Before an Independent Hearings Panel
Appointed by Waimakariri District Council

under:	the Resource Management Act 1991
in the matter of:	Submissions and further submissions on the Proposed Waimakariri District Plan
and:	Hearing Stream 12: Rezoning requests (larger scale)
and:	**Carter Group Property Limited** *(Submitter 237)*
and:	**Rolleston Industrial Developments Limited** *(Submitter 160)*

Statement of evidence of Victor Mkurutsi Mthamo (Soils) on behalf of Carter Group Limited and Rolleston Industrial Developments Limited

Dated: 5 March 2024

Reference: J M Appleyard (jo.appleyard@chapmantripp.com)
LMN Forrester (lucy.forrester@chapmantripp.com)

chapmantripp.com
T +64 3 353 4130
F +64 4 472 7111

PO Box 2510
Christchurch 8140
New Zealand

Auckland
Wellington
Christchurch

chapman tripp

STATEMENT OF EVIDENCE OF VICTOR MKURUTSI MTHAMO ON BEHALF OF CARTER GROUP LIMITED AND ROLLESTON INDUSTRIAL DEVELOPMENTS LIMITED

INTRODUCTION

1 My full name is Victor Mkurutsi Mthamo.

2 My full name is Victor Mkurutsi Mthamo and I am a Principal Consultant for the environmental science, engineering and project management consultancy Reeftide Environmental and Projects Limited (Reeftide). I have been in this role for almost 12 years. Prior to this I was a Senior Associate with the surveying, environmental science and engineering, and resource management consulting firm CPG New Zealand Limited (now rebranded to Calibre Consulting Limited), where I was also the South Island Environmental Sciences Manager. I have worked in the area of environmental science and engineering for over 29 years.

3 I have the following qualifications:

3.1 Bachelor of Agricultural Engineering (Honours) with a major in Soil Science and Water Resources (University of Zimbabwe); Master of Engineering Science in Water Resources (University of Melbourne in Victoria, Australia); Master of Business Administration (University of Zimbabwe). I hold an Advanced Certificate in Overseer Nutrient Management modelling qualification. I am a member of Engineering New Zealand (MEngNZ) and am a Chartered Professional Engineer (CPEng) and an International Professional Engineer (IntPE). I am a past National Technical Committee Member of (i) Water New Zealand and (ii) New Zealand Land Treatment Collective (NZLTC).

4 My specific experience relevant to this evidence includes:

4.1 Stormwater planning, catchment hydraulic and hydrological modelling and design.

4.2 Presenting evidence at a regional council hearing on catchment wide modelling that I carried out to assess the effects of flooding in the lower reaches of the Waitaki catchment in South Canterbury.

4.3 Regular engagement by Christchurch City Council (*CCC*) as a Three Waters Planning Engineer. In this role as a stormwater planning engineer, I review stormwater designs and modelling by various engineers from consulting firms and I peer review their reports (concepts, calculations and detailed designs) and provide them with the required guidance for solutions that are acceptable to the CCC. As a result, I am conversant with various hydrological modelling tools, flooding assessments and flood mitigation.

4.4 Designing and implementing numerous on-farm irrigation schemes, soil investigations and land use assessments. Examples of projects include Hunter Downs Irrigation Scheme, North Bank Hydro Project, Mararoa-Waiau Rivers Irrigation Feasibility Study and the North Canterbury Lower Waiau Irrigation Feasibility Assessment.

4.5 Assessing large subdivisions in relation to stormwater management, earthworks and the associated actual and potential impacts on soils, groundwater and surface waterways and how to effectively use erosion and management control plans to mitigate the potential impacts that may occur during the construction works.

4.6 Assessing effects on soils and groundwater associated with onsite and community wastewater discharge systems such as the Wainui Community wastewater discharge consent.

4.7 Assessing actual and potential effects on groundwater and surface water associated with groundwater and surface water takes.

4.8 Providing quarry soils and rehabilitation expert evidence for the extension of the Road Metals Quarry on West Coast Road in Templeton in 2018. My evidence at the hearing covered the effect on soils and groundwater resulting from the changes to site levels post rehabilitation. I assessed the effectiveness of adopting a 300 mm topsoil layer and whether or not this was sufficient for plant growth and providing contaminant attenuation, treatment and removal to protect the underlying groundwater.

4.9 Acting as a soils and rehabilitation expert witness for the proposed Roydon Quarry in Templeton in 2019 and 2020. Fulton Hogan's proposal was for the establishment of a quarry and extraction of aggregate. I provided an assessment of the soils' versatility and the effect of the requested changes to the land use on the land's productivity potential.

4.10 Acting as an expert witness at the proposed Fulton Hogan Miners Quarry extension in 2020 and 2021. I provided an assessment of the soils, their versatility and productivity potential with and without mitigation post quarrying.

4.11 More recently, I have been involved with a number of Plan Changes across the Selwyn District. These include:

(a) Plan Change 66 (PC66) in Rolleston.

(b) Plan Change 67 (PC67) in West Melton.

(c) Plan Change 68 (PC68) in Prebbleton.

(d) Plan Change 69 (PC69) in Lincoln.

(e) Plan Change 71 (PC71) in Rolleston.

(f) Plan Change 74 (PC74) in Rolleston.

(g) Plan Change 75 (PC75) in Rolleston.

(h) Plan Change 79 (PC79) in Prebbleton.

(i) Plan Change 80 (PC80) in Rolleston.

(j) Plan Change 81 (PC81) in Rolleston.

(k) Plan Change 82 (PC82) in Rolleston.

(l) Plan Change 31 (PC31) in Ōhoka.

5 I am familiar with the submitters' request to rezone land bound by Mill Road, Whites Road, Bradleys Road (the *Site*).

6 I was involved in private plan change 31 (*PC31*) to rezone this land under the operative District Plan.

CODE OF CONDUCT

7 Although this is not an Environment Court hearing, I note that in preparing my evidence I have reviewed the Code of Conduct for Expert Witnesses contained in Part 9 of the Environment Court Practice Note 2023. I have complied with it in preparing my evidence. I confirm that the issues addressed in this statement of evidence are within my area of expertise, except where relying on the opinion or evidence of other witnesses. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

8 I have been asked by the submitters to provide evidence in relation to the proposed rezoning. This evidence covers the following matters:

8.1 my assessment of the productivity of the existing soils within the Site;

8.2 the long-term constraints associated with the highly productive soils within the surrounding area; and

8.3 the effects of those constraints on the soils' productive potential.

9 In assessing the above, I have also been asked to consider rezoning of different highly productive land within the District that has a relatively lower productive capacity.

10 In preparing my evidence I have reviewed:

10.1 The Proposed District Plan;

10.2 The National Policy Statement on Highly Productive Land 2022 (*NPS-HPL*);

10.3 The evidence of **Mr Greg Akehurst**, **Mr Tim Walsh** and **Mr Eoghan O'Neill**;

10.4 Further submissions relevant to my expertise relating to the rezoning of the Site; and

10.5 The relevant documents from PC31.

SUMMARY OF EVIDENCE

11 High Productive Land (*HPL*) or versatile soils are regarded as the best possible land or soils for agricultural production because of their properties.

12 The Site is comprised of Land Use Capability (*LUC*) Classes 2 and 3 soils. LUC 2 makes up 2.45% of the Site, while LUC 3 makes up the remaining 97.55%.

13 The Site is not 'highly productive land' for the purposes of the NPS-HPL.

14 There are some 'constraints' which will (in some cases significantly) affect the productive capacity of any site. These include poor to very poor soil drainage, moisture limits and irrigation availability, nutrient limits, characteristics of soils, and drinking water protection zones. I summarise the impact of these factors on the Site as follows:

14.1 Poor drainage: the soils are poorly drained, and this impacts the land's productive potential.

14.2 Soils: while the soils are predominantly classified as LUC 2 – 3, there is significant variability in the nature and extent of those soils across the Site. Some spatial variability even over short distances affect the management of the land.

14.3 Moisture deficits and irrigation availability: the Site experiences moisture deficits. There are two consents that are used for irrigation. However, at least one of the consents is subject to minimum flows in the Ōhoka Stream. These restrictions were further enhanced under the regional council Plan Change 7 to the Canterbury Land and Water Regional Plan (*CLWRP*) which became operative in September 2023 and thus reduced the reliability of the consents exposing productive uses to moisture deficits.

14.4 Nutrient limits: in my opinion, the Site soils are such that application of nutrients to the Site would be essential to support land-based primary production activities. However, strict nutrient limits are currently in place through the CLWRP and the recent Plan Change 7 to the CLWRP which would significantly constrain the use of nutrients at the Site. In my opinion, those limits are unlikely to ease in the short or medium term. The baseline N loss rate is 14 kg/ha/year. Future N losses are determined by the baseline loss rate.

14.5 Drinking Water Protection Zone: the water supply source for Ōhoka is taken from two bores whose drinking water protection zone overlay part of the Site thus reducing the area that is available for productive use.

15 In addition to these factors, the 'costs' of losing the Site for land-based primary production must also, in my opinion, be considered in the context of land which would remain available for those activities within the Waimakariri District and the Canterbury region. In particular, of all the "highly productive land" in those geographical areas, the Site represents a reduction of only:

15.1 0.0002% and 0.0016% in Canterbury and in the Waimakariri District respectively under the regional policy statement definition of HPL.

16 I have looked at alternative sites within this area, and, having regard to the various factors relevant to productive capacity, I have not identified any sites which in an overall sense would be less suitable for land-based primary production than the Site. This is in large part because, as set out in my evidence, the ability of the Site to support primary production over the long term is constrained by a number of factors.

17 For that same reason, it is my opinion, supported by the evidence of **Mr Akehurst**, that the long-term environmental, social and economic costs associated with the loss of the Site for primary production are negligible.

18 Therefore, it is my conclusion that the submitters' proposal would result in the negligible loss of LUC Class 2 and 3 soils within both the district and the region since the Site is subject to a number of constraints which significantly limit its productive capacity over the long term.

DEFINING HIGHLY PRODUCTIVE LAND SOILS

National Policy Statement for Highly Productive Land 2022 (***NPS-HPL***)

19 The NPS-HPL was gazetted on Monday 19 September 2022 and came into effect on Monday 17 October 2022.

20 The NPS-HPL aims to protect HPL for use in land-based primary production, both now and for future generations. "Land-based primary production" encompasses production from agricultural, pastoral, horticultural, or forestry activities that are reliant on the soil resource of the land.[1] To achieve this, the NPS-HPL requires the identification of HPL at a regional level, and imposes varying levels of constraint on the rezoning, subdivision, land use and development of that land.

21 The NPS-HPL defines HPL as:

21.1 "…*land that has been mapped in accordance with clause 3.4 and is included in an operative regional policy statement as required by clause 3.5 (but see clause 3.5(7) for what is treated as highly productive land before the maps are included in an operative regional policy statement and clause 3.5(6) for when land is rezoned and therefore ceases to be highly productive land)".*[2]

21.2 Clause 3.5(7) states that "*Until a regional policy statement containing maps of highly productive land in the region is operative, each relevant territorial authority and consent authority must apply this National Policy Statement as if references to highly productive land were references to land that, at the commencement date:*

(a) *is*
(i) *zoned general rural or rural production; and*
(ii) *LUC 1, 2, or 3 land; but*

(b) *is not:*
(i) *identified for future urban development; or*
(ii) *subject to a Council initiated, or an adopted, notified plan change to rezone it from general rural or rural production to urban or rural lifestyle".*

22 As illustrated above, the New Zealand Land Resource Inventory (*NZLRI*) mapping shows that the Site is LUC 2 (2.45%) and 3 (97.55%) land. I understand the Site is proposed to be rezoned Rural Lifestyle Zone under the Proposed District Plan. Therefore,

---

1 National Policy Statement for Highly Productive Land 2022, clause 2.1.

2 National Policy Statement for Highly Productive Land 2022, clause 1.3(1), definition of 'highly productive land'.

while the Site currently meets the criteria in clause 3.5(7)(a), it is not 'highly productive land' under the NPS-HPL because it meets the exclusion in clause 3.5(7)(b)(ii). I understand the evidence of **Mr Walsh** and the legal submissions on behalf of the submitters will address this interpretation in detail.

The Canterbury Regional Policy Statement (CRPS)

23 The CRPS defines 'versatile soils' as those that are in LUC Classes 1 and 2.[3] Class 3 is not included.

24 Given the Site contains LUC Class 2 soils, the CRPS will be a relevant consideration in the rezoning of this land. I have calculated the amount of LUC Class 2 soils on the Site to be:

24.1 3.82 ha gross (Table 3 below);

24.2 0.64 ha net (Table 7 below).

DESCRIPTION OF THE SITE AND CURRENT LAND USE

Location

25 The Site is bound by Mill Road, Whites Road, Bradleys Road and some lifestyle blocks to the southwest and is comprised of a number of individual lots and parcels.

