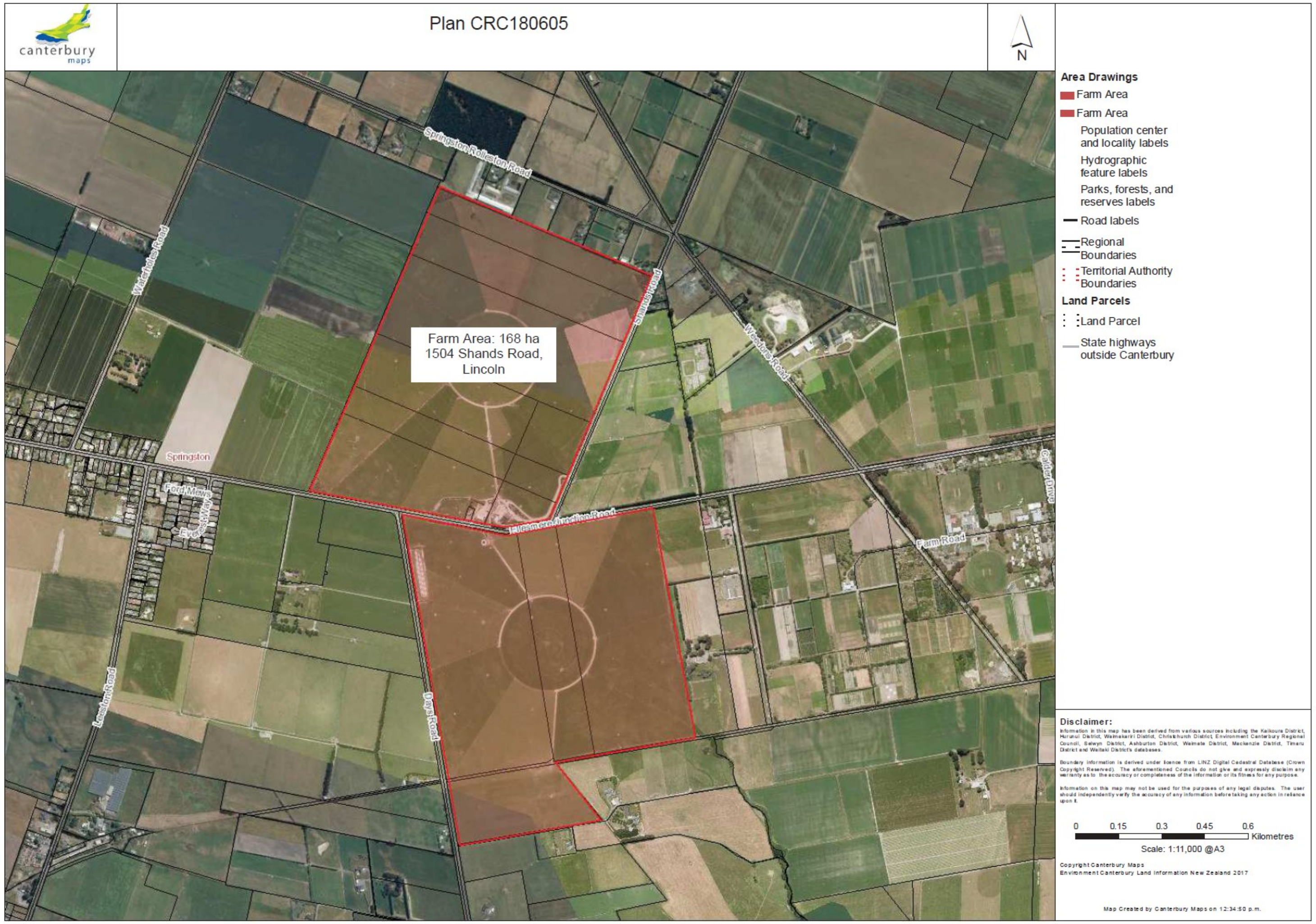
Property Details

Table 2 - Property Information

Property	Details
Location address	1504 Shands Road, Lincoln 7647
Legal description	RS6028; RS4565; RD4426; Part RS3684; Part RS3031; Part RS2803; Part RS2719; RS2775; RD2718; Part RS6377
Owned area (ha)	168.2
Effective area (ha)	164.8
Total farmed area (ha)	168.2
Topography	Flat
Rainfall (mm/yr)	609
Temperature (°C)	12.1
PET (mm/yr)	923
Latitude/Longitude	-43.6444; 172.4433
Distance from coast	30km

Climate information is from the climate data tool in Overseer.