26 The table in **Attachment 1** shows that the individual lots making up the site add up to 155.9 ha of which 152.56 ha is on the main property at 535 Mill Road/347 Whites Road (*Sherraine Holsteins Farm*). Sherraine Holsteins Farm makes up 97.8% of the proposed plan change area. **Attachment 1** also provides a figure showing the plan change area.

Land Use

27 The 152.56 ha Sherraine Holsteins Farm comprises a 111-ha milking platform and a 41-ha support block. The milking herd averages 170 cows. The replacements and bulls are raised on the support block. The farm winters all the stock on the attached support block.

28 Milking cows are contained within the dairy platform. During autumn, winter and spring any stock on the milk platform spends time on the feed pad. The feed pad reduces the time stock are on the pasture to prevent pugging and the compaction of the soil.

29 All stock is fed on grass with maize silage grown and used as feed on the pad over winter, autumn and spring.

[3] Canterbury Regional Policy Statement, Chapter 15 – Soils.

Surface Water and Groundwater

30 There are several waterways or drains that run through the Site. The most significant of the waterways is the Ōhoka Stream that runs from the northwest to the southeast.

31 Two springs and one groundwater seep also originate within the property and these feed into drains that run southeast and across Whites Road.

32 **Attachment 2** shows the location of the springs and some of the main surface waterways on the Site.

33 Groundwater flows from northwest to southeast. Groundwater levels and conditions are discussed in detail in the evidence of **Mr O'Neill** who notes in his evidence that, at paragraph 18:

> *"Groundwater at the site is estimated, using the record from bore M35/0596, to be an average of 0.64 m below ground level (bgl) with the highest recorded groundwater level at 0.14 m bgl (June 2018). Seasonal fluctuations in this bore are relatively small, commonly being 0.5 – 0.8 m. As expected, groundwater levels are generally highest in winter/spring and lowest in summer/autumn. It is noted that bore M35/0596 is close to spring M35/7485 (mapped location is 20 m away), and so may be in an area of the Site that has particularly high groundwater levels".*

34 Based on the above ground water level depths I expect the wider plan change area watertable to come close to the ground surface in some seasons.

Existing Irrigation

35 The Sherraine Holsteins Farm has consents to take groundwater for irrigation. 146 ha of the property is irrigated using guns and k-line systems. The irrigated areas and the irrigation systems are shown in **Attachment 2**. The other small blocks within the plan change area are not irrigated.

DESCRIPTION OF SITE SOILS

Existing Soils and Drainage

36 S-Maps Online[4] and Canterbury Maps[5] provide details of the soils under the Site. Table 1 provides details of the soils.

Table 1 – Soil Types and Area Under Each Soil Type

Soil Name	SMap Name	Soil Texture	Soil Depth (cm)	Permeability	Area (ha)	Percentage (%)
Ayreburn	Ayre_2a.1	Clay	45-100	Moderate/Slow	74.6	48%
Leeston	Lees_1a.1	Clay	20-45	Moderate/Slow	31	20%

[4] https://smap.landcareresearch.co.nz/
[5] https://canterburymaps.govt.nz/

Ayreburn	Ayre_1a.1	Clay	>100	Moderate/Slow	32.1	21%
Paynter	Payn_6a.1	Peat over Clay	>100	Slow	16.2	10%
Pahau	Paha_31a.1	Silty Loam over Clay	45-100	Moderate/Slow	1.5	<1%
Darnley	Darn_1a.1	Silty Loam	20-45	Moderate/Slow	<1	<0.4
Leeston	Lees_3a.1	Stony Clay	20-45	Moderate/Slow	<1	<0.3
Total Area					**155.9**	**100**

37 Table 2 summarises the drainage properties of the Site and the areas under each drainage class.

Table 2 – Drainage Properties of the Soils

Drainage Description	Area (ha)	Percentage (%)
Very Poorly Drained	16.5	10.5
Poorly Drained	136.4	87.5
Imperfectly Drained	<3	<2
Moderately Well Drained	<1	<1
Total Area	**155.9**	**100**

38 Table 1 and 2 show that 98% of the soils have poor to very poor drainage. Permeability is moderate to slow.

39 Poor drainage can have significant impact on the soil's productive potential and crop/plant yields, unless the crop types grown are suited to wet feet.

Land Use Capability

40 The LUC classification classifies land according to those properties that determine its capacity for long-term sustained production.[6] There are eight different classes, illustrated on Figure 1 below. As set out further below, the LUC classification of a site is one of the key 'criteria' in determining whether soils are highly productive or not.

6 Land Use Capability (LUC) Survey Handbook, 3rd edition (tupu.nz), page 8.

<table>
<tr><td rowspan="9">Increasing Limitations to Use</td><td>LUC class</td><td>Arable Cropping Suitability†</td><td>Pastoral Suitability</td><td>Production Forestry Suitability *</td><td>General Suitability</td><td rowspan="9">Decreasing Versatility of Use</td></tr>
<tr><td>1</td><td rowspan="4">High
↓
Low</td><td rowspan="7">High
↓
Low</td><td rowspan="7">High
↓
Low</td><td rowspan="4">Multiple Use Land</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td><td rowspan="4">Unsuitable</td><td rowspan="3">Pastoral or Forestry Land</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td>Unsuitable</td><td>Unsuitable</td><td>Catchment Protection</td></tr>
</table>

Figure 1 – Relationship between the Versatility and LUC Classes (Lynn et al, 2009[7])

41 As shown in Table 3 below, under the NZLRI default mapping, the Site is comprised of LUC 2 and 3 soils.

Table 3 – Gross Default LUC Classes within the Site

LUC Class	Area (ha)	%age
LUC 2w	3.82	2.45%
LUC 3w	152.111	97.55%
Total	**155.93**	**100%**

42 The "w" in Table 3 indicates *"soil wetness resulting from poor drainage or a high-water table"* (Refer to **Attachment 3**), being the dominant limitation on the Site's productive capacity.

43 The LUC 2-3 classes in Table 3 mean the soils are theoretically suitable for a wide range of arable cropping activities, although these are subject to limitations imposed by the degree of wetness and other factors that I discuss later in my evidence.

PRODUCTIVE CAPACITY OF SOILS

Introduction

44 The primary purpose of my evidence is to discuss the effect of the proposed rezoning on the Site's productive potential. Land productive potential encompasses many facets, of which soil is one of them.

45 "Productive capacity" can generally be defined as the ability of the land to support land-based primary production over the long term, based on an assessment of:

45.1 Physical characteristics (such as soil type, properties, and versatility); and

[7] http://envirolink.govt.nz/assets/Envirolink/83-mldc7-MarlboroughSoilsAdvice.pdf

45.2 Legal constraints (such as consent notices, local authority covenants, and easements); and

45.3 The size and shape of existing and proposed land parcels.

46 Similar guidance has previously been given by the Environment Court[8] on factors which indicate productive capacity (illustrated in Table 4 below):

Table 4 – List of Factors Determining Versatility

Soil texture	Soil structure	Soil water holding capacity
Soil organic matter stability	Site's slope	Site drainage
Temperature of the site	Aspect of the site	Stormwater movements
Floodplain matters	Wind exposure	Shelter planted
Availability of irrigation water	Transport, both ease and distance	Effect of the use on neighbours
Access from the road	Proximity to airport	Proximity to port
Supply of labour	Previous cropping history	Soil contamination
Sunlight hours	Electricity supply	District scheme
Economic and resale factors		

47 Based on my desktop analysis and observations from my site visit, a number of the factors in Table 4 affect or are relevant to the Site. These in my opinion, significantly constrain the ability to undertake land-based primary production at the Site as I discuss further below.

48 I now discuss the relevant factors and the extent to which the limitations may or may not be able to be managed.

Soil Properties

49 As I have noted the soils are LUC Classes 2 and 3 with LUC Class 3 soils making up almost 98% of the Site. This theoretically indicates the Site's suitability for arable cropping.[9] Table 1 shows that soil properties such as depth and permeability vary within each soil type and between soil types. For example:

49.1 The Ayreburn soils have a depth range 45-100 cm (Ayre_2a.1) to >100 cm (Ayre_1a.1).

---

8 *Canterbury Regional Council v Selwyn District Council [1997] NZRMA 25, Judge Treadwell presiding.*

9 *Lynn et al., (2009), Land Use Capability (LUC) Survey Handbook, 3rd edition (tupu.nz).*

49.2 Leeston and Darnley soils are shallow (20-45 cm) compared to other soil types e.g. the Ayreburn soils.

49.3 Differences in soil textures.

50 Geotechnical investigations[10] by Tetra Tech Coffee also confirm that:

50.1 The soils are comprised primarily of silts topsoils (0.25-0.35 m thick) and clayey subsoils from approximately 0.5 m to 1.2 m below the ground level.

50.2 Mottling occurs from about 0.2 m below the ground level with most test pits showing mottling from 0.3 m. This implies that that waterlogging occurs to these depths. This is supported by the groundwater levels from **Mr O'Neill's** evidence I have discussed in Paragraph 33.

51 The variability in soil properties can have adverse implications on the management of the soils and crops if the soil's productivity potential is to be achieved. This requires additional management as the different soil units can lead to differences in germination times, irrigation needs during the growth of crops, and differences in optimal harvest dates. It can also lead to variability in overall yields, which could impact the economic viability of primary production on what is already a small area of land.

Groundwater and Poor Drainage

Introduction

52 I have discussed the Site drainage properties in Paragraphs 37-39 and concluded that 98% of the Site has poor to very poor drainage.

53 While the Site soils may be in LUC 2 and 3, the soils have a significant physical constraint which is wetness.

54 Poor management and excessive wetness or poorly drained soils affect production as some crops/plants do not do well in these soils. Reid and Morton (2019)[11] carried out surveys of commercial crops in Hawke's Bay and Gisborne in 1998–99 and 1999–2000 and concluded that:

> "*…70% lost yield because of insufficient or poorly timed irrigation, and 84% lost yield because of inadequate nutrition. The nutrients most usually in short supply were nitrogen (N) and phosphorus (P). However, extra fertiliser will not compensate for poor crop establishment, water stress, or waterlogging due to heavy rain, excessive irrigation or poor drainage*".

---

[10] *Tetra Tech Coffey. 2023. 535 Mill Road, Ōhoka Geotechnical Assessment Report. Prepared for Rolleston Industrial Developments Ltd.*

[11] *http://www.processvegetables.co.nz/assets/Uploads/Nutrient-Management-for-Vegetable-Crops-in-NZ-Manual-Feb-2019.pdf*

Property Owner Experience with the Soil Drainage

55 Mr and Mrs Peter and Rhonda Sherriff have owned and operated Sherraine Holsteins Farm since 2003. I met with Mr Sherriff and we discussed his experience over the 30 years he has farmed on the property. Mr Sherriff outlined the challenges that poor drainage had on the farm. I summarise the key points from our discussion below.

56 The Site comprises irrigated pasture and has predominantly been used for dairy farming for the last 30 years, and prior to that a mixture of dairy, livestock and arable farming.

57 To supplement animal feed the farm has tried to grow maize over the years. The crop has not usually done well because:

57.1 It had to be planted late (end November to December) because of the paddock's wetness and poor drainage.

57.2 The crop has to be taken out by end of March as the soil wetness and pugging impact farm machinery trafficability if harvesting is done any time later. In one year they failed to harvest or lost a whole crop as the soils were too wet and pugging was serious. While short season varieties have helped, this has not removed the constraints related to the soil wetness and poor drainage.

57.3 The crop requires regular irrigation in January-February to either meet the crop water demands or to keep the soils moist so that they do not crack. I discuss moisture availability and irrigation further below in my evidence.

58 When pugging has occurred it has taken a whole season to get the soil back into a productive state.

59 After moderate to significant rainfalls or frequent low rainfall events water either just sits on the ground because of the low soil infiltration rates until it evaporates or runs off into the drains and waterways within the Site.

60 Runoff to the waterways increases the contaminant risks to the waterways as the farm also applies effluent to the land. This needs to be carefully managed on the Site.

61 Given the high groundwater on the Site it is also easy for contaminant to reach and contaminate groundwater. This needs to be carefully managed on the Site.

62 Because of the heavy clays and the soil wetness pugging is a problem that must be actively manged on the Site. To prevent soil pugging they do not feed out on the paddocks but use a feed pad for the 150-230 cows managed on the farm at any one time.

63 Tile drains have been installed over the years. They were placed as closely as practicable to one another to improve drainage but even then they are not very effective because of:

63.1 the lack of adequate grades across to the outfalls; and

63.2 the heavy textured soils which reduce the water movements through the soil. Effectiveness might be improved by placing even more drains between the existing ones but this is unlikely to be economically viable.

64 As a result of the risks associated with intensification on the Site, the farm has had to operate as a low input (nutrients, stocking rates etc) farm and this has made the economics of farming on the Site more than challenging. The low input status of the farm is reflected in the Overseer modelling results for 2020 which show a baseline nitrogen leaching rate of 14 kg/ha.