Farm Map



Plan CRC180605
canterbury maps
N
Farm Area: 168 ha
1504 Shands Road,
Lincoln
Springston Rolleston Road
Shands Road
Days Road
Farm Road
Springston
Area Drawings
Farm Area
Farm Area
Population center and locality labels
Hydrographic feature labels
Parks, forests, and reserves labels
Road labels
Regional Boundaries
Territorial Authority Boundaries
Land Parcels
Land Parcel
State highways outside Canterbury
Disclaimer:
0 0.15 0.3 0.45 0.6 Kilometres
Scale: 1:11,000 @A3

Farm System Analysis

2020-21 Year End Farm System

During the 2020-21 period the farm operated as an irrigated dairy farm. The total area is 168.2ha and effective area is 164.8ha. The 3.4ha non effective area comprised of the milking shed, yard and office areas. The farm had new fixed grid areas installed for the 2020-21 period, resulting in the farm being irrigated by a mixture of pivots, K-lines and fixed grid sprinklers.

Soils

There are seven soil types present on the property as shown in the table below. The sibling name for the soil types are used throughout this report when referring to different blocks. Each block name contains the soil type of such block.

Table 3 - Soils

Sibling Name	Eff Area (ha)	Soil Order	Texture	Drainage	PAW 0-100cm	PAW 0-60cm	PAW 0-30cm
Flax_4a.1	39	Pallic	Loam over sandy loam	Well drained	171	104	62
Waka_3a.1	32.8	Gley	Silty loam over clay	Poorly drained	169	102	58
Waka_1a.1	31.4	Pallic	Silty loam	Moderately well drained	153	96	55
Temp_1a.1	26.6	Pallic	Silty loam	Moderately well drained	157	101	56
Temp_2a.1	11.4	Pallic	Silty loam	Moderately well drained	141	107	60
Barr_5a.1	10	Pallic	Silty loam	Imperfectly drained	147	99	57
Temp_4a.1	9.2	Pallic	Silty loam	Imperfectly drained	154	105	58
Total effective	**164.8**						

Information sourced from S-maps

Soil Fertility

Soil test values from Ravensdown records were averaged across the 20-21 period and entered as shown in the table below:

Table 4 - Soil Fertility

Block	Olsen P	K	Ca	Mg	Na	Org-S
Effluent	44	21	11	35	12	7
Non effluent north block	35	11	11	27	12	7
Non effluent south block	44	11	12	37	15	10

Stock System Information

Dairy

Table 5 - Dairy Herd

Herd		2020-21 Year End Farm System			
Cows	Breed	F x J			
	Mean calving date	12th August 2020			
	Dry-Off date	27th May 2021			
	Peak cows (1 December)	549			
	Average live weight	521			
	Cow Numbers	**Month**	**# Milking Cows***		**In shed feeding (Y/N)**
		July 2019	60		N
		Aug 2019	450		N
		Sept 2019	558		N
		Oct 2019	555		N
		Nov 2019	554		N
		Dec 2019	549		N
		Jan 2020	548		N
		Feb 2020	548		N
		Mar 2020	546		N
		Apr 2020	471		N
		May 2020	432		N
		Jun 2020	-		N
Dairy Information	Production kg/MS	280,381			
	Lactation length	288			
	Once a day milking	35 from 20th Feb, 15 from March 25th – modelled as never			
	Calves fed milk powder	No			
Replacements	Rate %	27.5%			
	On/off farm when	All replacements remain off farm until they join the milking herd.			

Note: numbers reported are what are on farm as at month end. Movements within the month are reported in Overseer®FM.

*Cow movements were as followed:

CLASS	BREED	EVENT TYPE	DATE	NUMBER OF ANIMALS
Milking herd	F x J cross	Purchase/Bring on	14 July	16
Milking herd	F x J cross	Purchase/Bring on	21 July	44
Milking herd	F x J cross	Purchase/Bring on	04 August	182
Milking herd	F x J cross	Purchase/Bring on	11 August	97
Milking herd	F x J cross	Purchase/Bring on	18 August	73
Milking herd	F x J cross	Purchase/Bring on	25 August	38
Milking herd	F x J cross	Purchase/Bring on	08 September	66
Milking herd	F x J cross	Purchase/Bring on	15 September	19
Milking herd	F x J cross	Sale/Take off	15 September	1
Milking herd	F x J cross	Purchase/Bring on	22 September	24
Milking herd	F x J cross	Sale/Take off	01 October	3
Milking herd	F x J cross	Sale/Take off	01 November	1
Milking herd	F x J cross	Sale/Take off	01 December	5
Milking herd	F x J cross	Sale/Take off	01 January	1
Milking herd	F x J cross	Sale/Take off	01 March	2
Milking herd	F x J cross	Sale/Take off	01 April	75
Milking herd	F x J cross	Sale/Take off	01 May	39
Milking herd	F x J cross	Sale/Take off	27 May	432

There were no bulls on farm during the season.

Pasture Fertiliser

Fertiliser applications for Superphosphate/Sulphur Super 15 and Ammo 31 were modelled based on Hawkeye spreading records. Urea and N-protect applications were provided by the farm manager.

Points to note:

1. Fertiliser applications have been pro-rated across blocks and therefore application rates may appear slightly lower than what was actually applied.
2. Fertiliser purchase records are for 'Lincoln University – Dairy Farm'
3. Fertiliser programs were different for the effluent and non-effluent area as tabulated below.

Pasture Fertiliser

Table 6 - Fertiliser

Month	Non - Effluent Area					
	Product	Kg/ha	N	P	K	S
			Kg N/ha	Kg P/ha	Kg K/ha	Kg S/ha
Aug 20	Ammo31	8	2	0	0	1
Sept 20	Ammo31	80	24	0	0	11
Sept 20	Sulphur super 15/Superphosphate	-	0	47	0	63
Oct 20	Urea	28	13	0	0	0
Nov 20	Urea	31	14	0	0	0
Nov 20	N-protect	30	14	0	0	0
Dec 20	N-protect	43	20	0	0	0
Jan 21	N-protect	21	10	0	0	0
Feb 21	N-protect	52	24	0	0	0
Mar 21	N-protect	58	27	0	0	0
Apr 21	N-protect	26	12	0	0	0
Total			**160**	**47**	**0**	**75**

Month	Effluent Area					
	Product	Kg/ha	N	P	K	S
			Kg N/ha	Kg P/ha	Kg K/ha	Kg S/ha
Aug 20	Ammo31	12	4	0	0	2
Sept 20	Ammo31	80	24	0	0	11
Sept 20	Sulphur super 15/Superphosphate	-	0	39	0	59
Total			**28**	**39**	**0**	**72**

Pasture Species and Production

Pasture was modelled as ryegrass/white clover mix. There was approximately 5% on average of plantain mixed through the paddocks. In the 2021-22 season the farm is planning to incorporate strips of plantain in each paddock accounting for approximately 30% of each paddock. Due to a low around of plantain currently in the pasture mix, pasture was modelled as ryegrass/white clover as per Overseer BPIS advice.

Pasture across the farm was modelled with the same relative productivity due to the efficient irrigation management across the farm and also adjustment of the fertiliser program for the effluent area to accommodate nutrients supplied through effluent.

Table 7 - Pasture

Block Name	Relative Productivity	Overseer®FM assumed Utilisation %	Overseer®FM Estimated Pasture Production TDM/ha/yr
Irrigated pasture effluent	1	85	22.6
Irrigated pasture non effluent	1	85	22.6

Irrigation Systems and Management

The farm held CRC916834 and CRC010786 to take and use groundwater. Part of the conditions in the consent outline;

CRC916834: The rate at which water is abstracted from bore M36/0604, 250mm diameter and 36 metres deep, shall not exceed 30 litres per second, with a maximum volume not exceeding 18140 cubic metres per week.

CRC010786: The rate at which water is taken from bore M36/3067, 305 millimetres diameter and 93.0 metres deep, at or about map reference NZMS 260 M36:659-288, shall not exceed 98 litres per second.

Irrigation changes from the 19/20 season include installation of a fixed grid area on the north block, replacing an area of sprinklers. Irrigation was therefore applied over the following areas:

- Fixed grid – 8.4ha
- K-line – 9.9ha
- North pivot – 53.8ha
- South pivot – 48.8ha
- Pivot 2 & 3 (north block) – 17.4ha
- Spray lines – 22.1ha

Three soil moisture probes are used for the property. Irrigation strategy has been modelled as Trigger point, fixed depth applied, using a trigger deficit for the different irrigation types as outlined below. Water usage data for the 2020-21 season was 511,123m^3 for the South block, and 367,000m^3 for the North block, totalling 878,123m^3. Overseer estimated water usage at 749,833m^3.

Table 8 - Irrigation

Irrigation type		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Overseer Estimated annual Volume applied (mm/yr)
North pivot	Depth mm/pass	5	6	6	6	6	6	6	5	465-471
	Return (days)	1	1	1	1	1	1	1	1	
	Trigger (mm deficit)	20	20	20	20	20	20	20	20	
Pivot 2 & 3	Depth mm/pass	5	5	5	5	5	5	5	5	530
	Return (days)	1	1	1	1	1	1	1	1	
	Trigger (mm deficit)	10	10	10	10	10	10	10	10	
South pivot	Depth mm/pass	6	6	6	6	6	6	6	6	450-456
	Return (days)	1	1	1	1	1	1	1	1	
	Trigger (mm deficit)	25	25	25	25	25	25	25	25	
Fixed grid	Depth mm/pass	10	10	10	10	10	10	10	10	480
	Return (days)	2	2	2	2	2	2	2	2	
	Trigger (mm deficit)	20	20	20	20	20	20	20	20	
Spray lines	Depth mm/pass	35	35	35	35	35	35	35		455
	Return (days)	8	8	8	8	8	8	8		
	Trigger (mm deficit)	40	40	40	40	40	40	40		
K-Line	Depth mm/pass	20	20	20	20	20	20	20		440
	Return (days)	4	4	4	4	4	4	4		
	Trigger (mm deficit)	30	30	30	30	30	30	30		