65 These site-specific experiences, observations and challenges are not a surprise to me. I would expect these on any land with heavy soils, poor drainage, high watertable and a multitude of waterways running through it.

Consideration of Alternative Crops

66 While the soils are classified LUC2 and 3, the implication is that the soils are suitable for a wide range of arable crop production. However, regardless of management strategies some plants/arable crops do not tolerate waterlogged soils and would not be suitable on the Site. A few examples of these are swedes, barley, chicory, lucerne, Pipfruit, stonefruit, berryfruit, avocadoes, carrots, onions etc.

67 The list above is only a small sample of crops affected by poor drainage and this demonstrates that while the soils are technically considered highly productive, they do have inherent limitations that reduce the range of crops that can be grown. This results in a lack of crop diversity which in turn leads to recurring soil and plant diseases.

68 In summary, poorly drained areas will generally not be able to achieve the productive potential assumed by just looking at the LUC classes.

Summary of Drainage Issues at the Site

69 At least 98% (Table 3) of the soils are Poorly or Very Poorly Drained. Poor drainage, limited aeration, moderate to slow permeability, heavy soil structure and waterlogging vulnerability significantly limits the soil’s suitability for horticulture and several arable crop options.

Moisture Availability and Irrigation

Introduction

70 Despite the poor drainage, the land still requires water for irrigation in order to ensure maximum agricultural productivity.

71 When I spoke to Mr Sherriff he also advised that one of their management strategies on the clay soils was to keep the moisture content well above the permanent wilting point and at more than field capacity to prevent the clay soils from cracking which has to be avoided because:

71.1 It affects plant productivity by breaking (or opening up) and exposing the small feeder roots, which reduces the overall ability of the plant to absorb water and nutrients. This affects the crop yields and quality.

71.2 It promotes preferential pathways of water and leachate movements through the soils resulting in increased groundwater contamination.

Moisture Deficits Requirements

72 Table 5 is a summary of soil moisture deficits for Ōhoka based on the climatic data available at the Ōhoka CWS (Station 43251).

Table 5– Sample Statistics for Maximum Soil Moisture Deficits in mm (Ōhoka CWS)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	130.9	111.4	42.9	53.2	6.1	2.7	4.7	13.9	36.6	62.8	50.9	41.3
2019	121.4	139.5	133.2	123.5	92.1	5.9	9.3	9.8	19.5	39.9	94.3	132
2020	146.4	146.9	132.7	90.6	91.1	71.6	4.9	25.3	35.5	96.2	100.3	128.2
2021	134.2	133.2	134.6	132.9	120.1	1.3	-	-	-	-	-	-

73 Table 5 shows that moisture deficits of 111.4-146.9 mm in January and February and this, for many crops, is the period of peak water demands and it is likely to coincide with the periods of the lowest Ōhoka Stream flows.

Existing Consents

74 Therefore, water availability is an important limiting factor for primary production. The Site holds two water take and use consents which are:

74.1 CRC991827 permits:

(a) The taking and using water at:

(i) 22.8 L/s and a daily volume of 1,809 m^3/day each from M35/0326 and M35/0367 depending on the flow in the Ōhoka Stream (i.e. >800 and >300 L/s).

(ii) 16 L/s with a combined volume not exceeding 1,267 m^3/day and with a combined volume not exceeding 5,069 m^3 in any period of seven consecutive days. When Ōhoka Stream is at or less than 300 L/s, max combined rate limited to 16 L/s and

(b) The taking and using of water is for the purpose of "…*irrigation of crops and pasture for grazing livestock including milking dairy cows*".

74.2 CRC991022 permits:

(a) The taking a maximum of 60 L/s from wells M35/9423, M35/3064, M35/3065 at a combined volume not exceeding 4,968 m^3/day.

(b) The taking and using of water is for the purpose of " …*irrigation of crops and pasture for grazing livestock including milking dairy cows".*

(c) The application of effluent provided a backflow preventer is used.

75 CRC991827 has restrictions associated with the flow rates in Ōhoka Stream. There are no readily available statistics on the ECan website to determine the probability exceedance statistics associated with the restrictions. In the absence of such flow statistics, it can be surmised that:

75.1 When there are no restrictions there is sufficient water available to irrigate the full area.

75.2 When partial restrictions are in place there is insufficient water to irrigate the full area.

76 If or when the consent restrictions come into effect during the peak growing period for any crops, the productivity is significantly impacted regardless of the soil's inherent productive potential.

Canterbury Land and Water Regional Plan (CLWRP) - Plan Change 7

77 Further changes to the minimum flow as a result of Plan Change 7 means change of the minimum flows on Ōhoka Stream as follows:

77.1 The minimum flows for A Permits are to change from 300 L/s to 420 L/s from 20 July 2027.

77.2 The allocation limit for A Permits will be 500 L/s which can be compared to the total allocation of 466.59 L/s at the time of the PC7 decisions or as at 2 February 2019[12].

78 The changes to the Ōhoka Stream minimum flows will affect consent CRC991827 which is subject to minimum flows in Ōhoka Stream. It will essentially reduce the reliability of the consent as the taking of water will be subject to stricter minimum flows and allocation limits for the A Permits.

79 In summary, implementation of the Plan Change 7 provisions will result in a reduction of the irrigation water available for abstraction and land-based productivity. This is an additional constraint to the soil's productive potential.

Drinking Water Exclusion Zone

80 The areas I presented in Table 3 are gross areas. However, not all of the soils comprising this area are productive – the homesteads, all fenced waterways and riparian areas are not grazed or farmed. I have estimated that this area would be of the order of 10-25% based on the high-level maps on Canterbury Maps.

81 Therefore, I estimate the unproductive areas of the Site conservatively at 21-40 ha (made up of the homestead and the other unproduction area) giving a net productive area of 116-136 ha across the plan change area. Most of these unproductive areas are within the LUC Class 3 soils which means the productive LUC Class 3 soils are in the range of 112-132 ha.

82 The Ōhoka Township water supply comes from Wells M35/5609 and BX24/0262. The Canterbury Map GIS shows the drinking water protection zones for these bores. **Attachment 2** shows the extent of the two protection zones. The protection zones are over an area of 7.14 ha of the Site. 3.96 ha of this is LUC Class 3 and 3.18 ha of LUC Class 2 soils.

83 The purpose of the protection zone is to ensure that activities that might have adverse effects on the drinking water supply are restricted so as to protect the community water supply. This means that intense agricultural activity within the protection zone would be limited. This reduces the productive area under LUC Class 3 to 108.8 -127.8 ha and the LUC Class 2 to just 0.64 ha. Table 6 is an update of Table 3 which summarises the areas within the Site not subject to the protection zone or the non-productive uses noted above.

Table 6 - Updated LUC Classes Areas within the Proposed Plan Change Area (taking into account non-productive areas and the Drinking Water Exclusion Zone)

---

12 *Resource Consent Inventory For Waimakariri Land and Water Solutions Programme (Version 2, Report Number R19/10), March 2018, prepared by Don Vattala & reviewed by Pattle Delamore Partners.*

LUC Class	Area (ha)	Percentage
LUC 2	0.64	0.5-0.6%
LUC 3	108.8-127.8	99.4-99.5%
Total	**109.4-128.4**	**100%**

Nutrient Management and Limits

CLWRP and Plan Change 7 to the CLWRP

84 Strict nutrient limits currently apply to primary production activities. The CLWRP and the recent Plan Change 7 to the CLWRP include numerous provisions that regulate land use and farming activities. These provisions make it difficult to intensify land use and agricultural production and thus constrain the productive potential of the land/soils irrespective of the LUC Class. Examples of policies in the CLWRP that relate to farming intensity are:

84.1 Policies 4.34-4.36 which relate to management of nutrient loss from farming among other activities.

84.2 Policies 4.37 to 4.38H which apply to individual farming activities, nutrient user groups and farming enterprises.

84.3 Policy 4.38 applies to areas that are within the Red Nutrient Allocation Zone. The Site is within the Red Ashley-Waimakariri Nutrient Allocation Zone. Policy 4.38 seeks improved water quality outcomes by:

(a) *avoiding the granting of any resource consent that will allow nitrogen losses from a farming activity to exceed the Baseline GMP Loss Rate, except where Policy 4.38C applies; and*

(b) *including on any resource consent granted for the use of land for a farming activity, conditions that:*

(i) *limit the nitrogen loss calculation for the farming activity to a rate not exceeding the Baseline GMP Loss Rate; and*

(ii) *require farming activities to operate at or below the Good Management Practice Loss Rate, in any circumstance where that Good Management Practice Loss Rate has not been influenced by severe extraordinary events (including but not limited to droughts or floods) and is less than the Baseline GMP Loss Rate; and*

(c) *requiring a Farm Environment Plan as part of any application for resource consent to use land for a farming activity, and requiring that Farm Environment Plan to be prepared in accordance with Schedule 7 of this Plan.*

84.4 Policy 4.74 require resource consents for the use of land for farming activities and the associated discharge of nutrients in catchments that are zoned Red. The Site is located in the Red Nutrient Allocation Zone.

84.5 Policy 4.36A relates to vegetable production requirements to achieve the nutrient requirements for the regions.

84.6 Rules 5.42CA to 5.42CD set out the rules for vegetable production on a regional basis.

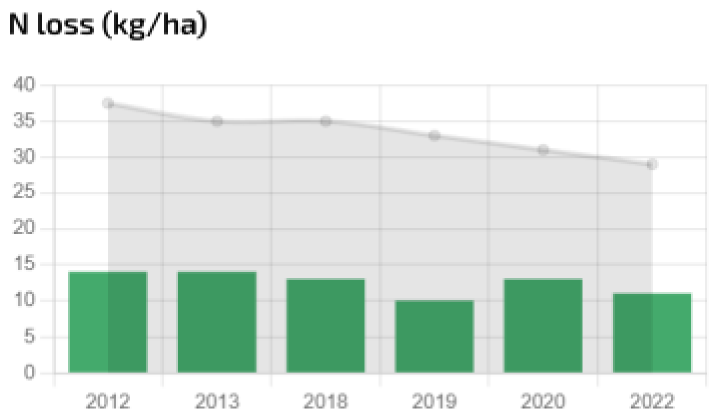
84.7 Sub-regional Rules 8.5.21 to 8.5.26 relate to the use of land >5 ha for farming activities and sets out conditions for permitted to non-complying activities depending on the nitrate loss rates for the farming activity.

85 The nutrient requirements set out in the various rules seek to address excessive groundwater nutrient concentrations in the catchment over which the Site lies.

The Site's Modelled N Losses

86 **Attachment 4** is the Overseer Summary Report for the Baseline (i.e. N losses averaged over 2009-2013)). This shows that the baseline N loss is 14 kg/ha/year.

87 The farm has been operated at low stocking levels for several years as reflected in **Attachment 4.** The extract below (Figure 2) is from the report and provides the N loss trends over several years.



YEAR	FARM	MEDIAN
2012	14	37.5
2013	14	35
2018	13	35
2019	10	33

Figure 2 – Nitrogen Loss Trends

88 I was supplied with a copy of the most recent (year ending 2020) Overseer modelling report for the farm. This shows that:

88.1 N losses ranging from 4 kg/ha (house) to 18 kg/ha (Blue Gum Block).

88.2 The average N losses for the farm were at 16 kg/ha.

89 Given the low leaching rates at the Site and the sensitivity of the Site to flooding and wetness there is no room for any further increases to the leaching losses.

90 From the foregoing it is clear that the N losses have been kept at low levels through prudent farm system management which has also meant keeping inputs at low levels with the consequence being less than optimal productivity.

Effect of Nutrient Reductions on Productivity

91 The effects of these limits have been identified in various literature. For example:

91.1 A Landcare Research study called "*Modelling Economic Impacts of Nutrient Allocation Policies in Canterbury: Hinds Catchment*" in 2013 prepared for the Ministry for the Environment[13] concluded that loss in productivity could result in revenue reductions of up to 41% with an average of 14% across the farming systems studied.

91.2 Reports prepared by the Agribusiness Group (2014)[14,15] on behalf of Ministry for Primary Industry found significant reductions in yield and profitability resulting from nutrient reductions.

91.3 The Agribusiness Group reports also include budgets showing losses for some crops with the conclusion that "*At the 10% reduction in the amount of nitrogen applied the Gross Margin result is reduced to approximately one third to a half of that under the Status Quo situation and from there it dips towards a close to breakeven scenario which means that it would not be economic to grow the crop. This reflects the relatively tight margins which these crops are grown under*"[14].