Effluent

The farm held CRC143396 to discharge effluent to land. The effluent system consisted of a sump and saucer, into a ClearTech® system which was in its first season of full use during the 20/21 period. Treated effluent was applied via the inner ring of the North pivot (see map), at a depth of 8-9mm. This area covered approximately 32.8ha. Approximately every two months a slurry tanker took the pond solids from the farm to the east block run off.

The liquid effluent entered the ClearTech® system and was treated with coagulant. This removed approximately two thirds of the liquid as clarified water which was then pumped to a water tank. The treated effluent was then applied or stored as required. In order to represent this in Overseer, all FDE was modelled as exported. The ClearTech® treated FDE portion was then re imported by first calculating the estimated FDE generated from the milking shed per cow per day (estimated using 70L/cow) and calculating this over the milking season 1st August to 31st May. To mimic the action of the coagulant, this total volume was reduced by two thirds to represent one third remaining as 'treated FDE' and two thirds remaining as clarified water. The clarified water portion was not modelled as this was assumed to be recycled. The nutrient concentrations of the treated FDE used were taken from previous research on ClearTech® (Cameron and Di, 2019); Total-N content averaged 447g m^{-3}, Total-P was 111.8g m^{-3}, potassium (K) was 195g m^{-3} and Sulphur (S) was 320.97g m^{-3}. Other nutrients were not used due to the focus of the modelling on NPKS.

The concentration of nutrients were calculated for the treated FDE volume (volume FDE produced/month x concentration of nutrient (g/kg)). The total NPKS (kg/month) for the treated FDE produced from August to May was then averaged over the period of August to May and applied in the form of organic fertiliser. The type of organic material selected was imported dairy effluent, in a slurry/liquid form. The total kg/month applied over the effluent area from August to May for each nutrient NPKS is summarised below.

Table 9. NPKS applied (kg/month) over the effluent area from October to March.

Block	Area (ha)	N (kg/month)	P (kg/month)	K (kg/month)	S (kg/month)
EFFLUENT BLOCK PIVOT (BARR_5A.1)	6.6	31	8	14	22
EFFLUENT BLOCK PIVOT (TEMP_1A.1)	13.4	63	16	28	46
EFFLUENT BLOCK PIVOT (TEMP_2A.1)	2.6	12	3	5	9
EFFLUENT BLOCK PIVOT (TEMP_4A.1)	2.1	10	2	4	7
EFFLUENT BLOCK PIVOT (WAKA_3A.1)	8.1	38	10	17	28

Supplements

See maps for location of silage made.

Table 10 - Supplements Fed

Supplements	Source	Amount (TDM)	Destination	Months Fed
Grass silage	Imported	261.7	Dairy cows in paddock	Mid Aug-Mid Oct, Feb-End Apr
Grass silage	Made on farm – Paddock S5 & S6*	15.3tDM Nov 14.56tDM Jan	To storage for spring 21**	-
Grass silage	Made on farm – Paddocks N4 & N9*	14.56tDM Nov 10.4tDM Jan	To storage for spring 21**	-

*For the purposes of this nutrient budget, silage was made over the pivot non effluent south block and north block respectively and not on a paddock level

**modelled as exported

Cropping

No crops were grown on farm during the 20-21 season or 19-20 season

Existing Resource Consent Information

Table 11 - Resource Consents

Consent #	Activity	Commencement Date	Expiry Date
CRC143396	to discharge contaminants to land and air	03 Apr 2009	31 Mar 2044
CRC916834	to take groundwater, at or about map reference M36:648-288 for irrigation of up to 103 hectares	29 Sep 1993	31 Aug 2028
CRC010786	to take and use groundwater.	04 Dec 2000	31 Jan 2035
CRC180605	To use land for farming activity.	17 Oct 2017	17 Oct 2032

Summary of Nutrient Loss Indicators

Table 12 - Nutrient Loss Indicators

	Farm System 2020/21
System Type	Irrigated dairy
Area (ha)	168.2
Nitrogen leaching loss to water (Total kg N/yr)	4,365
Nitrogen leaching loss to water (kg N/ha/yr)	26
Phosphorus runoff to water (Total kg P/yr)	227
Phosphorus runoff to water (kg P/ha/yr)	1.4