---

[13] *Landcare Research (2013). Modelling Economic Impacts of Nutrient Allocation Policies in Canterbury: Hinds Catchment. Prepared for the Ministry for the Environment. https://environment.govt.nz/assets/Publications/Files/modelling-economic-impacts-of-nutrient-allocation-policies-canterbury.pdf*

[14] *The Agribusiness Group (2014). Nutrient Performance and Financial Analysis of Lower Waikato Horticulture Growers. Prepared for MPI. https://www.horizons.govt.nz/HRC/media/Media/One%20Plan%20Documents/Nutrient-Performance-and-Financial-Analysis-of-Horticultural-Systems-in-Horizons-Region-2014.pdf?ext=.pdf.*

[15] *The Agribusiness Group (June 2014). Nutrient Performance and Financial Analysis of Horticultural Systems in the Horizons Region. Prepared for MPI.*

91.4 Samarasinghe et al (2011)[16] carried out research in the Hurunui District and concluded that reduction in nutrients below the baseline levels resulted in >5% loss in revenue. For some enterprises, this would be a net economic and financial loss.

Permanency of the Nutrient Limits

92 The limits in the CLWRP and Plan Change 7 to the CLWRP are examples of initiatives being taken to mitigate the adverse effects resulting from excessive groundwater nutrient concentrations in the catchment (in which the Site is located). These concentrations primarily result from primary production activities (e.g. dairying and arable agriculture) of the 70s, 80s, 90s and early 2000s. The effects of the more recent (1980s to the present day) intensification in dairying and other agricultural activities will manifest over the next 20, 30, and 40 years, and in my opinion, are likely to be considerably worse than what the catchment is experiencing now because of this intensification.

93 For that reason, any mitigation initiatives – while important - are in my opinion, highly unlikely to maintain nutrient levels at the current levels or restore them to the pre-intensification levels. Therefore, greater limitations on the application of nutrients and nutrient rates should be expected. These constraints would further limit the capacity of the Site to establish and maintain land-based primary production.

94 Therefore, I conclude that:

94.1 The Site has no potential for increased intensification and the current low productivity (as demonstrated by the current low stocking rates) will be an on-going issue due to the nutrient constraints. The fact that the Site has LUC Class 2 and 3 soils is not reflected by the Site's productive potential.

94.2 It is, therefore, important that the soils' productive potential is not overstated given the constraints that are imposed by the CLWRP.

POSITIVE BENEFITS OF THE REZONING REQUEST

95 The rezoning request proposes to convert dairy agricultural land to residential land. This means the current nutrient leaching into groundwater and flows into surface waterways from the farming activities would cease. The impact on groundwater and surface water quality would also cease.

---

[16] *Samarasinghe , O. Daigneault A, Greenhalgh, S, Sinclair , R (2011) Modelling Economic Impacts of Nutrient Reduction Policies in the Hurunui Catchment, Canterbury. https://www.nzae.org.nz/wp-content/uploads/2011/Session4/42_Samarasinghe.pdf*

96 The effects of the current farming activities are best summarised by The Environment Canterbury Technical Report No. R18/81[17]. The report concluded that:

96.1 *"Any increases of nitrate in groundwater are likely to affect the ecology of spring-fed streams, especially the Cust Main Drain, Ōhoka Stream and Kaiapoi River. Groundwater in parts of the Cust subzone are also close to the drinking-water limit for nitrate and some groundwater may become unpotable without decreasing nitrogen discharges".*

96.2 *"Groundwater nitrate-N data from two of the wells, at Eyrewell and Ōhoka did have increasing trends. Concentrations have risen from around 6.5 mg/L to 7.5 mg/L nitrate-N at our monitoring site in Ōhoka in 10 years".*

97 The rezoning request will change the nature and character of the discharges from the Site:

97.1 Wastewater will be reticulated and pumped to the Council's wastewater treatment system which is in Kaiapoi.

97.2 Stormwater will be the main source of discharges. Typical contaminants associated with stormwater are sediment, heavy metals and hydrocarbons. Nutrients (nitrates and phosphorus) and pathogens will also be likely contaminants. However, these will be at levels significantly less than those discharged from dairy farming activities.

97.3 Stormwater from the development will be treated via a treatment train that will ensure removal of various contaminants to levels below the limits in Schedule 8 of the CLWRP so that discharges to the waterways will have no more than minor or less than minor effects on the receiving environments.

98 Another positive benefit of the rezoning request is that by removing this land from productive agriculture:

98.1 Any excess water from the irrigation consents can be made available (transferred) to alternative sites (Paragraphs 99-105) with less constraints than the proposed Site. This means that those alternative sites might become more productive as they will have access to more water for irrigation. I understand that the existing consented water may also be used for the proposed developed Site e.g. potable water supply. Therefore, not all the consented water may be available for transfer to alternative sites with less

[17] *Environment Canterbury Technical Report. 2016. The current state of groundwater quality in the Waimakariri CWMS zone. Report* R16/48.

constraints.

98.2 The irrigation consents can be surrendered all together and this will assist the regional council claw back the overallocated groundwater within the zone.

98.3 The nitrate discharges under the Site will cease and this will help achieve the nitrate load reductions required to reach the Waimakariri Zone Committee nitrate targets for Nitrate Priority Areas (*NPA*)[18] downstream of the Site (I note that the site is not in an NPA. However, Ōhoka Stream flows through the site and into the downstream NPAs).

ALTERNATIVE OPTIONS ASSESSMENT

99 I have been asked to consider whether there are any sites within the Waimakariri District which could feasibly and practicably accommodate the proposed development capacity on land and that have less productive potential than the Site, while still achieving a well-functioning urban environment.

100 In **Attachment 5** I present the LUC classes of the land within the Waimakariri District.

101 I undertook a desktop review of the LUC Classes of this land:

101.1 The nearest land that is >LUC Class 3 is:

(a) to the southwest between the Eyre River and Waimakariri River; and

(b) a smaller area in Fernside along Boundary and Oxford Roads approximately 8 km northwest of the Site.

101.2 Most of the other land within the district is LUC Class 2 or 3 land, with a small remainder being LUC1.

102 I consider there will be very few sites across the district that have less productive potential than the Site. In my opinion, there is a significant amount of other LUC 1-3 land that is likely to be subject to less constraints on productive capacity compared to the Site. In particular these constraints are:

102.1 The drainage issues discussed with Mr Sherriff and the challenges of farming on the land.

102.2 The significant risks posed to the waterways and the groundwater in and around the site. Most other LUC Class 3

---

[18] *Nitrate Priority Area (NPA) is a defined area within the Waimakariri sub-region where reductions in nitrogen loss from farming activities are required beyond the Baseline GMP loss rate.*

land in the vicinity of the Site is likely to have better drainage, deeper and better class soils. In **Attachment 6** I show the areas within the close proximity to the Site that have the same soils as the Site. While I have not assessed each and every land parcel outside of the Site, it is my opinion that there is likely to be other land parcels that are LUC Class 3 land shown in **Appendices 4** and **5** that will have better soils than the soils at the Site.

103 A series of constraint maps for the Waimakariri District are produced in the evidence of **Mr Walsh** and show that the Site is one of the few areas with the least number of constraints for land development (noting that not all of these constraints relate to the land productivity). This is discussed in more detail in the evidence of **Mr Walsh**.

104 Based on that review, I conclude that there is no land within that subject area that has overall lower productive capacity than the Site, given the multitude of constraints I have discussed for this Site.

105 Therefore, it is my opinion that if residential supply is needed, the Site is the appropriate location for that from a productive capacity perspective. It is better to develop in this location than to develop on more productive (i.e. with less constraints) LUC Class 1 and 2 land.

CONSIDERATION OF THE CANTERBURY REGIONAL POLICY STATEMENT AND THE PROPOSED WAIMAKARIRI DISTRICT PLAN

106 The CRPS defines 'versatile soils' as those that are in LUC Classes 1 and 2. Class 3 is not included.

107 Based on this the amount of versatile soils on the Site would only be a gross of 3.82 ha (Table 3) or a net of 0.64 ha (Table 7 below).

108 The CRPS and the Proposed Waimakariri District Plan both seek to ensure that rural land is managed to ensure that it remains available for productive rural activities.

109 I consider that the rezoning request is consistent with the provisions of the CRPS and the Proposed Waimakariri District Plan given the relatively small amount of land defined as versatile on the Site (Paragraphs 107, 111-116).

110 I have outlined the difficulties associated with managing the land for productive rural activities and the risks associated with use of the Site for rural productive activities. When I consider these site-specific factors I am of the opinion that there are better alternative options for primary production, as I have outlined in Paragraphs 99-102.

CUMULATIVE LOSSES OF HPL

111 In my opinion, any costs associated with the loss of the Site for primary production activities must be viewed in the wider context of available productive land.

112 Under the CRPS definition of versatile soils, only 0.64 ha (Paragraph 83) of the land under the Site would be removed from the:

112.1 39,478 ha[19] of LUC Class 1 and 2 within Waimakariri District; or

112.2 293,700 ha of LUC Class 1 and 2 within Canterbury.

113 In Table 7 below, I give a sense of the proportional loss of HPL within the district and the region as a result of the rezoning request for the Site under the CRPS definition of HPL.

Table 7 - Potential Reduction in HPL as a Result of the Proposed Plan Change

LU Class	**Canterbury (ha)**	**Waimakariri (ha)**	**Plan Change Area (ha)**	**Potential Reduction in HPL Under the RPS**	
				Canterbury	**Waimakariri**
LUC1	23,200	39,478	0	**0.0002%**	**0.0016%**
LUC2	270,500		0.64		
Area	**293,700**	**39,478**	**0.64**		

114 The reduction in versatile soils would be 0.0002% and 0.0016% in Canterbury and in Waimakariri District, respectively.

115 If LUC3 is included in the above, the reduction highly productive land in the district and region would be <0.33% and 0.015% respectively.

116 Table 7 above shows that the reductions in HPL as a result of the rezoning request in the region and district would be insignificant.

CONCLUSION

117 In summary, I support the submitters' proposal to rezone the Site for urban purposes on the basis that:

117.1 There are multiple long-term constraints on the capacity of the Site to support primary production activities.

117.2 In light of these constraints, the overall benefits of retaining this land for primary production are, in my opinion, negligible. That is especially so, given that:

[19] https://www.mpi.govt.nz/assets/dmstemp/HPL_submissions/2-3-21/E6.-Waimakariri-DC-Attachment-Redacted.pdf

(a) There are likely to be very few other rural sites within the Waimakariri District that have lower productive capability or less constraints than the Site.

(b) The proportional reductions in HPL in the district and the region as a result of the rezoning of the Site are insignificant.