Discussion on Nutrient Loss Indicators

The key influences on Nitrogen loss are discussed below:

Soil type, drainage and Profile Available Water (PAW)

The soil type has a large impact on N leached. The Profile Available Water (PAW) values for the property ranged from 96 through to 107 at 0-60 cm (Waka_1a.1 and Temp_2a.1, respectively). The Profile Available Water is described as "the amount of water potentially available to plant growth that can be stored in the soil to specific soil depths". It therefore makes sense that the soils with the lowest PAW will have higher N leaching as there will be more drainage from these soils. Soils with lower PAW are less able to buffer against changes in nitrogen losses to the bottom of the root zone (from stocking rates, crop yields, irrigation volumes) as the soils typically have larger pores and are flushed frequently as compared to a soil with a higher PAW. There is a range of soils and drainage on farm from poorly drained to well drained.

Irrigation method and management

The irrigation method and volume applied can have an impact on N leaching, particularly when coupled with the soil type and PAW information for a block. Lowering the application depth per pass of irrigation types can reduce the risk of drainage events occurring and depending on the soil moisture deficit at irrigation events, provide more flexibility of the soil to store rainfall that may occur after irrigating. A reduction in drainage typically transfers to a reduction in modelled N loss assuming all other factors remain the same because water in drainage acts as a vector to move nitrogen down through the soil profile. The farm utilises several soil moisture monitoring probes on different soils, which increases the efficiency of water usage.

N use

The farms average fertiliser N use is 126kgN/ha/yr. Generally, the higher the nitrogen usage, the higher risk of N leaching. The effluent area fertiliser program is adjusted to accommodate the extra nutrients from effluent applied.

ClearTech

The use of ClearTech system on farm allows for the recycling of water use and therefore the reduction of effluent liquid volume to be applied, providing more flexibility in applying effluent in times of low risk.

Appendix List

References

Maps

- Paddock map
- Soil map
- LMU map
- Effluent map
- Supplements map

Overseer®FM Output

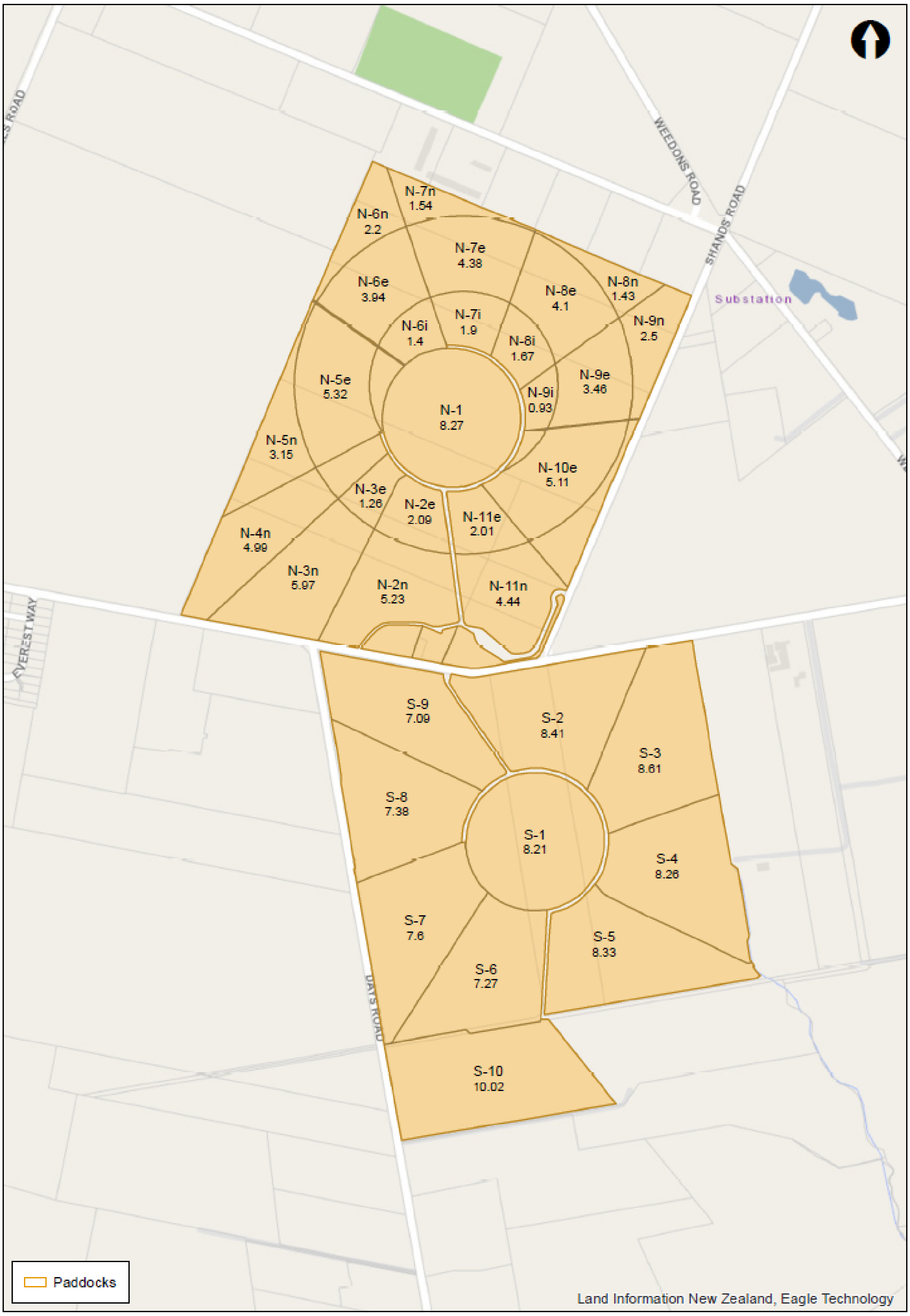
- Farm Details
- Farm Results
- Analysis Comments
- Blocks
- Farm Soils
- Enterprises
- Supplements
- Crops
- Fertiliser
- Irrigators
- Structures/Effluent System
- Nutrient Budgets
- Effluent Report