Dated: 5 March 2024

____

Victor Mkurutsi Mthamo

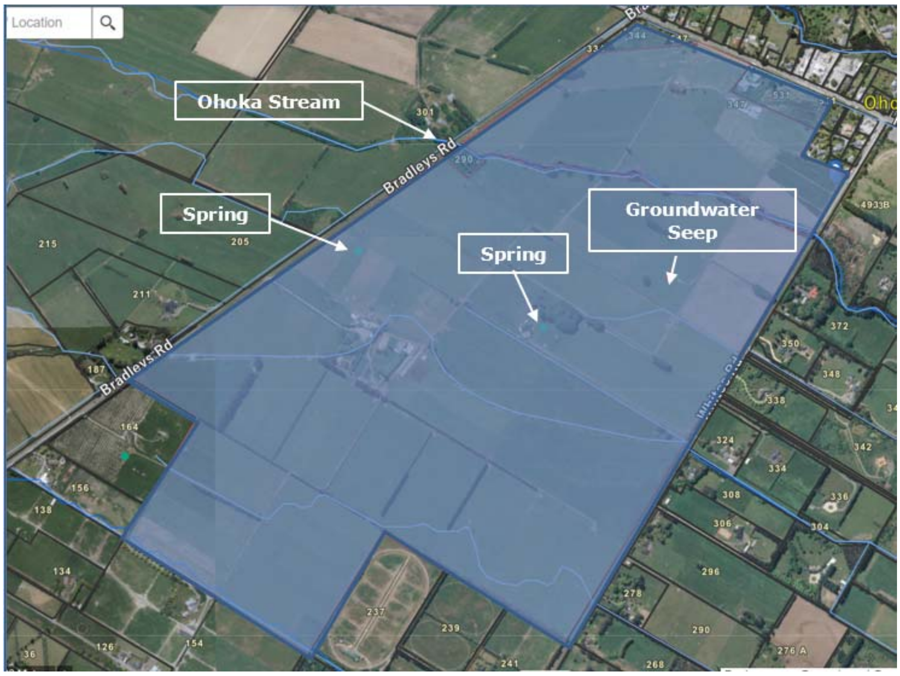
ATTACHMENT 1 – INDIVIDUAL LAND PARCELS AND THE SITE

Details of the Individual Land Parcels

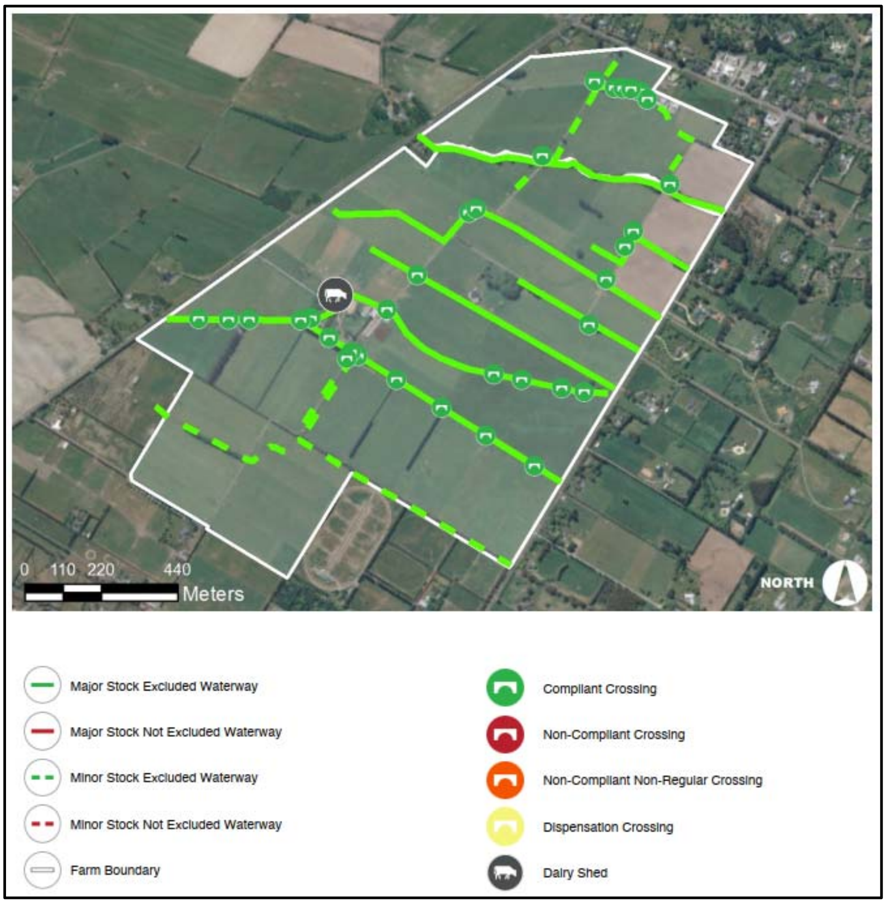
Legal Description	Area (ha)
Lot 2 DP61732	20 (part of Sherraine Holsteins Farm)
Lot 2 DP318615	22.922 (part of Sherraine Holsteins Farm)
Lot 3 DP318615	43.7275 (part of Sherraine Holsteins Farm)
Part Lot 1 DP8301	65.9144 (part of Sherraine Holsteins Farm)
Lot 1 DP55849	0.4230
Lot 2 DP55404	0.9080
Pt RS 2220	0.0387
Lot 1 DP318615	1.8540
Pt Lot 1 DP 2267	0.1434
Total	**155.931**

Proposed rezoning Area

ATTACHMENT 2 – LOCATION MAPS



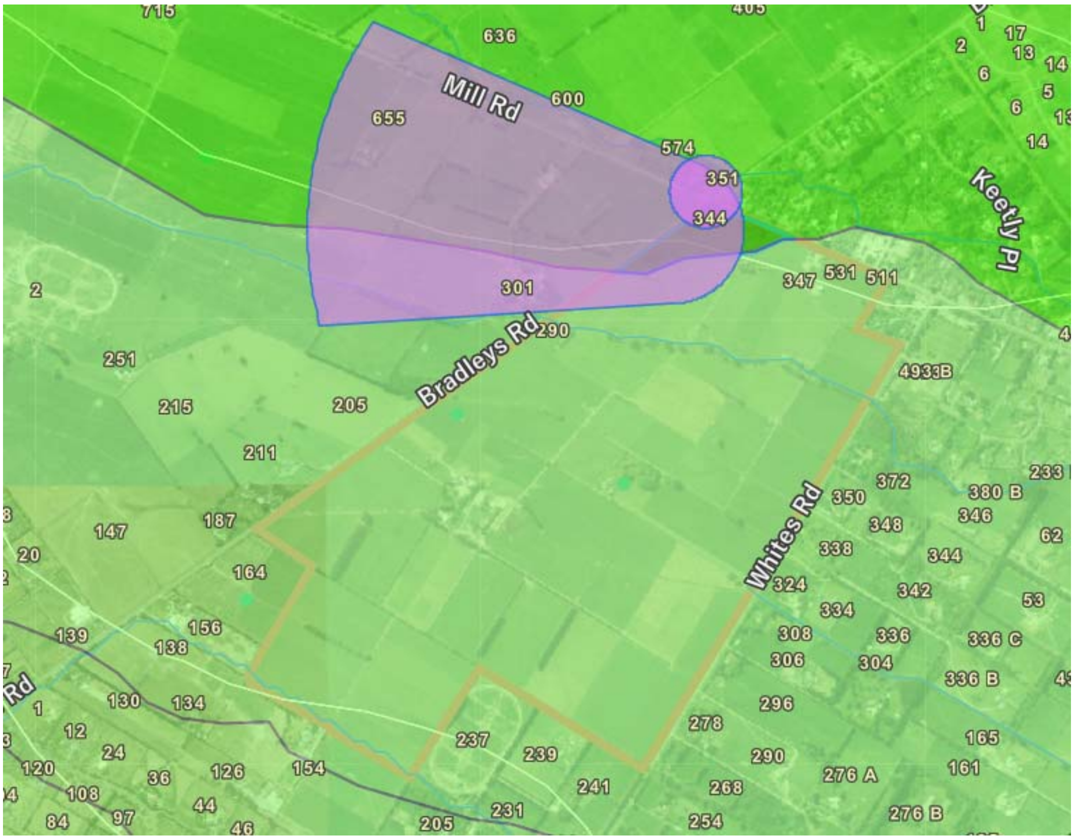
Location of the Drains and Springs Through the Site (Source: Canterbury Maps)



Location of the Drains and Springs Through the Site (Source: Farmsource)[20]

[20] FarmSource. Tiaki Farm Environmental Plan. December 2020.

Current Irrigation Plan (Source- Farm Environment Plan Prepared By Farmsource[21])

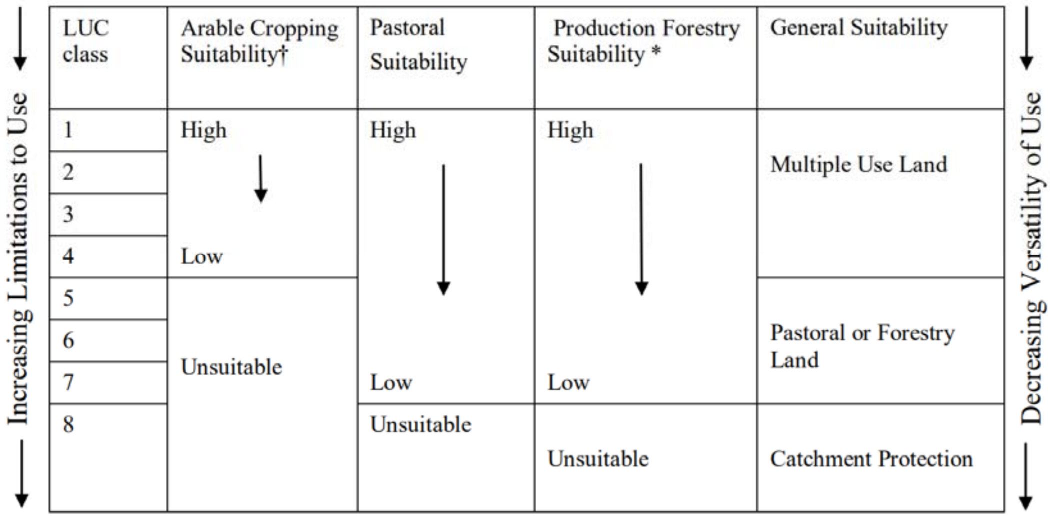


Drinking Water Protection Zones for Wells BX24/0262 and M35/5609

[21] FarmSource. Tiaki Farm Environmental Plan. December 2020.

ATTACHMENT 3 – THE NEW ZEALAND LAND RESOURCE INVENTORY (NZLRI)

The figure below shows the potential land uses and the relationship between the versatility and LUC classes. High Class/versatile soils are defined as Class 1, 2, or 3 soils as delineated by the New Zealand Land Resource Inventory (New Zealand Soil Bureau amended 1986).



Relationship between the Versatility and LUC Classes (Lynn et al, 2009)

LUC Class Definitions

LUC Class code	***Description***
1	Class 1 land is the most versatile multi-use land with minimal physical limitations to arable use. It is nearly level, has deep easily worked soils and there is practically no risk of erosion. The soils are well drained and not seriously affected by drought. They are usually well supplied with plant nutrients and responsive to applied fertilisers. The climate is favourable for the growth of a wide range of cultivated crops, vineyards and berry fields, pasture, tree crops or production forestry.
2	This is good land with slight limitations to arable use which makes it more difficult to manage than Class 1. Management practices to overcome these limitations are easy to apply. Depending on the limitation, the land can be suitable for many cultivated crops, vineyards and berry fields, pasture, tree crops or production forestry. Limitations may be – a) slight to moderate susceptibility to erosion; b) gentle slopes; c) soils of only moderate depth; d) wetness existing permanently as a slight limitation after drainage; e) occasional damaging flooding; f) unfavourable structure and difficulty in working.
3	This class of land has moderate physical limitations to arable use. These limitations restrict the choice of crops and the intensity of cultivation, and/or make special conservation practices necessary. Depending on the limitation, Class 3 land can be suitable for cultivated crops, vineyards and berry fields, pasture, tree crops or production forestry. Limitations may be – a) moderate susceptibility to erosion under cultivation; b) rolling slopes; c) shallow or stony soils; d) wetness or water-logging after drainage; e) frequent damaging overflow; f) low moisture holding capacity; g) low natural fertility not easily corrected.
4	This land has severe physical limitations to arable use. These limitations substantially reduce the range of crops which can be grown, and/or make intensive soil conservation and careful management necessary. Because of these difficulties, Class 4 land is suitable only for occasional cropping but is suitable for pasture, tree crops or production forestry. Limitations may be – a) moderate to high susceptibility to erosion under cultivation; b) strongly rolling slopes; c) very shallow soils; d) excessive wetness with continued hazard of water-logging after drainage; e) frequent flooding; f) very low moisture holding capacity; g) low fertility very difficult to correct.

LUC Class code	*Description*
5	High producing land unsuitable for arable use, but only slight limitations for pastoral or forestry use
6	Non-arable land with moderate limitations for use under perennial vegetation such as pasture or forest
7	Non-arable land with severe limitations to use under perennial vegetation such as pasture or forest
8	Land with very severe to extreme limitations or hazards that make it unsuitable for cropping, pasture or forestry

LUC Subclasses

LUC subclass modifier	*Description*
e	erosion susceptibility, deposition or the effects of past erosion damage first limits production
w	soil wetness resulting from poor drainage or a high-water table, or from frequent overflow from streams or coastal waters first limits production
s	soil physical or chemical properties in the rooting zone such as shallowness, stoniness, low moisture holding capacity, low fertility (which is difficult to correct), salinity, or toxicity first limits production
c	climatic limitations such as coldness, frost frequency, and salt-laden onshore winds first limits production

LUC Units

LUC unit identifier	*Description*
1 2 :	A number that makes the combined LUC expression unique. It associates and orders polygons below the level of LUC subclass, on the basis of common landform, productive potential, physical limitation and management behaviour

ATTACHMENT 4 – OVERSEER SUMMARY REPORT FOR THE BASELINE

OVERSEER
FARM SUMMARY REPORT

Printed date: 6 Jul 2023, 3:47PM
Printed by: Overseer Sys Admin

SHERRAINE HOLSTEINS LTD - SHERRIFF P & R

347 Whites Rd, Ohoka 7692, New Zealand

Baseline 9-13

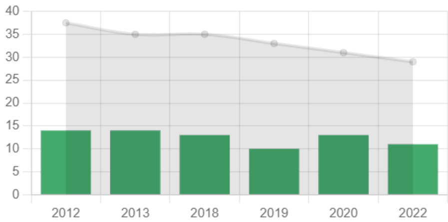
Analysis type	Scenario
Model version	6.5.2

FARM MAP

FARM TRENDS

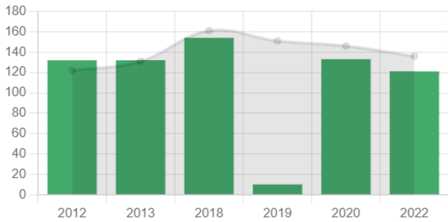
The farm value represents the farms Year End analyses results for each year. The median value represents the current mid-point of the data from Year End analyses in the OverseerFM database.

N loss (kg/ha)



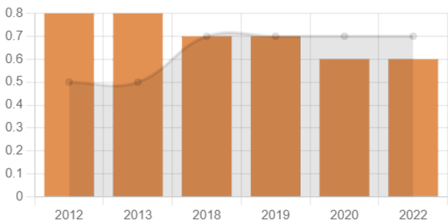
YEAR	FARM	MEDIAN
2012	14	37.5
2013	14	35
2018	13	35
2019	10	33
2020	13	31
2022	11	29

N surplus (kg/ha)



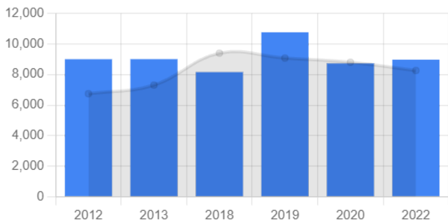
YEAR	FARM	MEDIAN
2012	132	122
2013	132	131
2018	154	161
2019	10	151
2020	133	146
2022	121	136

P loss (kg/ha)



YEAR	FARM	MEDIAN
2012	0.8	0.5
2013	0.8	0.5
2018	0.7	0.7
2019	0.7	0.7
2020	0.6	0.7
2022	0.6	0.7

GHG (kg eCO2/ha)



YEAR	FARM	MEDIAN
2012	8,999	6,742
2013	9,003	7,308
2018	8,154	9,395
2019	10,761	9,077
2020	8,725	8,802.5
2022	8,967	8,260

GREENHOUSE GAS EMISSIONS

	BASELINE 9-13
Total GHG emissions (CO2-e tonnes/yr)	1,366.8
Methane (CO2-e tonnes/yr)	901.1
N2O (CO2-e tonnes/yr)	236.5
CO2 (CO2-e tonnes/yr)	229.2

CO2-e FOOTPRINT

	BASELINE 9-13
Dairy (kg/cow)	7,603

NUTRIENTS

		BASELINE 9-13
Nitrogen	Total loss (kg)	2,183
	Loss/ha (kg/ha)	14
	NCE (%)	28
	N Surplus (kg/ha)	132
Phosphorus	Total loss (kg)	114
	Loss/ha (kg/ha)	0.8
	P Surplus (kg/ha)	14

NITROGEN

Nutrients are brought onto the farm and taken up by plants that are eaten by animals. Animals move around the farm and deposit nutrients in the form of urine and dung. Nutrients are removed in the form of products (meat, crops and milk). The difference between the nutrients added and products removed is the N surplus. Remaining nutrients undergo various biological processes, are lost to the atmosphere and when drainage occurs may leach or runoff from the farm.

ADDITIONS 183 kg/ha – PRODUCTS 52 kg/ha = TRANSFERS 46 kg/ha + LOSS TO AIR 71 kg/ha + OTHER LOSSES 15 kg/ha

1 - Nitrogen surplus is total additions minus product removed (131 kg/ha)

2 - The numbers in the nutrient budget have been rounded and so may not balance exactly

NITROGEN BROUGHT ONTO FARM

Nutrients added to the farm via supplements, climate, fertiliser and effluent.

		BASELINE 9-13
Irrigation	Nutrients from irrigation. Nutrient concentration is define for each system.	11
Fertiliser, lime and other	Nutrients added to the farm in fertiliser. Includes synthetic, organic, lime and imported pig/dairy effluent.'	64
Rain/clover fixation	Nutrients from rainfall and fixation of atmospheric nitrogen by legumes/clover.	85
Supplements	Nutrients from supplements imported onto the farm.	23
Total		183

NITROGEN REMOVED AS PRODUCT

Nutrients removed from the farm as product and as supplements. The difference between this and nutrients added is then susceptible to leaching or runoff from the farm.

		BASELINE 9-13
As product	Nutrients leaving the farm as product (crops, milk, meat etc.).	52
Total		52

TRANSFER OF NUTRIENTS

The biological processes that change nutrients available on farm. These nutrients are not taken up by plants and so are removed from the nutrient pool. Also includes the balance of the nutrients in supplements that are transferred to/from storage.

		BASELINE 9-13
Organic pool	Minerialisation plus immobilisation. Mineralisation (decomposing organic nutrients from cultivation of crops) adds nutrients and so is a negative number, immobilisation (nutrients taken up by soil organisms) removes nutrients and so is positive. If more is mineralised than immobilised the number is negative.	41
Inorganic soil pool	Change in plant available nutrients based on soil tests.	11
Root and stover residuals	Difference in nutrient amount between the beginning and end of the year in stolons and roots added as residue.	3
Standing plant material	Difference in nutrient amount between the beginning and end of the year in the standing crop.	-9
Total		46

NITROGEN LOST TO THE ATMOSPHERE

The nutrients lost into the atmosphere through volatilisation and denitrification.

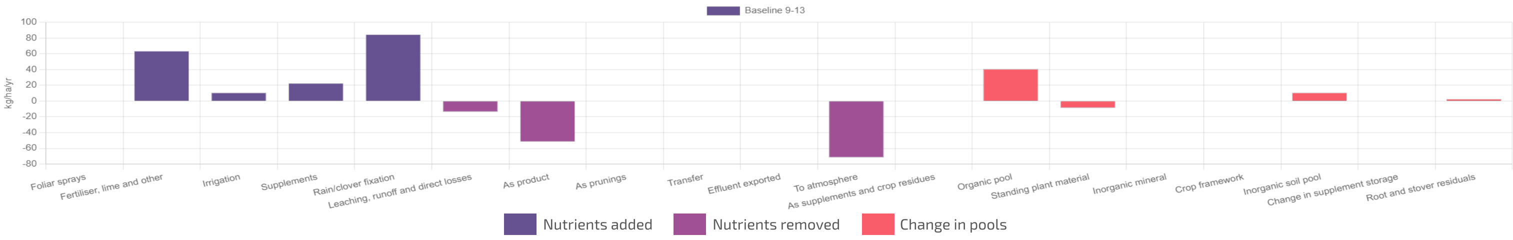
		BASELINE 9-13
Denitrification - background	Background conversion of nitrate to nitrogen gas.	10
Volatilisation - other	Background loss of nitrogen to the atmosphere as ammonia.	21
Volatilisation - urine	Loss of nitrogen in urine to the atmosphere as ammonia.	27
Denitrification - urine	Conversion of nitrate from urine to nitrogen gas.	10
Volatilisation - fertiliser	Loss of nitrogen in fertiliser to the atmosphere as ammonia.	3
Total		71

OTHER NITROGEN LOST FROM THE FARM

The nutrients lost from runoff, leaching or directly into water. This is where the excess nutrients runoff or drain from the farm due to water movement (drainage), or are deposited directly into water ways.

		BASELINE 9-13
Leaching - urine patches	Nutrients from urine that has leached below the root zone.	6
Leaching - other	Nutrients from other sources (not urine) that has leached below the root zone.	9
Total		15

NITROGEN MOVEMENTS



PHOSPHORUS

Nutrients are brought onto the farm and taken up by plants that are eaten by animals. Animals move around the farm and deposit nutrients in the form of urine and dung. Nutrients are removed in the form of products (meat, crops and milk). The difference between the nutrients added and products removed is the P surplus. Remaining nutrients undergo various biological processes, are lost to the atmosphere and when drainage occurs may leach or runoff from the farm.

ADDITIONS		PRODUCTS		TRANSFERS		LOSS TO AIR		OTHER LOSSES
22 kg/ha	−	9 kg/ha	=	14 kg/ha	+	0 kg/ha	+	0.8 kg/ha

1 - Phosphorus surplus is total additions minus product removed (13 kg/ha)

2 - The numbers in the nutrient budget have been rounded and so may not balance exactly

PHOSPHORUS BROUGHT ONTO FARM

Nutrients added to the farm via supplements, climate, fertiliser and effluent.

		BASELINE 9-13
Fertiliser, lime and other	Nutrients added to the farm in fertiliser. Includes synthetic, organic, lime and imported pig/dairy effluent.'	17
Supplements	Nutrients from supplements imported onto the farm.	5
Total		22

PHOSPHORUS REMOVED AS PRODUCT

Nutrients removed from the farm as product and as supplements. The difference between this and nutrients added is then susceptible to leaching or runoff from the farm.

		BASELINE 9-13
As product	Nutrients leaving the farm as product (crops, milk, meat etc.).	9
Total		9

TRANSFER OF NUTRIENTS

The biological processes that change nutrients available on farm. These nutrients are not taken up by plants and so are removed from the nutrient pool. Also includes the balance of the nutrients in supplements that are transferred to/from storage.

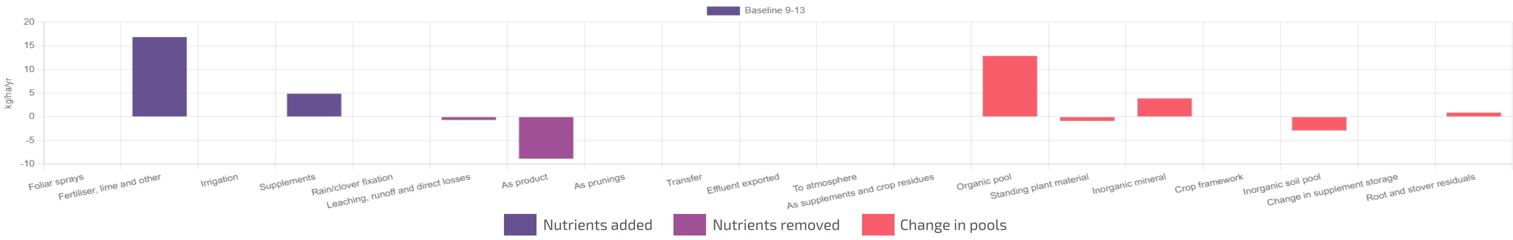
		BASELINE 9-13
Inorganic mineral	Nutrients adsorbed on (adhered to) clay minerals and undissolved lime.	4
Organic pool	Mineralisation plus immobilisation. Mineralisation (decomposing organic nutrients from cultivation of crops) adds nutrients and so is a negative number, immobilisation (nutrients taken up by soil organisms) removes nutrients and so is positive. If more is mineralised than immobilised the number is negative.	13
Inorganic soil pool	Change in plant available nutrients based on soil tests.	-3
Root and stover residuals	Difference in nutrient amount between the beginning and end of the year in stolons and roots added as residue.	1
Standing plant material	Difference in nutrient amount between the beginning and end of the year in the standing crop.	-1
Total		14

OTHER PHOSPHORUS LOST FROM THE FARM

The nutrients lost from runoff, leaching or directly into water. This is where the excess nutrients runoff or drain from the farm due to water movement (drainage), or are deposited directly into water ways.

		BASELINE 9-13
Runoff	Nutrients lossed during runoff (over land).	0.5
Leaching - other	Nutrients from other sources (not urine) that has leached below the root zone.	0.3
Total		0.8

PHOSPHORUS MOVEMENTS



PHYSICAL CHARACTERISTICS

		BASELINE 9-13
Land area	Farm area (ha)	**152.2**
	Productive block area (ha)	**146.2**
Climate	Average temperature (°C)	**11.7**
	Average rainfall (mm)	**648**
	Average PET (mm)	**907**

FARM SOILS

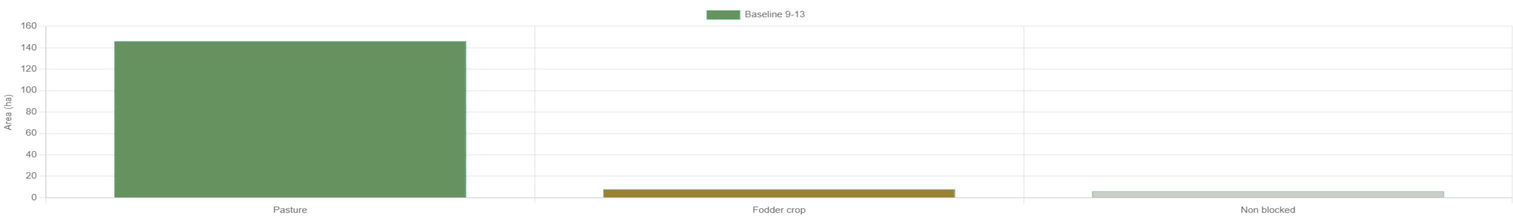
		BASELINE 9-13
Sedimentary/Gley Ayre_2a.1	Area (ha)	**87.2**
	Properties modified	**Yes**
Sedimentary/Gley Ayre_2a.1	Area (ha)	**87.2**
	Properties modified	**Yes**

1 - Olsen P is calculated using soil test results, proportioned by the area of the farm that this soil covers.