References

Cameron, Keith & J. Di, Hong. 2019. A new method to treat farm dairy effluent to produce clarified water for recycling and to reduce environmental risks from the land application of effluent. Journal of Soils and Sediments. 10.1007/s11368-018-02227-w.

Maps

Paddock map

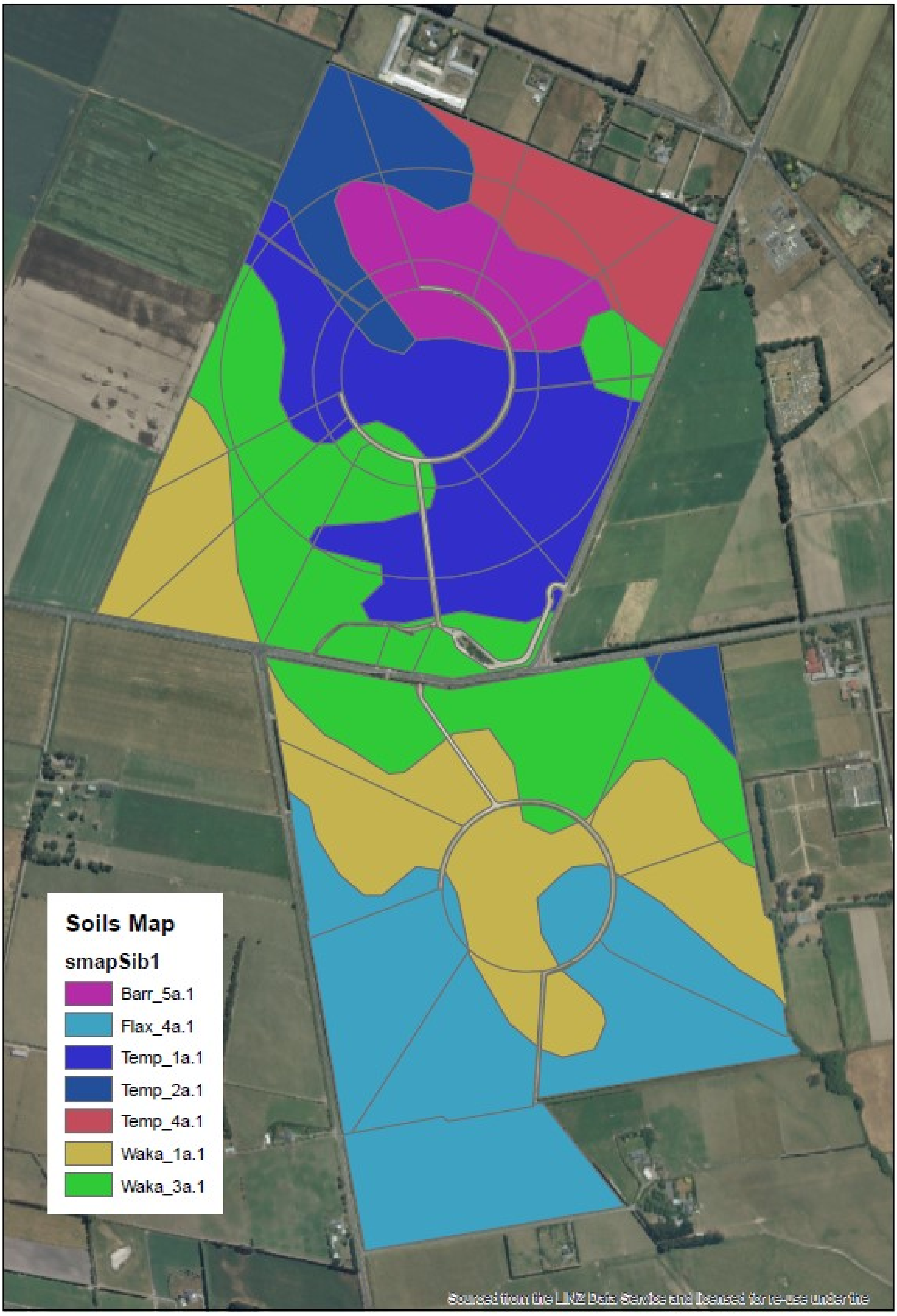


LINCOLN UNIVERSITY - DAIRY FARM - 7095663
Date printed: 22/07/2021
0800 73 73 73
www.hawkeye.farm

0 50 100 200 300 400
Metres

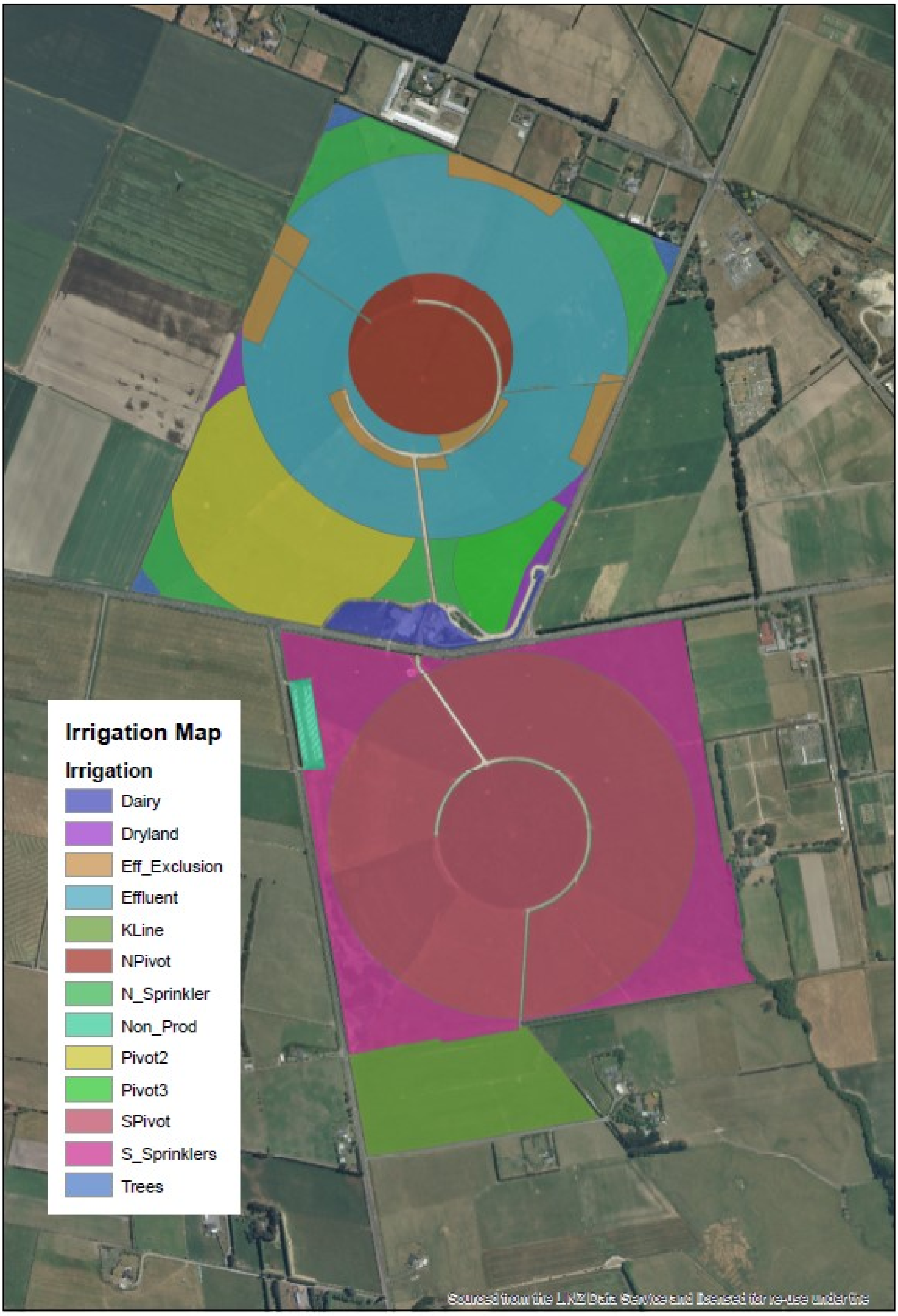
HawkEye.

Soil map



LMU map

Note the 'N_Sprinkler' area is now Fixed grid



Yellow shaded = effluent application area

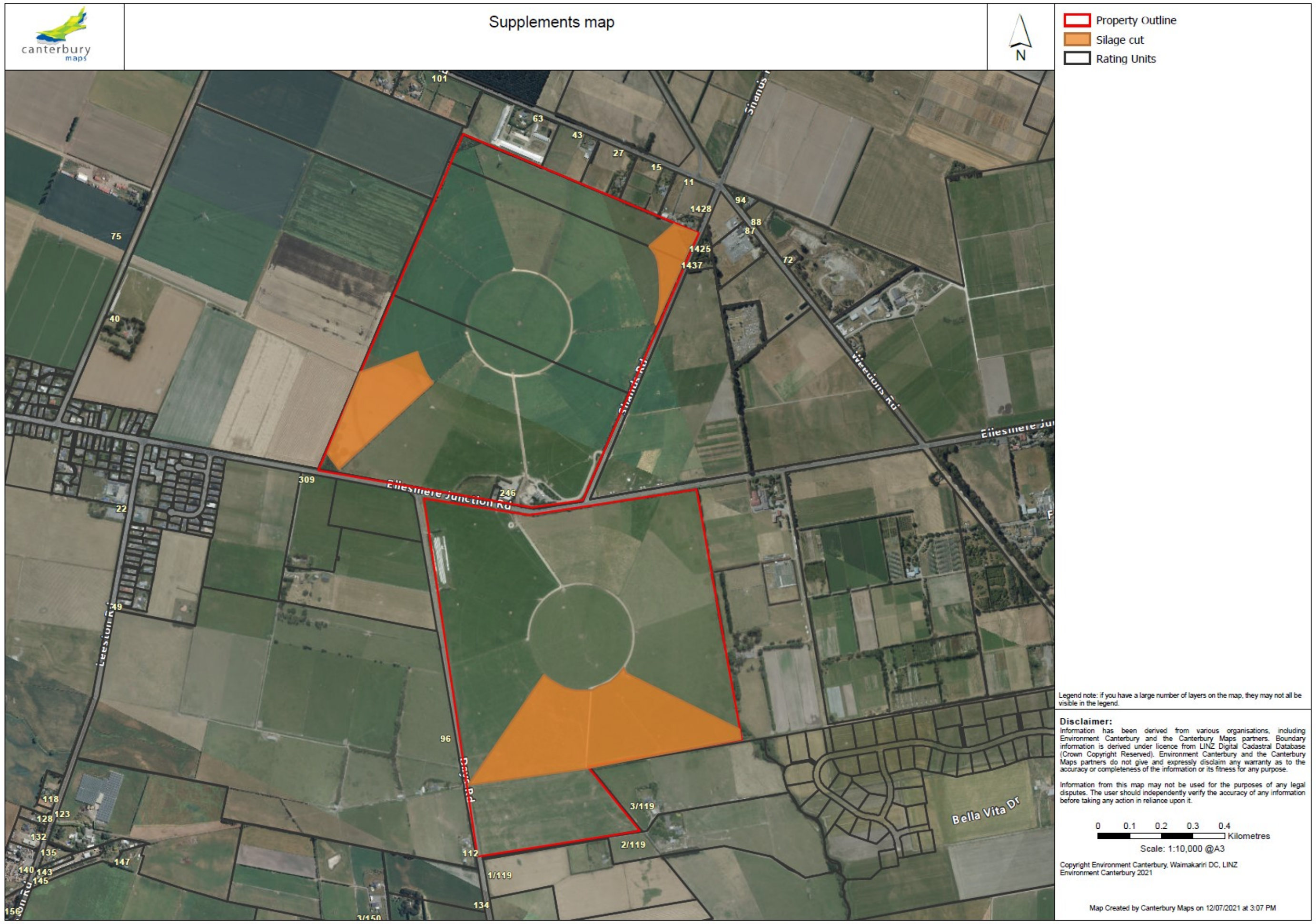
Effluent map

LINCOLN UNIVERSITY - DAIRY FARM - 7095663
Date printed: 12/07/2021
0800 73 73 73
www.hawkeye.farm

HawkEye.

Supplements map

Orange shaded = silage cut



Overseer® FM Output