BLOCK TYPES

		BASELINE 9-13
Pasture	Area (ha)	**146**
	Pasture grown (T/DM/Yr)	**1,513**
	Pasture intake (T/DM/Yr)	**1,160**
	Supplements harvested (T/DM/Yr)	**117**
Fodder crop	Area (ha)	**8**
	Pasture grown (T/DM/Yr)	**10**
	Pasture intake (T/DM/Yr)	**9**
Non blocked	Area (ha)	**6**
Total area	**(ha)**	**152**

EFFECTIVE AREA BY BLOCK TYPE



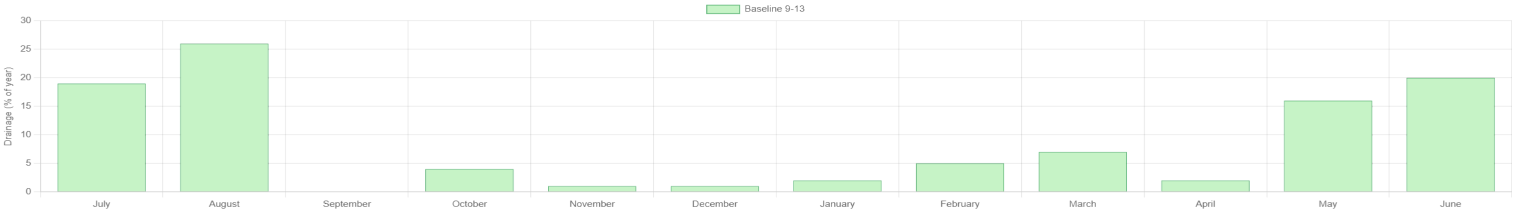
DRAINAGE

Drainage indicates the amount of water draining below the root zone of typical crops or pastures (60cm). Drainage occurs when the amount of water (from rainfall and irrigation) exceeds the water holding capacity of the soil. When water drains it can take any excess nitrogen below this root zone and so risks leaching from the farm into the water table below.

The model uses a 30 year average climate for each block's location. The following graph shows the percentage of annual drainage that occurs each month using this average climate. This provides an indication of when the highest leaching risk is for the farm when under average conditions.

		BASELINE 9-13
Drainage	Average drainage at 60cm (mm)	-
	Nitrogen concentration in water drained (ppm)	-

WHEN DRAINAGE AT 60CM OCCURS



The selected analysis does not contain any wetland information

CROPS

		BASELINE 9-13
Ryegrass/white clover	Area (ha)	**138.2**
	Pasture grown (T/DM/Yr)	**1,430**
	Pasture intake (T/DM/Yr)	**1,095**
	Supplements (T/DM/Yr)	**112**
Maize silage	Area (ha)	**8**
	Yield (T/ha dry matter)	**160**

ANIMALS

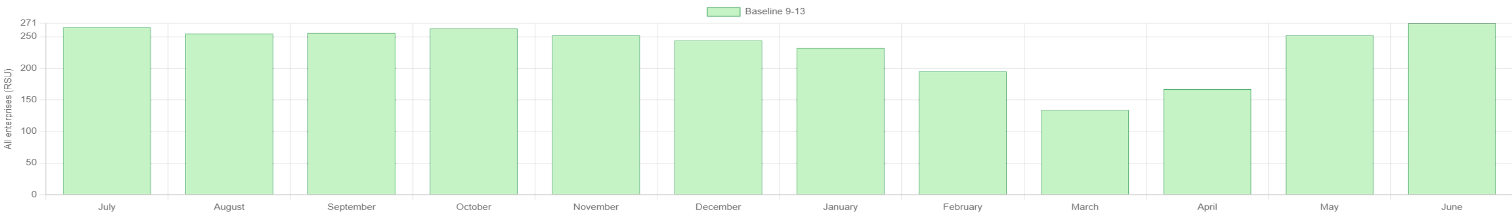
		BASELINE 9-13
RSU	Total RSU (RSU)	2,783
	RSU per farm area (RSU)	18.29
	RSU per productive area (RSU)	19.04
Production	Total liveweight brought (kg/ha grazed)	93
	Total liveweight reared (kg/ha grazed)	109
	Total liveweight sold (kg/ha grazed)	197
	Milk production per cow (kg milk solids / cow)	561.8
	Milk solids (kg/ha grazed)	692
	Milking herd size (peak cows/ha grazed)	1.2

ENTERPRISE RSU

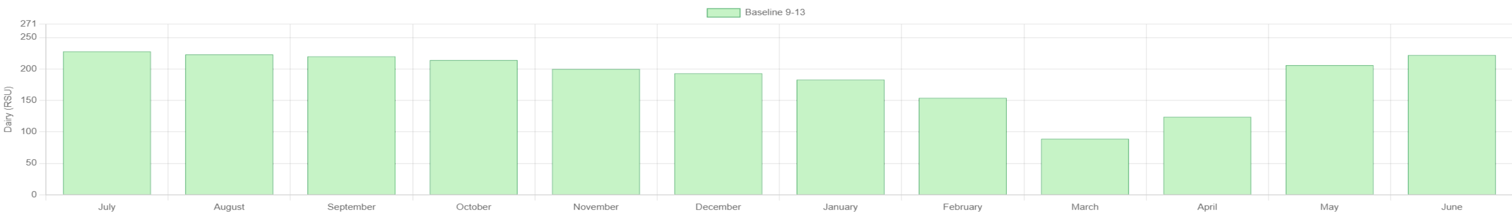
		BASELINE 9-13
Dairy	Total RSU (RSU)	2,253
	RSU per farm area (RSU/ha)	14.8
	RSU per grazed area (RSU/ha)	15.41
Dairy replacements	Total RSU (RSU)	530
	RSU per farm area (RSU/ha)	3.48
	RSU per grazed area (RSU/ha)	3.62

ENTERPRISE RSU BY MONTH

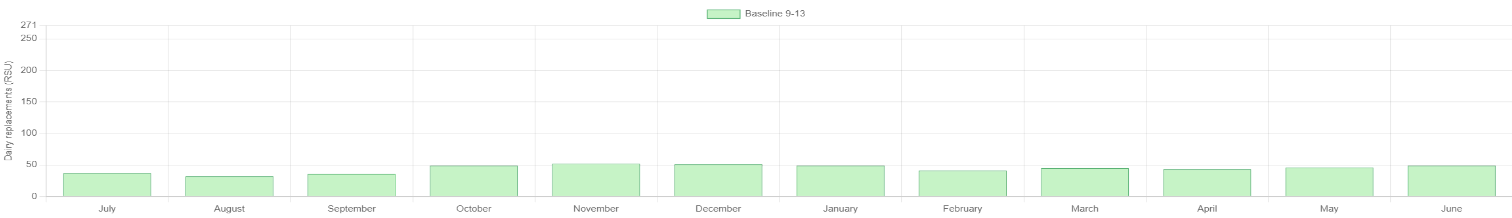
ALL ENTERPRISES (RSU)



DAIRY (RSU)

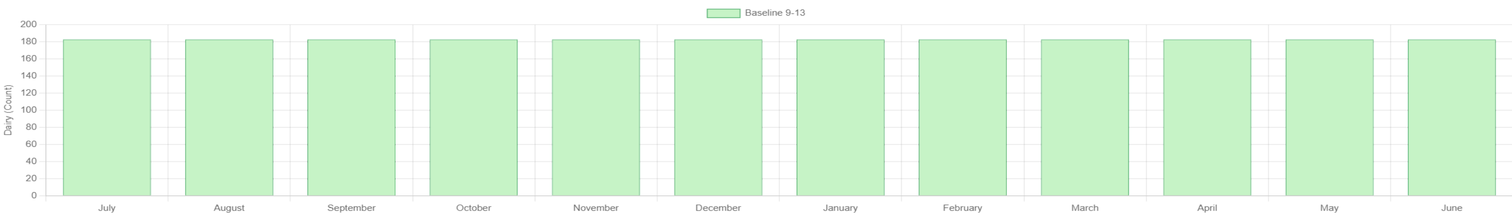


DAIRY REPLACEMENTS (RSU)

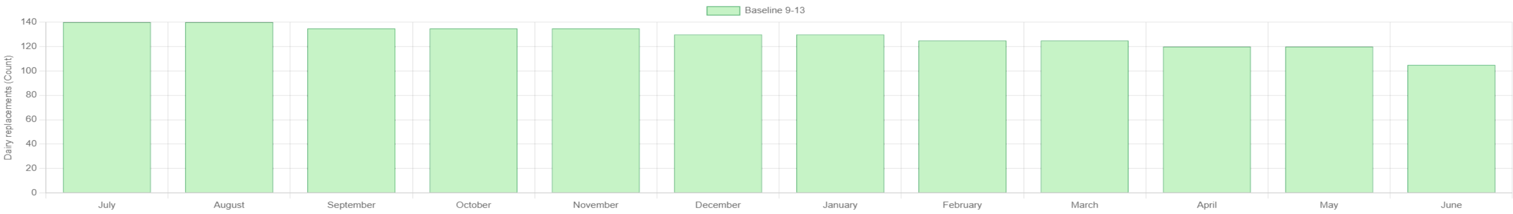


ENTERPRISE STOCK NUMBERS BY MONTH

DAIRY (COUNT)



DAIRY REPLACEMENTS (COUNT)

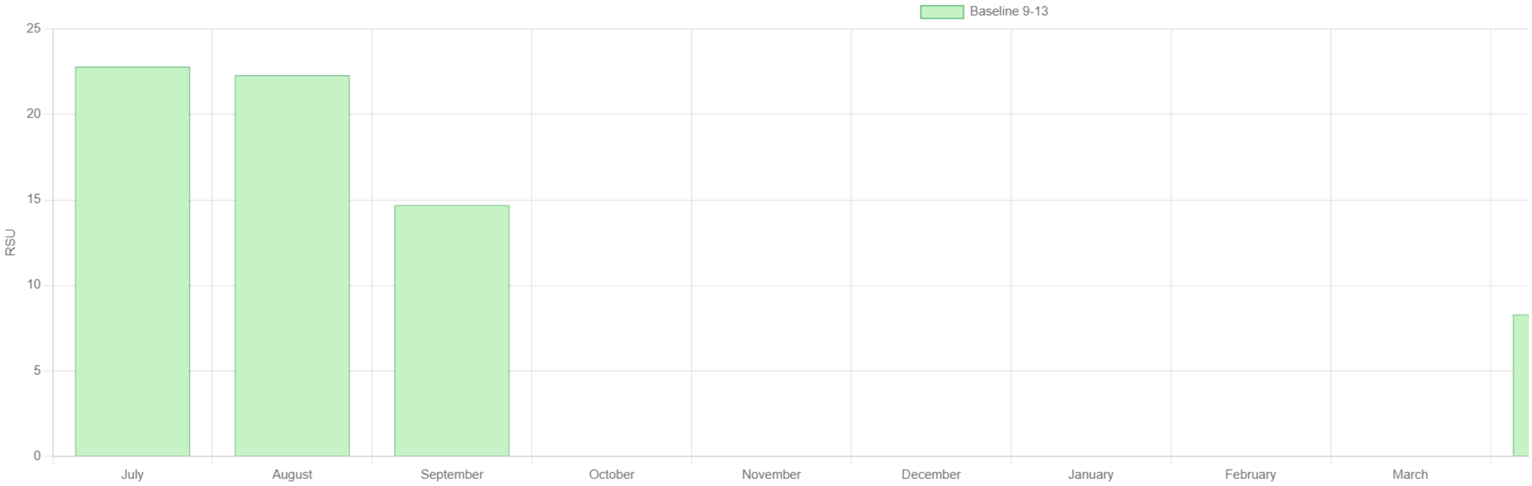


STRUCTURES

		BASELINE 9-13
Feed pad - Dairy	RSU on structure (RSU)	110.8
Covered wintering pad/shelter - Dairy	RSU on structure (RSU)	280.6

STRUCTURE RSU BY MONTH

FEED PAD - DAIRY



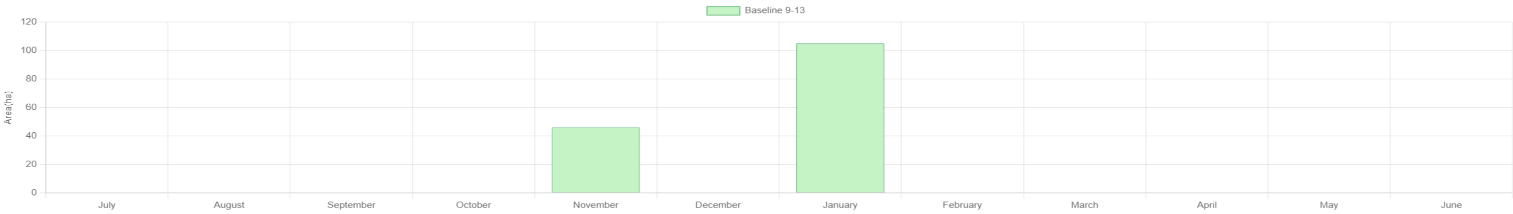
COVERED WINTERING PAD/SHELTER - DAIRY

EFFLUENT

		BASELINE 9-13
Area receiving liquid	Total area (ha)	54
	Pastoral area receiving liquid (ha)	54
	% of farm pastoral area (%)	39
	Average liquid effluent (N/ha/yr)	41
	Average other (N/ha/yr)	17
Source of N in effluent blocks	Effluent from farm dairy (%)	35
	Effluent from Feed pad (%)	18
	Solids (%)	46
Area of farm to apply all effluent to achieve rates of	150 kg N/ha/yr - Liquid (ha)	15
	150 kg N/ha/yr - Solid (ha)	18
	150 kg N/ha/yr - Total (ha)	33
	Maintenance K (ha)	1,286
	100 kg K/ha/yr (ha)	63
	Maintenance K Warning (ha)	63

EFFLUENT SOLIDS BY MONTH

SOLIDS APPLICATION AREA BY MONTH



FEED

		BASELINE 9-13
RSU	Total (RSU)	2,786
	Crops (RSU)	284
	Pasture (RSU)	1,990
	Farm supplements (RSU)	175
	Imported other supplements (RSU)	337

RSU - DAIRY

	BASELINE 9-13
Total (RSU)	2,256
Crops (RSU)	284
Pasture (RSU)	1,460
Farm supplements (RSU)	175
Imported other supplements (RSU)	337

RSU - DAIRY REPLACEMENTS

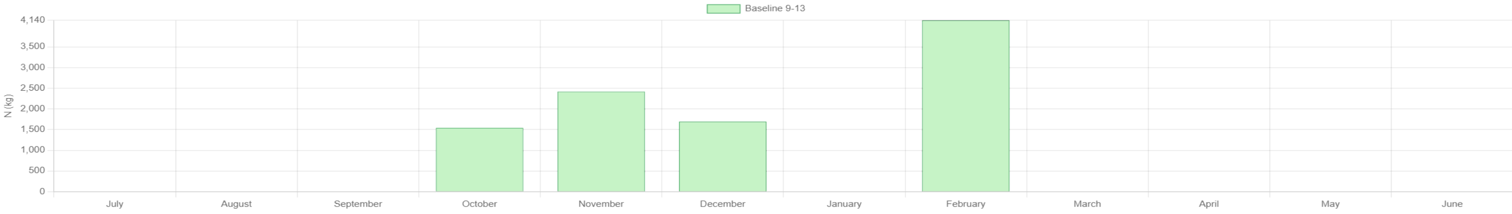
	BASELINE 9-13
Total (RSU)	530
Pasture (RSU)	530

FERTILISER

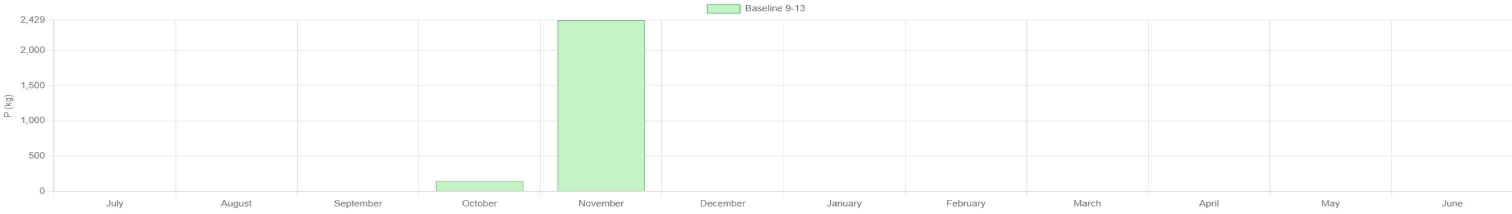
		BASELINE 9-13
Synthetic N	Pasture (kg)	7,749.849
	Pasture (kg/ha)	92
Synthetic N	Fodder crop (kg)	2,032
	Fodder crop (kg/ha)	254
Synthetic P	Pasture (kg)	2,265.713
	Pasture (kg/ha)	27
Synthetic P	Fodder crop (kg)	296
	Fodder crop (kg/ha)	37

FERTILISER NUTRIENTS BY MONTH

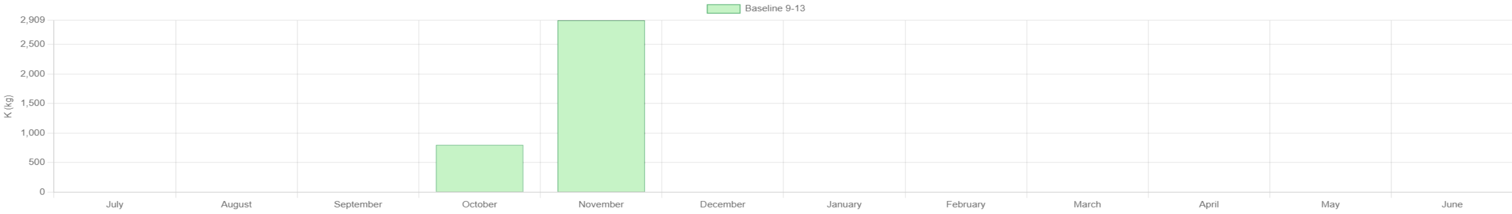
N (KG)



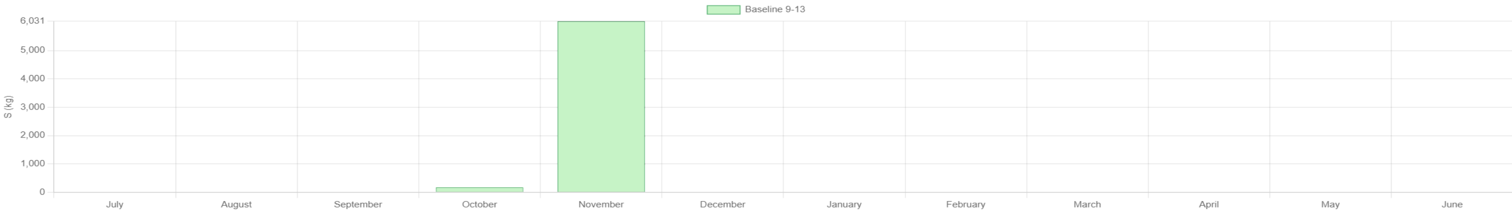
P (KG)



K (KG)



S (KG)



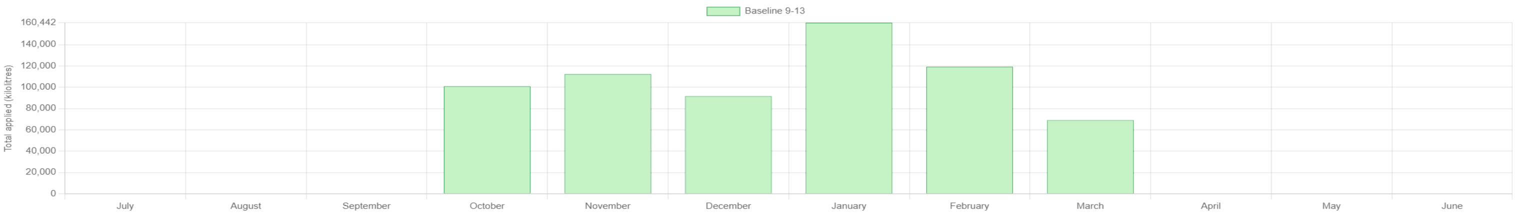
IRRIGATION

	BASELINE 9-13
Total irrigated area (ha)	146.2
Travelling irrigator (ha)	127.8
Spraylines (ha)	18.4

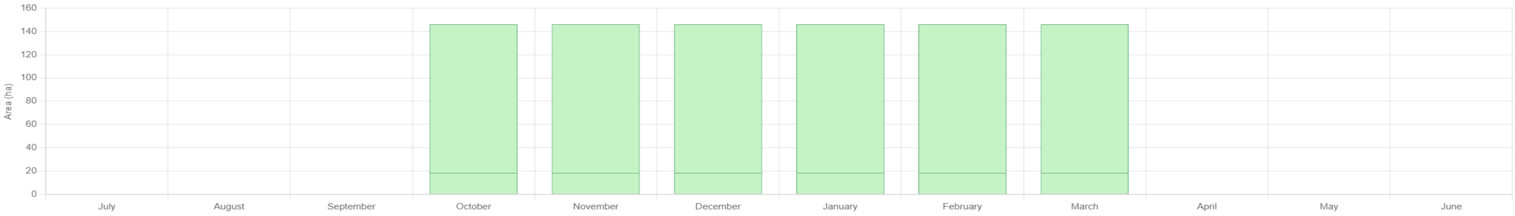
SOIL MOISTURE ASSESSMENT TYPE USAGE	BASELINE 9-13
Trigger point; fixed depth applied (%)	33
Depth applied to achieve target; fixed return period (%)	67

IRRIGATED AMOUNTS BY MONTH

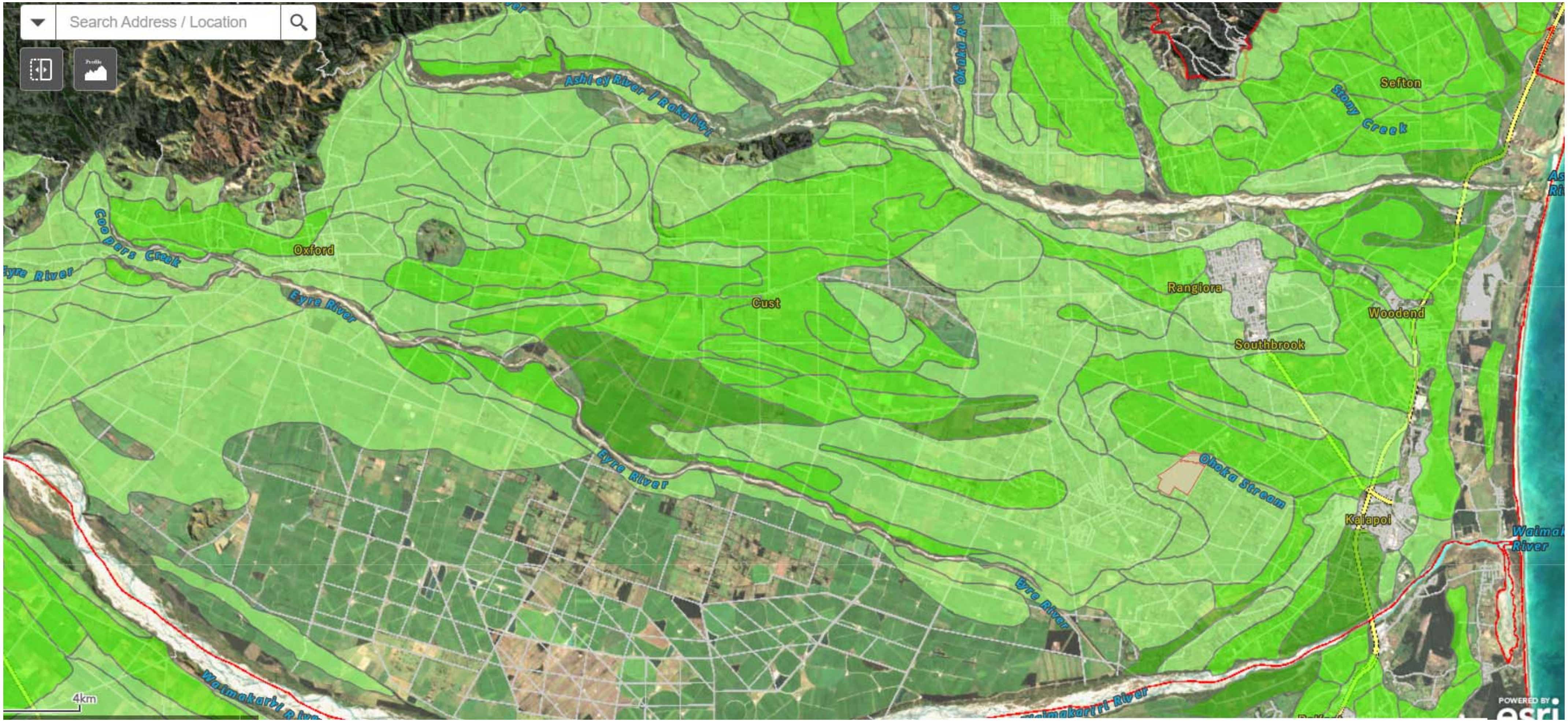
TOTAL APPLIED (KILOLITRES)



IRRIGATED AREA BY MONTH



ATTACHMENT 5 – HPL AREA WITHIN THE WIDER DISTRICT WITH THE SITE MARKED



Search Address / Location
Profile
Ashley River / Rakahuri
Okuku River
Sefton
Stony Creek
Coopers Creek
Oxford
Eyre River
Cust
Rangiora
Woodend
Southbrook
Ohoka Stream
Kaiapoi
Waimakariri River
4km
POWERED BY esri

ATTACHMENT 6 – HPL AREA IN PROXIMITY TO THE SITE AND THE SOILS SIMILAR TO THE SITE